IPCC WGI SR15 Second Order Draft Review Comments And Responses - Chapter 2

Comment No	From Page	From Line	To Page	To Line	Comment	Response
4348					The report mentioned the concept of material efficiency, energy efficiency, end-use efficiency, efficiency improvement many times. Most of them are qualitative description. We suggest to add quantitative description. [Xiangzheng Deng, China]	Due to space limitations we are unable to add additional information on material use. This should be treated in AR6 WGIII.
5848					Stylistically this chapter felt very uneven which made for a hard read. Section 2.3 was most accessible and my recommendation is that redrafts should make efforts to be consistent with that overall style to aid the reader [Peter Thorne, Ireland]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
5850					With the exception of some parts of Section 2.5 none of the statements made in the ES occur in or are easily traceable to the underlying Chapter text. As in comments made on the report as a whole and to Chapter 1 this means that you are making the reader work very hard to understand the lineage underlying the confidence / uncertainty laden statements in the ES. My suggestion is to include all ES language in the underlying text as (sub-section) summaries. This then allows a direct link and also ensures, if done properly taht the text directly supports the final assessment taht is elevated to the ES and on (for a subset) to the SPM. [Peter Thorne, Ireland]	Traceability improved for ES statements.
5852					Almost throughout there is insufficient effort made to discuss the figures and help the reader draw the inferences you wish them to. If including figures, which is good, then the reader needs to be guided in how to draw out the salient aspects you wish them to take away. Sometimes this is done well, but often the figure seems to have been cited in the text almosta s an afterthought. Figures should be (seen to be) integral. If a figure does not support the text in the interests of brevity its inclusion should be queried. [Peter Thorne, Ireland]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
5854					Sometimes the disparity in the availability of scenarios or their assumptions for different conditions being met vis-a-vis limits and overshoots leads to counter-intuitive results arising presumably solely from sampling effects. For example, in Figure 2.17 you end up with a non-intuitive result that the strict condition of never exceeding 1.5C has a larger carbon budget than scenarios allowing overshoot and return. Yet there is no justification given for this counter-intuitive result in the accompaying text. There are other, similar, examples particularly when comparing the range of scenarios consistent with each possible criteria being met that yield equally potentially paradoxical result. Careful attention would be advisable to review all figures and tables to identify any such acses and make sure the associated assessment text explicitly addresses it to avoid reader confusion. [Peter Thorne, Ireland]	We have attempted to address such cases.
5856					It felt to me that Sections 2.3 and 2.4 may benefit from being combined given a degree of similarity in structure and resulting overlap in aspects of the text. [Peter Thorne, Ireland]	2.3 and 2.4 reframed to avoid overlap
5878					I feel as a reader that it would have helped me enormously in interpreting the chapter as a whole if it had started with rather than finished with Section 2.6. Many of the aspects covered in Section 2.6 are critical to reader comprehension of what came before. Therefore consideration should be given to whether all or at least critical aspects of Section 2.6 should be elevated to come directly following the ES. If so, some redrafting may be required. [Peter Thorne, Ireland]	Revised to move much of 2.6 to start.
9126					The discount rate discussion which begins on page 97 must be much more rigorous, with the reasons for chosing a lower social discount rate for the purposes of this report of 1-2% real much more fully elaborated. It is a very inadequate discussion currently. The section does not even mention that one of the primary reasons why a social discount rate should be used for any and all economic analysis in this report is that in this way considerations of inter-generational equity can be incorporated in the resultant pathways derived. Shockingly the term "inter-generational equity", and the issues that it represents, are not even mentioned once in all of Chapter 2. This is totally unprofessional and unacceptable on the part of the authors of this chapter, and the same is true of the discussion in the SPM. Page 108, lines 20-24 make it clear that the use of an inappropriately high 5% discount rate can change the time-dependence of emissions reductions, because the investment in renewable resources are pushed back in time. This is one reason why the proper choice of the discount rate matters so much. Furthermore, the existing text and sentence from lines 24-26 on page 108 completely mis-interprets the material in Rogelj, et.al., 2013, and the supplementary material for this article. This is really the only reference used to defend that hypothesis that a reduction in the discount rate from 5% to a social discount rate such as 1-2% would have a relatively minor impact on the resultant mix of electricity supply technologies, including negative emissions technologies. But, unfortunately, this sentence on page 108 is false. [Richard Rosen, Germany]	Discount rate information included in technical annex (values ranged from about 2 to 8%, so indeed span a fairly broad range). Issues of intergenerational equity are addressed in ch 5.
11698					We have made a considerable number of comments on this chapter and suggested areas for improvement. However we would like to note that this is a very helpful chapter overall and represents a lot of hard work (both in terms of the chapter itself and the underlying analysis) for which we are very appreciative. Hopefully the comments can help improve it further. [United Kingdom (of Great Britain and Northern Ireland)]	thank you
19128					I commend the authors for a significantly improved manuscript. Consistency across the chapters and with the SPM has increased but there remains a few areas of concern. [Olivier Boucher, France]	Thank you.
29664					Overall a well balanced chapter on CCS aspects, positive and negative, in context with other mitigation options. Good use of International Journal of Greenhouse Gas Control Special Issue (2015) as a key source of information for updating the IPCC Special Report on CCS (2005). [Tim Dixon, United Kingdom (of Great Britain and Northern Ireland)]	Thank you.
32324					All of my comments made in my review of Chapter 2 for the First Order Draft have been adequately addressed by the authors for the Second Order Draft, thank you. [Aaron Glenn, Canada]	Good to hear.
33500					The chapter neglects much talk about biodiversity and ecosystems which are likely to be impacted with differing land uses from differing 1.5C pathways. This should be recognised in the Executive Summary, Section 2.3.3.2 and Section 2.4.4 [Stephen Cornelius, United Kingdom (of Great Britain and Northern Ireland)]	These topics are addressed in Ch 4

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11700					General comment on chapter - this was included in overarching comments on entire report but we want to make sure that it is captured at chapter level too - The role of bioenergy and land based CDR is not clear. This is a crucial issue that will receive a lot of attention, yet the main messages are not clearly communicated and there is no sense of an overall perspective on feasibility. There are no scenarios without major implications for land use, yet it is not clear in the SPM or executive summary for Chapter 2 that even if we do not go down a BECCS route, that bioenergy will be operating on a vast scale (the largest form of renewables in many scenarios). The feasibility of this large scale adoption of bioenergy and/or BECCS is skirted around - challenges are mentioned, but fundamentally no clear picture emerges. It would be very helpful to have a clear and objective look that lays out all of the benefits and risks of these technologies. Additionally, there is no robust description to an alternative if the sustainability concerns around BECCS and bioenergy means they are not feasible (at the scale assumed in the scenarios). Beyond reduced demand, what are the alternatives? Policy makers need to know whether 1.5C (2C) is out of reach should these technologies not be available at scale. None of these issues are sufficiently clearly articulated. The feasibility of BECCS is likely to be an issue on which the SR is scrutinised carefully and a lack of clarity on these issues risks undermining the credibility of the report. [United Kingdom (of Great Britain and Northern Ireland)]	Accepted - Clarity has been enhanced in the following ways: (1) Section 2.3 of the Final Government Draft (FGD) will include a box highlighting system dynamics of restricting BECCS, which responds to the demand for being clear what it means for the mitigation pathway (and land use) if for whatever reason we do not go down a BECCS route. This is done with the aim of elevating the conclusion to the SPM. (2) On the feasibility of BECCS/bioenergy, the individual options are assessed in 4, with impacts also assessed in chapter 3. More efficient cross-referencing to the respective sections, so that this (complementary) information is at hand, yet does not need to be repeated in the light of our space constraints in this chapter.
11702					General comment on chapter - this was included in overarching comments on entire report but we want to make sure that it is captured at chapter level too - A clearer narrative and use of global carbon budgets is required. As currently written, the budget concept is confusing and it is not sufficiently clear what new policy focused messages have emerged. A focused narrative that describes what a carbon budget is, why the concept is useful, how the specific numbers have been derived, where uncertainties emerge from, the significance of the broad range and what the key findings are from the latest values is needed. As it stands, the discussion in Chapter 2 is confused, inconsistent and does not present a strong message to policy makers. It is particularly important the carbon budget concepts are clearly articulated that it forms the basis of the rationale for net zero emissions and immediate action, and given the focus on this area of the debate after the publication of Millar et al. [United Kingdom (of Great Britain and Northern Ireland)]	Carbon budget section rewritten to be clearer and easier to follow.
11704					General comment on chapter - this was included in overarching comments on entire report but we want to make sure that it is captured at chapter level too - There are regularly inconsistencies between chapters, in particular between Chapter 2 and 4. These appear to have been written in parallel, rather than one informing and providing the basis for the other (for example, the scenarios of chapter 2 do not appear to have been used in any great detail in the feasibility discussion in chapter 4). We also provide a number of examples of numerical inconsistencies. We recognise and appreciate the limited amount of time available to produce the report, but for the next draft it is important that these inconsistencies are removed and that the chapters are truly integrated and complement and inform each other. [United Kingdom (of Great Britain and Northern Ireland)]	We have attempted to reconcile inconsistencies between the two chapters.
11706					General comment on chapter - this was included in overarching comments on entire report but we want to make sure that it is captured at chapter level too - It would be helpful to have greater clarity on the difference in mitigation efforts between 1.5C and 2C. There are points made in this respect (e.g. greater balance on rapid emission reduction than on additional CDR) and they are clear and well made in isolation and Chapter 2 has useful material on the specific elements on 1.5C pathways (but not this is not necessarily explicitly compared against 2C). However it could be improved if there were a single focused summary that draws together all of the different themes. This would be a very helpful narrative for policymakers. The SPM may be an apppriate place, or perhaps a dedicated box in Chapter 2. [United Kingdom (of Great Britain and Northern Ireland)]	Considered for SPM. In ch 2 there is indeed a lot of discussion on 1.5 vs 2C, so this seems well addressed.
40122					This Executive Summary does an excellent job of conveying the (sometimes) complicated elements of mitigation measurements and action into an understandable narrative. The authors are to be commended. [Ko Barrett, United States of America]	thank you
46480					Chapter length estimate is 50.9 IPCC pages (10.9 over the 40 page limit agreed by the IPCC panel). This estimate does not include figures, tables, references, FAQs, and cross-chapter boxes but does include chapter-boxes and main text and the executive summary. Please find areas of the chapter than can be edited down to reduce the length of the final chapter draft. [Sarah Connors, France]	shortened
46614					Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted.
47254					Comment submitted by Afra Hamid (afra_hamid@yahoo.com) via the TSU: Add a paragraph related to adaptation [Sarah Connors, France]	This is covered in later chapters of the SR, and given space limitations we do not have room to add more here.
51124					On the treatment of CDR requirements in scenarios, quoting from Cross-Chapter Box 3.1: "Indeed, scenarios that limit end-of-century warming to below 1.5°C are available that use no (Grubler et al.; van Vuuren et al.) or annual amounts of less than 1.5 GtCO2 yr-1 (Bertram et al.; van Vuuren et al.) – the lower end of the assessed potential range, see Table 1 – in 2050. (...) Because scenario design (which is determined by the research question that is explored) determines to a large degree the deployment of BECCS in scenarios, averaging over an arbitrary selection of scenarios does not contain much valuable information." (p. 3-175) [Linda Schneider, Germany]	This is indeed what the SOD stated.
54512					Further to my previous comment, the emphasis put on BECCS appears undue an exaggerated, since the technology does not yet exist. In fact, several measures for climate mitigation by land use management appear superior to bioenergy, which do not seem appropriately represented. [Miguel Brandão, Sweden]	Multiple types of land-use related measures are included, not only BECCS, and this is clarified in the chapter.
11708					General comment on chapter - this was included in overarching comments on entire report but we want to make sure that it is captured at chapter level too - It would be helpful to provide greater clarity on the strengths and limitations of Integrated Assessment Models. The role of SSPs in driving and influencing the scenarios needs to be expanded and made more transparent, along with a fuller description of exactly why the reliance on BECCS/CDR emerges in models. Beyond this the main messages from the helpful discussion in 2.6.1 should be more clearly communicated to policy makers - for example to highlight what is missing from IAMs and how this may make the mitigation challenge easier or harder. The main overarching messages of the report are very heavily based on IAMs and a it would be helpful to be more open about the strengths and limitations (i.e. a general sense of the full uncertainty space). What would be helpful would be a clearer sense of how the quantitative results of IAMs emerge to form the high level statements/numbers of the report. [United Kingdom (of Great Britain and Northern Ireland)]	The Annex to ch 2 now provides additional analysis of the strengths and limitations of the models.

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19112					There is a general lack of consideration of the effect of decreasing emissions of (cooling) aerosols in this chapter and in the report in general. Decreasing aerosol emissions could result in a substantial rapid warming that would last several decades. There is a limited amount of literature on the subject, yet this cannot be ignored. Emissions of black carbon from kerosene lamps (page 7, line 3) seem a lot more anecdotal than the real possibility of a substantial decrease in emissions of sulfate, nitrate and OC aerosols in a highly-mitigated world. The combination of an aerosol forcing in the lower part of the range (ie more negative aerosol forcing) and a climate sensitivity in the upper part of the range could result in a >1 K warming upon cessation of aerosol emissions ! [Olivier Boucher, France]	The impacts of a decrease in cooling aerosols are included in all the assessed pathways, and have been called out more clearly in the revised chapter.
32696					This is a general comment that is relevant to large sections of Chapter 2. Often the text makes it seem like there were a group of scenarios that were compatible with hiting a target of 1.5 degrees C or 2.0 degrees C by 2100 that modelers happened to discover, and then the text describes their characteristics, such as there were X number of overshoot scenarios or Y number of non-overshoot scenarios. This kind of presentation, of course, is highly deceptive. The scenarios published in the literature, and, especially, those reported in Chapter 2 were chosed to be run and discussed by the members of research teams that use certain integrated assessment models. So the distribution of the kinds of results, e.g. overshoot or not, is caused by decisions that these research teams made. Thus, the fact that almost all pathways or scenarios reported in Chapter 2 is not a consequence of anything except that choices that the IAM modelers made as to which types of scenarios they desired to produce. That is why most scenarios contain huge amounts of negative emissions technologies of various sorts, especially after 2050 to 2100. The modelers chose those results, they did not just "happen". This fact must be made clear to the readers, namely that the distribution of results, and the predominance of overshoot scenarios which rely on very large amounts of negative emissions technologies were the choice of the IAM modelers who both published dozens of research papers, and who were also authors of Chapter 2. [Richard Rosen, Germany]	The IPCC assesses the literature and does not perform its own research. We therefore assess the available scenarios. The chapter includes discussion of how model scenarios are created, and the new Annex in particular discusses at length the strengths and limitations of the IAMs.
35498					The models used/referred in this chapter (and the whole report) only cursorily refer to electricity storage and its use while devoting significant attention to carbon storage, when technology progress for the former is much greater than the latter; and the former is likely to have a much bigger impact on electricity and energy systems in the coming decade or so. It would be good if there is at least some reasons given for this treatment to the two kinds of storage. [Ashok Sreenivas, India]	Technological progress in electricity storage is indeed important for the integration of intermittent renewables. However, due to the limited scope, time and page length available to the chapter team, this has not been discussed here. It should, however, feature in the AR6 WG3 assessment of the energy system.
51104					You should explain the term "likelihood" to not actually refer to likelihood or chance in a probability sense but as a matter of distribution of outcomes across the models, which, given that they differ in their geophysical assumptions, cannot all be correct. Since some models will turn out to be more accurate than others, you should make it clear to policy-makers and readers that this is not an issue of probability but of distribution across models that make different assumptions, e.g. about climate sensitivity. [Linda Schneider, Germany]	They can not all be correct, but the point is that we do not know the exact climate sensitivity so given the state of our knowledge there is a distribution of possible results and the likelihood does represent our estimate of the probability of reaching the target given existing uncertainties. We use the same geophysical assumptions for all models (by putting all emissions through a single set of impact calculations).
54582					terms 'greenhouse gases' and 'GHG' have been used on and off throughout the text. The abbreviation GHG should be used instead. [Qudsia Zafar, Pakistan]	Editorial - will harmonize.
59898					It is critical that the chapter drastically reduce its use of the word "critical." "Critical" implies something must happen or must be done if something else is to occur (here hitting the 1.5°C target by 2100 or earlier). Given current conditions, most of the things that are described as critical will be very difficult to accomplish for economic, political, technical, social, or other reasons – especially on a global scale. So if so many very difficult – many likely impossible – things must happen to hit the 1.5°C target, the obvious question "Why bother?" comes to mind. From an editing perspective, simply delete the word "critical" or phrase "it is critical" and the text will lose nothing in meaning or content. [United States of America]	Editorial - some uses appropriate, some revised.
59900					The concept of "sustainable development" is a central theme of this chapter, but it is never explicitly defined. If "sustainable development" is defined elsewhere in the document, the location should be referenced after the term first appears in the text (page 2-9, line 8). If not defined elsewhere, a Box should be added to the chapter describing for readers what the authors mean by "sustainable development." [United States of America]	Editorial - defined in glossary that any reader can look up. Not standard to refer to glossary every time an entry is first used.

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32698					Another fatal flaw in asking policy makers to rely on the results of any of the pathways to 1.5 or 2.0 degrees C that include substantial amounts of negative emissions technologies is that the chapter and the referenced research papers do not include vital information for policy makers to see before they could justifiable find any of the results for these kinds of scenarios credible and possible to implement. In particular, the need for transparency requires that tables be inluded in chapter 2 that contain all the key cost and operating parameters that apply to each kind of negative emissions technology used in each IAM. Right now there is not a single table of such critical assumptions to the IAMs in the draft report. This is crazy. To find any scenario that results from running any given IAM credible, policy makers and other readers need to know the assumed capital costs over time for each negative emissions technology, the assumed operating costs, the percentages of the input carbon from fuels that is captured and sequestered underground for each technology, the assumed cost of the input fuels over time, etc. The reader would also need to know if these input assumptions to the IAMs included the costs of building extensive new pipeline system to carry the liquid CO2 to its site of sequestration, and the operating costs and characteristics of these new pipeline systems. The reader also needs to know where the sequestration of this huge amount of CO2 is going to occur, whether or not this will cause earthquakes that will bother the citizens in near by towns, etc., and what is the likelihood that citizens will even approve the sequestration of massive amounts of CO2 near where they live. The authors of Chapter 2 have been totally dishonest with their readers by ignoring all these crucial topics, and by keeping secret all the key assumptions behind each and every scenario that relies on negative emissions technologies. The future of how to mitigate climate change, which is crucial for the world to do, cannot depend on secret assumptions and secret cost effectiveness analyses based on those assumptions. If any real world planner actually presented a climate change mitigation plan to any government based on similar sets of secret assumptions they would be subject to massive lawsuits!!! Thus, as far as I can see, all the scenarios that are described at length in Chapter 2 that are based on significant amounts of investment in negative emissions technologies, are based on a set of secret assumptions and fantasies, none of which policy makers should accept. This major program could be cured, but it would take a massive effort over the next few months. The first step must be to include extensive tables, with careful documentation, of all the assumptions made with regard to negative emissions technologies, especially their capital cost, including the cost of the sequestration system pipeline costs, and leakage rates. Unless the modelers who wrote research papers referenced in Chapter 2 and other chapters are willing to provide those materials quickly to the Chapter 2 authors, the authors of Chapter 2 have no moral choice but to reject describing all scenarios that rely on negative emissions technologies. [Richard Rosen, Germany]	It is correct that IAM and the assumptions feeding into them are important information to better understand scenarios. This IPCC Special Report can here only rely on information available in the literature and to a limited amount carry out additional synthesis work. While the aspects highlighted by the reviewer are of interest and fundamental, they appear to be of a broader nature than a pure 1.5°C pathway context. Without dismissing their importance, but taking into account both the approved scope of this chapter, the timeline and resources available to the chapter, incorporating a full assessment of these issues has not been possible. However, a more elaborated Technical Annex to the chapter now does provide an overview of the mitigation measures considered in by the various IAMs underlying the 1.5°C pathways that are assessed by this chapter. This is still far from the depth of information requested by the reviewer, but hopefully already a first step in providing a clearer insight into the assumptions underlying the assessed scenarios. Unless this information becomes available in the public domain it will be very hard if not impossible for any future assessment to provide the overview of data requested by the reviewer.
51116					The overall framing and summary of Chapter 2 should highlight that 1.5 is scientifically, technologically and economically feasible, yet not without fast and encompassing mitigation action that needs to go beyond what has hitherto been deemed (politically) feasible. It currently gives way to much prominence to risky and currently non-existing CDR technologies, a reliance on which makes 1.5 impossible if they turn out to be unfeasible (for technical, political, social, ecological, economic, ethical reasons or else). It should be made clear to readers that without substantial and immediate climate action, no CDR silver bullet will come in and save the day in the second half of the century. [Linda Schneider, Germany]	We agree with these points, and the chapter does explain that mitigation challenges are very high to meet 1.5C and that most pathways rely on CDR, with attendant risks.
59904					Doesn't this chapter really show the need and value of investing broadly in potential mitigation technologies now (CDR, BECCS, afforestation, biochar, bioenergy, advanced nuclear, clean coal, harvest wood products, etc.)? Since we do not, and cannot, know now which of these can options can be made economical to bring to scale, or over what timeframes, incurring the R&D and scale-up related costs now can significantly expand out response options as it becomes clear we need to do much more to lower emissions. [United States of America]	Agreed, the chapter does show that multiple options are needed.
59906					This chapter needs a thorough edit. [United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
59912					Substantial discussion about optimal carbon pricing occupies section 2.5. However, the premise of the report is that net-zero emissions are either currently required, or will soon be required, to meet warming targets. Given this, would it not be simpler to frame the optimal carbon price as "the price which causes emissions to fall to zero?" Doing so would bypass complex and assumption-laden modeling frameworks, and could – if elected by policymakers – be implemented by simply ratcheting a carbon price up or down based on recent changes in atmospheric composition. [United States of America]	As the 1.5C scenarios reach net zero, this is in effect what they are showing and we need to follow the literature rather than ask groups to redefine their modeling frameworks.
59914					Section 2.5 is largely concerned with policy and economics. It should be titled as such, and should be placed at the beginning, rather than the end, of the chapter. Given that political will and market design are prerequisites of all of the technical changes detailed in the preceding sections, these technical sections could almost be considered appendices, with their relevance conditional on the political, economic, and institutional choices made. [United States of America]	Editorial - we prefer the ordering as is, and note that this is actually the beginning of a longer discussion in Ch 4.
51134					Heck et al. 2018 Biomass-based negative emissions difficult to reconcile with planetary boundaries, Nature Climate Change 8, 151-155 argues that in order to remain within safe planetary boundaries, in particular with regard to freshwater use, biogeochemical cycles, land-use change and biosphere integrity, less than 0.1GtC/yr CDR could be realised via BECCS. Given the SDG context of the present report, IAM scenarios that rely on excessive CDR (>200 GtCO2) should be excluded from consideration as the social, ecological, political, economic and ethical risks and adverse impacts of their technology deployment assumptions make them fundamentally incompatible with sustainable development. [Linda Schneider, Germany]	We do not believe that we are in position to exclude scenarios based on infeasibility given the complex and partially subjective nature of determining that, but we have cited Heck et al and we discuss (as does Ch 4) the SD impacts of CDR deployment and the potential trade-offs.
51148					Chapter 2 must be more transparent about how the scenario range came about and how much the available range is a direct product of the assumptions and choices made by the modelling teams. In particular, the value of discount rate chosen in the scenarios and the preference for CDR technologies over near-term and deeper emission reductions resulting from overly high discount rates (>1-2%, following Stern 2006) needs to be stated clearly. The fact that fewer pathways achieve 1.5 without or with very limited CDR does not per se mean that those scenarios are less likely, but instead indicates that only very few modelling runs were done with the explicit aim of exploring more transformative and safe pathways to 1.5 by eliminating or substantially limiting CDR. That is a grave methodological weakness of the available scenarios and should be communicated accordingly. [Linda Schneider, Germany]	Additional scenarios with less or no reliance on NETs now available, so included in revised chapter. Additional material on modeling choices included in new Technical Annex.

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51154					Given that such emphasis is placed on IAMs, there are important policy decisions associated with the use of key numerical parameters for the scenarios that need to be made transparent. This is especially so because policy makers and the broader public are unaware of the large degree to which the choice of numerical parameters determines the oucome of scenarios. Most importantly, the discount rate has a great impact on what is perceived to be cost-effective mitigation, and a high discount rate will incentivise postponing mitigation investments into the future. A range of discount rates should be modelled to illustrate its importance for the scenario outcomes. Cost-effective mitigation is a societal imperative, not a matter of private profit or loss. [Linda Schneider, Germany]	Discount rate information included in technical annex (values ranged from about 2 to 8%, so indeed span a fairly broad range).
51168					It is crucial to highlight that there are safer and more sustainable ways of removing CO2 from the atmosphere than through technological means. According to Dooley/Kartha (2018), an amount of 370-480 GtCO2 could be removed through forest ecosystem restoration and, to a lesser degree, reforestation. Other ecosystem restoration, such as moors and peatland, can achieve additional CO2 removal. Such ecological options are low- to no-cost, ready to be deployed, tested and proven, safe, provide for adaptation co-benefits and allow for livelihoods, food and water security to be sustained. Given the SDG context of the present report, these options should receive great attention. [Linda Schneider, Germany]	Afforestation/reforestation methods are included in the assessment. Ch 4 addresses the various socio-economic implications of mitigation choices (including these).
53970					ENTIRE CHAPTER: There are several aspects in this chapter that make it extremely limited, biased and unhelpful. Basically, the mitigations option it takes into account are Carbon Pricing, BECCS, Afforestation, Direct Air Capture. All these are ecologically, socially and or economically and technically unfeasible. The Chapter ignores their multiple impacts. References to review and add: https://www.sei-international.org/mediamanager/documents/Publications/Climate/SEI-WP-2016-08-Negative-emissions.pdf ; http://www.biofuelwatch.org.uk/wp-content/uploads/BECCS-report-web.pdf Additionally, it ignores alternatives such as scaling down industrial agri-food system which is one of main single contributors to climate change and massive support for decentralized small scale agroecological adn peasant agriculture and local markets that could have great potential for mitigation and prevention, as well as multiple synergies for sustainable development, particularly in the global South. References to add: https://www.grain.org/article/entries/4357-food-and-climate-change-the-forgotten-link / http://www.etcgroup.org/whowillfeedus [Elenita Daño, Philippines]	Sustainable development implications are touched on in Ch 2 but are primarily covered in Ch 4. Changes in food systems are included in the IAMs, but agreed only partially so we note that aspects of such changes may be on the low side in our assessment and compare with bottom-up literature.
59916					Statements in Chapter 2 refer to the need to reach net carbon neutrality by 2050, but Chapter 2 lacks an explanation of why this is necessary. A clear statement of how this result is derived from the carbon cycle is needed early in the Executive Summary and text for Chapter 2. Essentially, stabilizing the atmosphere at any temperature threshold requires that net carbon dioxide emissions go to zero. [United States of America]	Agreed, but this is already discussed in Ch 1 so does not need repeating in ch 2.
59918					The order of paragraphs in the Executive Summary for Chapter 2 can be improved. As it stands, the second paragraph (in bold letters) sets out an ambitious agenda that is followed by paragraphs with a lot of technical detail. The paragraphs on page 6 under the heading "The role of CO2 emissions and Carbon Dioxide Removal (CDR)" could be moved up to page 4, immediately before the heading "Remaining Carbon Budgets of 1.5°C pathways". This brings discussion of CDR and BECCS earlier into the Executive Summary. [United States of America]	ES greatly revised.
59920					It is important to convey that, even though no pathways have been identified to achieve the 1.5°C goal for a given set of scenario conditions, there may be pathways possible for that scenario. The report is only able to work from scenarios that have been published, and those do not represent all possible pathways (as has been noted in the text). [United States of America]	Agreed, and as the reviewer notes, this is stated in the text.
59922					The authors should be congratulated for preparing an assessment of this scope and level of detail. Nicely done. [United States of America]	thank you
59926					The Integrated Assessment Models (IAMs) used to project 1.5°C scenarios rely heavily on BECCS. However, there appears to be a lack of model runs and potential prejudice against baseload nuclear power. For example, in the US Mid-Century Strategy, nuclear had a roughly equal standing with BECCS as a necessary component of reaching deep decarbonization outcomes past 2050. [United States of America]	Added additional discussion of scenarios with greater reliance on nuclear (e.g. Berger et al), however most published scenarios do not include such a development so it cannot be a major part of our assessment of the literature.
54510					There are severeal references to IAMs but none to Life Cycle Assessment (LCA). It is important to note that in the comparison of alternatives (e.g. Renewable energy technologies) for meeting energy demand within the constraints accepted (<1.5°C increase), LCA has been widely used in policy making for comparing the efficiency of the different technologies. No reference is made in the report to LCA. It is not even properly defined in the Glossary and the terminology used is inconsistent with the most authoritative ones (e.g. ISO 14040-44). [Miguel Brandão, Sweden]	The chapter relies upon IAMs as in order to evaluate consistency with 1.5C it's necessary to have a full representation of the entire set of emission sources and land-use for the entire globe. LCA and bottom-up sector specific analyses are included as a way to shed light on the results from IAMs, but it is not possible to determine if those are 1.5C consistent on their own so those cannot be the centrepieces of the report.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
59896					The statement in section 2.1.3 that the scenarios collected "cover a wide range" is misleading (page 11, line 39-40). The list does not include scenarios in which temperature remains below 1.5°C with at least 66% probability, as stated on lines 28-29. The discussion of scenarios in section 2.2.3.2 (page 25, lines 23-28) does not describe scenarios with limited or no negative emissions. That is a critical omission and should be addressed. In section 2.3.1, the authors again argue that, since the "underlying scenario set covers a wide range of assumptions", this gives a robust indication of the lower limit of remaining fossil fuel and industry emissions. However, despite being wide, the scenario set is incomplete and thus cannot be considered the basis for "robust" conclusions. Moreover, the authors cite only one paper in the literature to complete their argument (Kriegler et al.). While one paper is informative it does not provide the high level of confidence required to make such a statement, particularly a statement that in turn is a critical part of the basis for the high level statement regarding the probability of remaining below 1.5°C, which serves as the final sentence in the final high-level statement in section SPM 1.2 (page 4, lines 6 and 7). It appears that the authors made the decision not to include off-shore wind in their analysis of the feasibility of the required energy transition (Chapter 4, page 83). Refer to the following sources: (i) 2016 Renewable Energy Data Book, December 2017. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy; (ii) Abramczyk et al. 2017: Positive Disruption: Limiting Global Temperature Rise to Well Below 2°C. Rocky Mountain Institute, 2107; (iii) Gahleitner, Gerda 2013: Hydrogen from renewable electricity: An international review of power-to-gas pilot plants for stationary applications. International Journal of Hydrogen Energy https://doi.org/10.1016/j.ijhydene.2012.12.010; (iv) Ram et al, 2017: Global Energy System based on 100% Renewable Energy – Power Sector. Lappeenranta University of Technology and Energy Watch Group, 2017; (v) Breyer, et al.: Solar photovoltaics demand for the global energy transition in the power sector. Progress in Photovoltaics Research and Applications, 2017. DOI 10.1002/pip.2950. Apparently, almost none of the voluminous research put out by the research group led by C. Breyer (i.e., two of the papers cite immediately prior) is reviewed by this IPCC report. Here are more relevant cites: (1) Pyndyck, Robert, 2017: The Use and MisUse of Models for Climate Policy. Review of Environmental Economics and Policy, volume 11, issue 2, Winter 2017, pp. 100-114; (2) IRENA, Renewable Power Generation Costs in 2017. http://www.irena.org/publications/2018/Jan/Renewable-power-generation-costs-in-2017; (3) BNEF, State of Clean Energy Investment, http://www.irena.org/publications/2018/Jan/Renewable-power-generation-costs-in-2017; (4) BNEF, New Energy Outlook, https://about.bnef.com/new-energy-outlook/; and (5) Lazard, Levelized Cost of Energy 2017 https://www.lazard.com/perspective/levelized-cost-of-energy-2017/ [United States of America]	The revised chapter includes an expanded scenario set that covers a substantially greater range than those in the SOD. For example, the chapter now does include scenarios with limited to no negative emissions as the reviewer asks. Hence we believe the language is appropriate to the revised version of the chapter. For citations, we appreciate the additional suggestions, but point out that this is an assessment rather than a review and not all papers can be included. We have added those that seem most appropriate from the suggestions of all reviewers during revision.
59902					The IAM results discussed in this chapter present the potential GHG mitigation potemtial of wind and solar power in very optimistic terms. Conversely, they present the potential of nuclear power as being very limited. But these results are completely an artifact of how these three types of power are built into the IAMs, which reflect the sustainable development community's current views of and preferences for these systems. Large-scale deployment wind and solar systems (i.e., meeting national and global electricity demands) have yet to be tried. Yes, they have real potential to be an important part of a low-emissions future but the downsides have yet to become well understood. For example, it appears both systems have very negative impacts on bird populations – particularly migratory birds. Additionally, some communities have blocked installation of wind turbines to preseve the value of their scenic landscape. Conversely, nuclear power is the only Zero GHG-emitting form of electricity generation that has been implemented on a large enough scale to know what national and global pluses and minuses would be, and what the costs would be of converting to nuclear on a scale needed to stay under 1.5°C. Note that whatever this scale is it would be within the 1.4-3.8 trillion USD annually from 2016-2050 (page 2-5, lines 55-56), and could be accomplished by 2050 (or quicker if needed). As noted later in the text, social views of nuclear power may change in the future as the need to reduce CO2 emissions becomes more clearly recognized and the time to achieve these reductions gets shortened. These points should be made clear in the discussion of the IAM results; otherwise, the presentation appears biased and incomplete. [United States of America]	Added additional discussion of scenarios with greater reliance on nuclear (e.g. Berger et al), however most published scenarios do not include such a development so it cannot be a major part of our assessment of the literature.
59928					According to the agreed outline, Chapter 2 is intended to be no more than 40 pages but it is currently 118 (references excluded). Reduce the length of the text by focusing on mitigation options specifically related to 1.5°C scenarios and minimizing discussion of general modeling and mitigation concepts or approaches potentially relevant to all climate change scenarios. [United States of America]	Chapter shortened and much modeling discussion moved to Annex.
59934					The chapter is way too long and complicated. It would be a better chapter if it was about 50% of the current length. [United States of America]	shortened
59908					Assessment of technological pathways for mitigation to a certain target may be considered fairly backwards. Instead of a litany of approaches for doing so, would it not be more constructive to analyze the institutional and economic frameworks required to induce markets to implement such measures? Nearly all of the components in the analyzed pathways would become profitable given a sufficiently high carbon price, which in turn would require a robust set of institutions to maintain the carbon market. Given such institutions, markets would likely be quite efficient in determining which particular mitigation technologies best-optimize the cost-performance tradeoff. As such, much of the technical analysis here is, while not entirely superfluous, certainly somewhat so. Further, the sheer amount of technical detail serves to detract from the more fundamental political and institutional challenges, which are both simpler and more challenging. [United States of America]	Ch 2 assesses the pathways from a primarily technical view, with socio-economic considerations brought in in section 2.5 but covered in detail in ch 4.
59910					For technologies with long lead times that are likely to be essential in deep decarbonization, market mechanisms like carbon pricing might not prompt sufficiently rapid investment if they tend to pursue lowest-hanging fruit. This suggests a role for non-market mechanisms in such cases. More generally, this chapter would be more useful if it identified which technologies might require non-market support, and for which purely market-based approaches would suffice, recognizing that market-based approaches are typically preferable given their relative simplicity and economic efficiency. Deployment of CCS might potentially be an example of a technology whose lead time might serve as a deterrent to investors reacting to a carbon market. Other examples exist of cases where market mechanisms might be entirely sufficient given a large carbon price. Development of such a typology might be helpful to policymakers. [United States of America]	We include information on carbon pricing, but this level of detail about lead-times by mitigation option is beyond the space limits of our chapter and should be covered in WGIII AR6.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
59924					Throughout the chapter, for instance in Table 2.10, the likely growth of (and therefore potential for mitigation) of solar power appears to be underestimated. The technical potential for solar power is many times greater than that of biomass, though the present assessment and many others use scenarios that show greater biopower than solar. The IEA has consistently under-predicted the growth of solar power in the last decade. IAMs have similarly underestimated solar power growth. As Creutzig et al. (2017) report, "the vast majority of energy transformation scenarios documented in the 2014 IPCC fifth assessment report (AR5) feature 2015 PV deployment levels of 50 TWh or less, which is less than half of the global PV production that was actually achieved in 2014." The costs of solar PV have dropped faster than even the most optimistic forecasts suggested and solar deployment has burgeoned accordingly. Scenarios and assessments, including the present one, continue to under-predict the growth of solar power. Note that Chapter 4, page 11, of the present draft states: "Some scenario studies outside IAMs suggest deep cuts of GHGs by high penetration of solar PV (Creutzig et al., 2017) or 100% wind, water, and solar energy by 2050 (Jacobson et al., 2017), although some of this work is contested (Clack et al., 2017)." Chapter 4, page 17, also states: "Disruptive innovation, as has been shown with roof-top solar, has led to considerably greater growth than expected and could change the modelling based on traditional assumptions." Continued under-prediction of solar power and its role in climate change mitigation has the likely effect of misguiding future policy, planning, and other decisions. It would be be helpful to include a statement about the historical under-prediction of solar power by the IEA and even IPCC AR5, and the likely repetition of this error in the present report, in chapter 2, possibly on page 62, line 22. [United States of America]	Discussion of solar power updated in chapter to reflect most recent literature.
59930					Here are several overarching comments on the chapter: (1) This chapter is very long with significant repetition and overlap in different sections of the chapter to be effective in communicating the opportunities and challenges for mitigation to meet the 1.5°C goals. The details need to be balanced with key messages and overall goals of the report; the authors should look for opportunities to make the document more concise, and coordinate across different sections to reduce redundancy and improve organizational structure. Specifically, the discussions in Sections 2.3 and 2.4 have significant overlap and can be streamlined and combined. (2) This chapter focuses on the technology options and economics of the 1.5°C pathways based on modeling and scenario analysis from integrated assessment and sectoral models. However, the chapter should provide more balanced views of mitigation pathways by improving discussion of the feasibility, implementation, and limitations of technology portfolios and individual technology options. The latter are discussed in detail in Chapter 4, which should be shortened and integrated into Chapter 2 at appropriate sections. (3) Related to comment #2, the chapter as it currently reads does not adequately address the technical, economic challenges and social, institutional, and behavioral barriers for implementing the technology pathways. As a result, the chapter does not appropriately convey the multidimensional issues and challenges for meeting the 1.5°C targets. This concern can be mitigated if authors address comment #2 above. (4) Discussion of the economic impacts of 1.5°C scenarios does not reflect the current state of the literature and the uncertainty. The chapter cites ranges of carbon prices for 1.5 and 2°C scenarios that do not reflect the ranges of carbon prices reported in the literature, and appears to project more optimistic estimates of the costs that are not fully supported by the literature. [United States of America]	Chapter shortened and discussion of implementation harmonized between ch 2 and ch 4. For economics, we have updated and checked that discussion is in accord with the literature we're aware of (the reviewer does not give citations for those that supposedly are different).
59936					One important issue that gets lost in in all the detail of the chapter is the challenge of 1.5°C. There's a lot of information, but it's hard to discern that this is a very large challenge. It would be good to find a way to make this clearer. A lot of it is just that the chapter is too long and filled with details. [United States of America]	Chapter shortened, ES revised to better highlight points such as this.
59940					The material on budgets is critical, including actual budgets and the possible ways to mention the budget. It could be shorter and clearer, but it is nonetheless strong and important. It would be great to really polish this section. [United States of America]	Greatly revised this section and we believe now much clearer.
59932					Sections addressing transformation (for instance, the intersection of energy and policy) under the auspices of sustainability would additionally benefit from Christopher Juniper's findings in his paper, Climate Change Progress through Sustainable Economics. In it, Mr. Juniper proposes that the challenges of climate change can only be met successfully if the principles of risk-averse sustainability are embraced – that is, building per capita natural (which is in decline) as well as human capital, both being necessary to create wealth. In particular, governments must take steps (e.g., policies) to ensure that more sustainable choices are also the most economically advantageous ones. The author describes progress in sustainability as reducing unnecessary suffering of people today and in the future such that, in theory, per capita global human and natural capital levels are increasing at least as fast as the population. Mr. Juniper states that there are really only two possible responses to declining natural capital: reduce the human activities responsible for it or implement "fixes" to stop it. The longer societies wait to reduce the causes of the decline, the more likely a dramatic solution will be enacted with little predictability, especially upon large-scale implementation. Climate change is one of the most studied threats to natural capital because of its (1) long-lasting impacts, (2) interactions with other natural capital resources and services, and (3) the likely long-time period of social and economic adjustments required to abandon GHG-intensive (i.e., carbon-based fossil fuels) economic systems. Consequently, climate change (and the resultant climate chaos) has correctly been dubbed a market failure – breakdowns of this kind occurring when markets fail to deliver desired outcomes due to flawed calculations. Mr. Juniper also comments on the role of management systems to address climate change, principally lifecycle-based systems, since inclusion of externalities into prices appears politically remote. Finally, to continually improve sustainability performance, a sustainable economic management system, or SEMS, for governments is proposed: a whole-system self-audit to occur at least every other year. According to the author, SEMS is based on four components leading to specific goals that are attained through detailed actions. [United States of America]	These are useful comments, but cover material addressed within chapter 4 & 5 rather than 2.
59938					Regarding the discussion of bioenergy and BECCS in Chapter 2 of the Special Report, given that many global climate models consider BECCS to be such a large component of achieving 1.5 or 2°C goals, the amount of discussion on BECCS was appropriate. The discussion on potential tradeoffs and considerations/impacts for its utilization was also appropriate, while perhaps more indirect land use change discussion could be added. While it is mentioned, overall the report could do a better job of discussing the current technological and cost considerations of bioenergy + CCS and that it isn't currently feasible to meet the needs that many models project it achieving for climate mitigation. There is quite a high level of dependency put on BECCS by projection scenarios, which argues for more discussion on its current status to show how far it really needs to progress. [United States of America]	Taken into account - On the tradeoffs/impacts of BECCS/bioenergy, the individual options are assessed in Chapter 4, with impacts also assessed in Chapter 3. More efficient cross-referencing to the respective sections, so that this (complementary) information is at hand, yet does not need to be repeated in the light of our space constraints in this chapter.
59942					The use of marker scenarios throughout the chapter combined with the ranges is very useful. This is a good middle of the road approach that allows an assessment of the ranges of possibilities but also lets the reader dig deep into examples. [United States of America]	Thank you. We've expanded the use of these to better link with ch 4 and SPM as well.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
59944					The CDR discussion could be sharper. There is a big emphasis on the notion of CDR being used not just for negative emissions, but also to offset other emissions. That's an important point to make, but the more basic question of whether CDR is needed gets lost in the discussion. This needs to be brought out more strongly. [United States of America]	Attempted to make this easier to follow in revised chapter.
59946					The material articulating the implications of the NDCs for 1.5°C is very useful. [United States of America]	thank you
59948					It is hard to understand the value of Section 2.4.2. It appears to simply be a repeat of material in Section 2.3, but not as concise or clearly on message. It could be dropped with minimal cost to chapter. [United States of America]	Sections 2.3 and 2.4 harmonized to remove repetition.
59950					Definitions of what stranded assets are is needed. There are many that exist and are in use. This report can provide a service to the reader by establishing a consistent vocabulary. The only occasion where a definition is provided is page 2-103, and it uses a financial definition. There are others, for example physical definitions. [United States of America]	Definition added to glossary
62280					This is an important chapter. It makes well use of the increasingly sophisticated capabilities of integrated assessment models and draws on sector-specific models where those can provide additional evidence. The first and primary function of those models is to represent the physical aspects of energy, land use, the flows of greenhouse gas emissions, and the dynamics of GHGs in the atmosphere. The secondary function is energy economic optimizations reflecting specific constraints, properties of technologies, and carbon prices. The fact that not all IAMs can produce 1.5 degree pathways, and expecially under SSP scenario assumptions of strong growth, are significant and should be emphasized. [Edgar Hertwich, United States of America]	Thank you, noted.
63176					Wouldnt it be more logical to first discuss methods and pathways of limiting warming (Chapter 4) before modeling their application? As it stands Chapter 4 seems like an annex to chapter 2, or what is the logic and intent? [Greg Rau, United States of America]	We have attempted to better clarify (in ch 1) how the SR covers the material, with ch 2 covering what the pathways are and ch 4 covering how those might be implemented.
63184					Rewrite: "Other CDR options, such as direct air capture and storage, are currently not by default included in model scenarios for limiting warming to 1.5°C. {2.3.1, 2.3.4}, but their possible use would increase chances of attaining that climate goal." [Greg Rau, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
59952					Chapters 2 and 4 should be more closely integrated. It would help if they could follow a similar organizational scheme. Recognizing the challenges of writing chapters in parallel, there is nevertheless an important potential synergy between the pathways discussed in Chapter 2 and the bottom-up assessment of the state of technology, human and institutional behavior, and systems that should be a core part of Chapter 4. This assessment of "how we are doing" should form one of the core elements if not the most important element of the full report. As it currently stands, Chapter 4 does not build sufficiently on the basis established by Chapter 2, thus leaving the reader with little concrete sense of the achievability of the pathways described in Chapter 2 or of what concrete measures would be required to achieve them. [United States of America]	We have tried to improve the links and consistency between chapters 2 and 4, for example by using the same marker scenarios in both.
59954					Chapters 2 and 4 should be organized so that Chapter 4 tracks the sectoral assessments in Chapter 2. For example, such a scheme might include parallel or related sections addressing the following sectoral issues: (1) Energy supply – with subsections on fuel mix, renewable energy, nuclear power, energy storage, linkages between the power sector and other sectors (e.g., electrification of transport and industrial processes), carbon capture and storage, adaptation of the energy supply; (2) Energy demand – including subsections on buildings, industry, transport (light duty vehicles, freight, aviation, marine, other mobile equipment), urban systems; (3) Land use – including subsections on forests and ecosystems, agriculture and food, etc.; (4) Carbon capture and storage (CCS) and carbon dioxide removal (CDR) – including subsections on geographic availability, applications in various sectors, state of technological advancement and specific needs to support commercialization and deployment, costs and cost-effectiveness; (5) Short-lived climate pollutants (SLCPs) – with subsections on each major SLCP; (6) Resilient infrastructure – with subsections addressing progress on adaptation of different types of infrastructure (industrial, urban systems, transport, power sector, water, etc.); (7) Resilient ecosystems – with subsections on different types of ecosystems, including oceans; (8) Solar radiation management; and (9) Systemic and cross-cutting issues. [United States of America]	We have tried to improve the links and consistency between chapters 2 and 4. We were not able to converge on parallel sections but have tried to harmonize the discussions more closely.
62282					There lies some risk in the extent to which the IPCC relies on IAMs in its evaluation of 1.5 degree options. While these models are increasingly sophisticated and appropriately represent emissions and related concentration increases, there are aspects of relevance to climate change mitigation which they do not cover well or at all. It is therefore problematic that evidence apart from the scenarios (model outcomes) provided by IAMs plays a supporting role at best and is often ignored. In addition, 1.5 degree scenarios are difficult to attain in these models. More time should be spent on investigating whether model outcomes, such as shares of renewable energy, rates of energy efficiency improvements and CDR employment etc. are indeed realistic. I do appreciate the discussion of model features and limitations in section 2.6.1, which could, however, offer more specific information about the assumptions and weakness of specific models which play a prominent role. [Edgar Hertwich, United States of America]	Additional discussion of results relevant to 1.5C from sources other than IAMs included to the extent such literature is available. Additional detail on IAMs added to Technical Annex.
407					It seems like "sustainable develpoment" has been reframed as "whole -system transformation". There are two problems with this: 1) the title of the chapter explicit refers to SD; and 2) section 2.3.3 does not provide a systems approach, nor is structured as one woudl expect from systems thinking. Rather, it is a fairly standard analysis by sector. [Harald Winkler, South Africa]	These two terms are not used synonymously.
8316					1. This chapter focuses much on energy transformation and over-emphasizes the importance of energy demand control and carbon dioxide removal. In fact, however, to limit the temperature increase to 1.5? above pre-industrial levels, it is necessary to take a number of measures and make transformations in the aspects of industry, energy, consumption and others. Moreover, the energy supply-side measures are equally important, in particular, to developing countries. Therefore, it is suggested that this chapter be more balanced in analysis by adding the transformation of other fields. In addition, this chapter makes a limited analysis of the need for sustainable development and the technical and economic feasibility of achieving 1.5?. It is suggested to add words as appropriate in this connection. 2. We think that 'scenario' and 'pathway' differ in meaning, due to which the latter is used only when an analysis and description of specific carbon emission reduction pathways are made. Many of the conclusions in this chapter are based on an analysis and comparison of different scenarios rather than an intended indication of pathways. To avoid any ambiguity, it is suggested that mere 'scenario' be used in this chapter, especially in the Executive Summary. [China]	We believe the chapter covers the various options in a balanced way, including supply and demand side. We do not see that there are other "fields" that could usefully be added. Sustainable development is only partially addressed in Ch 2 according to the SR outline, with that topic largely covered in ch 5.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
9988					We should acknowledge that the assessment methodologies used in chapter 2 for the mitigation pathways consistent with 1.5 global warming is currently the only available scientific approach to assess and develop such scenarios. Furthermore, we acknowledge that significant improvement of these models has been achieved during the recent years, however the limitations and gaps of these models have not been clearly addressed in the SPM section. This is important, particularly when dealing with such narrow pathways (1.5 vs 2.0) which requires rapid technological and human behavioral changes. [Saudi Arabia]	The Annex to ch 2 now provides additional analysis of the strengths and limitations of the models.
17982					General Comment - 1.5°C budgets: In addition to the TPB & TRB with return by 2100, the report should also comment on the possibility of temperatures returning to below 1.5°C after 2100. For example, in scenarios that do not return to 1.5°C by 2100, but where NETs deployment is substantial, could temperatures return to 1.5°C later if the rate of negative emissions is maintained? [Andrea TILCHE, Belgium]	Ch 1 defines such scenarios as inconsistent with 1.5C, so they are not covered in Ch 2.
17984					General Comment - provide stronger mitigation statements for SPM: The report should provide some more specific, quantified findings in the following areas. These should then be communicated also in the SPM. * Negative emission requirements in 1.5°C and 2°C scenarios should be described as annual amounts, not just cumulative, in order to give an extent of the ramp-up required. * Land areas (for agriculture, forest, BECCS) in 1.5°C and 2°C scenarios should be described in absolute terms (MHa). The existing metric (MHa converted per year) is only partially helpful [Andrea TILCHE, Belgium]	The chapter provides information on both these factors as a function of time and cumulative, so either are available. The material elevated to the SPM is decided by the SPM rather than the chapter author team.
17986					General Comment - Regional mitigation aspects: • There is no presentation of regional variations and how the convergence between regions would happens across the scenarios. Presentation of regional variations has been requested within the approved outline and are essential for understanding where the global efforts should focus on. Therefore the authors need to provide some analysis of the regional variations. This should be possible given that different assumed sectoral and regional efforts are integral to all the report's modelled scenarios. At the moment regional aspects are merely hinted at in the following places: • 2-9 (lines 46-47) mentions that the scenarios discussed incorporate regional differentiation in sectoral & policy development. • 2-38 mentions the global coordination of solutions deployment as a key element of 1.5°C pathways. • 2-45 (lines 1-20) mentions how the scenarios considered have different regional approaches (global cooperation from 2020, regional phase in etc.) • Box 2.3 looks at national pathway analysis using case studies from China, Finland, Japan and India. However, the box gives little detailed information about these countries (except China) and it is not clear what generalisable messages can be drawn from this section. • Low carbon investment projections differ per region, but most investment (~$1.3tn per year) is needed in Asia (2-103). [Andrea TILCHE, Belgium]	There is not space for regional analysis given the constraints of the SR1.5, and the national pathways box that we included in the SOD to attempt to cover this received mostly negative reviewer comments (and the SOD was too long), so it has been deleted. This will have to wait for AR6.
17988					Other general comments • Scenario classification: the chapter starts with a description of six scenario classes (Table 2.1) and some part of the chapter does develop around these scenario classes. However, from section 2.4 onwards new scenario classes are introduced without much explanation. The legend in the graphs are also unclear and unintelligent which makes it difficult to understand the analysis. It would be helpful for readers if the scenario classes presented in Table 2.1 are retained for the entire chapter. • The uncertainty is analysed by providing confidence intervals however it would require some explanation the underlying drivers of these uncertainties. For e.g., how much are due to underlying socio economic assumptions or due to geophysical conditions (e.g., w.r.t to temperatures and radiative forcing). This also means that the authors need to provide the assumptions more explicitly. • The use of insights from bottom-up models (in addition to IAMs) is helpful. The Box on national pathway literature is also a good idea, however; it needs better integration with the rest of the chapter. • The chapter is at many places written in a very technical way, which makes it difficult to understand. • The overall chapter length exceeds by a large margin and it will be very important to shorten and simplify the text. Accordingly, some suggestions are provided for removing repetitions within the chapter. • The chapter outline deviates from the approved outline, which may require explaining. [Andrea TILCHE, Belgium]	Chapter shortened. Scenario classes simplified and now used throughout chapter more consistently. Language also improved.
19312					The clear limitations to the modelling of land use should be made explicit. Land measures are effectively limited to bioenergy and afforestation (the carbon benefits of the former are fully attributed to the energy sector, although they accrue in the land sector), but soils (2nd largest active C pool after the oceans) are barely mentioned, and peat only once in passing. It is unclear how (if at all) land use impact other than LUC are taken into account (e.g. forest management). [Andrea TILCHE, Belgium]	Additional detail on the representation of the various land-use options in the models has been added to the Technical Annex to the chapter.
22522					I think that the text-boxes (3 in this chapter) interrupt the reading of the sub-sections where these are inserted. I wonder if these text-boxes would fit better at the end of the entire chapter [LUIS VALDES, Spain]	Just one box now, so hopefully not as much interruption.
22524					Why create categories in the text-boxes? I think "Cross-Chapter box 2.1" should be renamed and renumbered as "Box 2.2" and then the current Box 2.2. will be "Box 2.3" [LUIS VALDES, Spain]	Editorial decision of TSU as to box numbering.
19310					GENERAL COMMENT for the whole Chapter: It would be esential to better clarify how the interaction between the (bio)energy sector and land use is treated. The report seems (or at least gives the impression to the reader) to assume that bioenergy has no emissions (it is not explicitly stated, but results seem to suggest that it is counted with zero emissions, and with "negative emissions" for BECCS), but it is unclear where and how land use impacts are considered, and to what extent they are captured. The text states that all bioenergy (incl BECCS) is modelled endogenously and explicitly, but that is not possible without also internalising land use, which is not the case. [Andrea TILCHE, Belgium]	Taken into account - This comment is not in line with the available evidence on IAMs. Many of the IAMs here internalize land use. BECCS is treated as carbon neutral in the policy context, because it is assumed that the carbon accumulated while growing biomass is offset by emissions from combustion in the case without CCS. With CCS, this becomes negative because there are no (or limited) combustion emissions. For the models with land, the land use change emissions associated with clearing land for bioenergy are accounted for. This has been clarified in the technical annex, although a more in-depth discussion of this issue falls outside the scope of this Special Report.

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34150					Please consider to explain better in either chapter 1 or 2 the terms related to overshoot and its temporality, including the relations with anthropogenic emissions by sources and removals by sinks of GHGs. The terms "overshoot", "temperature overshoot", "Threshold return budget" and "temporary overshoot" are currently used in the report in a similar manner, in the glossary overshoot covers not only temperature, but also emissions and concentrations. This may lead to misunderstandings and please consider to use one easy understandable term more consistently e.g. "temperature overshoot" or "temporary overshoot" both in the report and the glossary. [Norway]	Language improved, and simplified, e.g. with threshold return budgets largely removed.
31382					There is a strong concern about sample selection bias for the assessment of this chapter. The assessment is based on the results of the modeling (Integrated Assessment Modeling) exercise, but they are limited to the results where solutions are found by the models (Integrated Assessment Modeling). However, there are many scenarios, especially 1.5°C scenarios, whose solutions are not gained by modelling analysis. It is necessary to indicate how many models could not find solutions explicitly, because this information has significant implication of the feasibilities of the scenarios. [Japan]	Accepted - This information is important indeed, but can only be provided in case a structured scenario analysis has been reported by the underlying studies. Insights from the SSPx-1.9 study have here been highlighted explicitly, both in Section 2.3 and Technical Annex Section 2.A.3
34152					Please clarify how the report deal with net emissions (both related to definitions and how it is modelled in the scenarios) including both emissions by sources and removals by sinks. This is especially important related to how the AFOLU sector is dealt with, and how it relates to the IPCC reporting guidelines for AFOLU and also whether it is only anthropogenic emissions and removals. The most relevant are the anthropogenic part. [Norway]	Modeling includes both anthropogenic and natural sources and sinks, though some of the natural sources are not yet adequately understood to be included in the modeling (e.g. permafrost). These are specifically discussed in section 2.2.
37884					This chapter could benefit from a figure that summarises the key policy relevant determinants of mitigation pathways in a simple and accessible fashion. These are the warming target and probability, 2030 GHGeq/yr emission levels and the cumulative need for CDR. Such a figure would also be highly useful also for the SPM. [Michiel Schaeffer, Netherlands]	This is more appropriate for Ch 1 in our opinion.
45586					Although lifestyle changes including less-meat-intensive diet have been suggested throughout the chapter, no clear strategies to achieve that have been proposed. Suggested educational strategies as well as economic and land-use restriction policies should be included in the text. [Adela M Sánchez-Moreiras, Spain]	Chapter 4 covers the implementation challenges and strategies for the mitigation options presented in ch 2.
47764					Please use full forms of words/phrases on first use followed by abbreviations on second use onwards. This applies to all abbreviations. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
45318					Report is still problematic in a way how it describes the possibility to reach 1.5 C. In many places in the text there is statement that there are many different ways to reach the 1.5 C aim. However, out of the total number of scenarios there are only a few scenarios where the aim is reached with decent probability (> 50%). And of those scenarios only ONE is reaching the aim without enourmous deployment of BECCS and CCS. From mitigation viewpoint these scenarios are overly optimistic, technology driven, and therefore giving wrong message for the politicians, almost an excuse to hinder the mitigation of emissions. I'm not saying that science behind the scenarios is not valid but I'm critizing the way how this science is worded in the report. Stronger message is needed asserting more clearly how low is the probability for restricting warming to 1.5 C. And how urgent measures we have to take if we want to manage in this slim chance of keeping warming even in 2 C. Moreveor, the uncertainties of overshooting scenarios (TRB) is not discussed enough. In 2.3.5 the tone of text is right. Other sections should adopt this. Another general problem is that although in section 2.6 tools are discussed, there is not a word about how forest sink reduction due increases harvests are accounted for. Due to pivotal role of forests, and forest based biomass in bioenergy scearios this impact should be discussed. Do all used IAMs or other tools estimateing this and used in this report account for this? [Tuomo Kalliokoski, Finland]	The tone has been scrutinized and the revised version accurately portrays that the challenges of reaching 1.5C are very high.
45574					Regarding mitigation options, more importance should be given throughout the chapter to green urban development (i.e. increase of community, collective, rooftop, and home gardens) and rural-urban linkage. Urban agriculture (cultivation, processing, and distribution of products by individuals, farmers, or community organizations in the urban context) will increase carbon sinks and improve food distribution systems. For example, Lee et al. (2015) concluded that urban agriculture in Seoul (Korea) could reduce CO2 emissions by 11,668 t/year. Future changes in food transport and distribution will be less drastic with a previously well-established urban agriculture. Moreover, besides the role of urban agriculture as carbon sink and energy demand reducer, it has also an essential role in reducing urban heat accumulation in a very effective way (by increasing surface albedo and cooling the air through evapotranspiration). The whole chapter should be reviewed to include this food system as a real alternative for mitigation. [Adela M Sánchez-Moreiras, Spain]	The food system in included via several options (e.g. dietary choice, livestock management, AFOLU). We believe that urban agriculture is likely to play a very minor role given its small scale, but agree that it'd be useful to assess the entire suite of options in AR6 WGIII.
47868					Comments on entire report: Please follow the same format throughout the report for some words/phrases and empirical formulae on application, e.g., 'short-term', 'long-term, 'land-use', 'CO2' etc. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47918					Please check the citations/references: Clarke et al. 2009; Joshi et al. 2016; Le Quere et al. 2016; Schneider et al. 2017; Shindell 2015; Victor et al. 2012; Wachsmuth and Duscha 2017;……full references available in reference list at the end of the report but no citation in the running text of the report. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47920					Please check the incomplete citations/references available at the reference section having no year mentioned for publication/acceptance of the articles: Fuss et al.; Gasser et al.; Grubb et al.; Holz et al.; Knobloch et al.; McCollum et al.; Mengis et al.; Minx et al.; Pietzcker et al.; Strefler et al.; Tokarska and Gillet; Tokarska et al.; Yanguas-Parra et al. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
49898					The chapter does not make any reference to market mechanisms which is being used as a tool for mitigation by many countries, especially the European Union [Himangana Gupta, India]	Carbon pricing, a market mechanism in most implementations, is discussed in section 2.5
49900					There is no mention of SRM in this chapter although CDR has been covered in detail. Although it is a controversial method under geoengineering, there could be atleast a reference to it covering some latest studies on whether it could be helpful or prove dangerous as a mitigation tool in the long run. [Himangana Gupta, India]	SRM is mentioned in the chapter (section 2.1) as not being part of the assessed pathways. This SR assesses SRM in a cross-chapter box.
53482					It would be useful to have a version of Table 2.1 (perhaps as an appendix) where in addition of the number of scenarios listed in the second column, the references to the studies where these scenarios come from are provided. This would allow users to quickly consult primary literature on the scenario classes they are most interested in without having to interrogate the scenario database, which may be intimidating to many. [Christian Holz, Canada]	References do not fit into Table 2.1, but these are described in the Annex as suggested.

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53492					In several places in the chapter, the authors state that all 1.5°C pathways rely on CDR technologies. This is inconsitent with the discussions elsewhere in the chapter, which mentions several CDR-free scenarios (e.g. Grübler et al 2017, Holz et al 2017, etc). I have pointed out several of these place in my comments but likley missed some. Care should be exercised to avoid such incorrect generalizations. [Christian Holz, Canada]	Agreed, revised to 'most' pathways.
57724					It would be helpful to define the TPB and TRB budgets in terms of the budgets definitions used in AR4 and AR5. [Steven Rose, United States of America]	These budgets are no longer emphasized in the chapter.
57726					To properly inform decision-makers about characteristics of 1.5 deg C pathways, the ES should be reformatted to include symmetrical information about 2, 2.5, etc. pathways. As is, it is difficult to see the trade-offs of increasing climate ambition. For example, what are the risks of passing 2 and 2.5 deg C and how demanding are the pathways? What are the challenges of containing temp to 2 and 2.5 deg C? [Steven Rose, United States of America]	Rejected - there is not enough space in the very short ES to cover other temperature targets in detail. Some information about 2C is given.
57730					The chapter ES and report SPN needs to include summary paragraphs on the mitigation welfare cost (more than carbon prices) of limiting warming to different thresholds--global and regional (1.5, 2, 2.5, 3 deg C, etc). This discussion should also include consideration of infeasible scenario results. The current quantitative results in the chapter ES are biased because they obviously only represent the models that could solve. Readers should know about the degree of infeasibilities and the report should help them interpret infeasibility. One, but not the only, interpretation is that costs are infinite. This may actually be true for 1.5 and 2 deg C when climate system dynamics are not in our favor (e.g., high equilibrium climate sensitivity). It may also be true without CDR. A paper that could be helpful on the total and incremental global and regional costs of lowering temperature constraints is Rose, S.K., R. Richels, G. Blanford, T. Rutherford, 2017. The Paris Agreement and Next Steps in Limiting Global Warming. Climatic Change 142(1), 255-270. Incremental costs of further lower the threshold increase at an increasing rate and this is an important observation and discussion for the public and policy-makers. [Steven Rose, United States of America]	The chapter includes information on the modeling of how costs increase as temperature targets are strengthened. Welfare costs are a topic for Ch 3.
57762					Somewhere in the report there needs to be discussion of trade-offs between benefits and costs in trying to achieve 1.5 deg C, 2 deg C, etc. Policy-makers need to think in these terms. Here is a disucssion paper that is in review that could be helpful: Rose, S.K., 2017. Managing Climate Damages: Exploring Trade-offs. EPRI, Palo Alto, CA. 3002009659. [Steven Rose, United States of America]	Benefits are not discussed in ch 2, but in ch 3, which also examines challenges associated with cost-benefit analyses.
58192					This second draft is much improved and includes some additional authors that are also international references in this topic. I had the opportunity to review the first draft, too, and overall this new version includes some new texts, references and reviewed estimates. Some of my original comments were, apparently, not properly observed, and my following comments are just in addition to them. Thus, I would recommend to revisit my previous comments as well. [Alexandre Strapasson, Brazil]	Noted
58384					I am sure this will be fixed, but I thought worth informing that in many places in the chapter there are spaces between words missing [Andrew Prag, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58470					Please cite IEA, 2017 (World Energy Outlook-2017) in lieu of IEA/IRENA, 2017 [Andrew Prag, France]	Done.
62960					The phrase 'sustainable development' is a lot in the chapter, but the exact meaning is not always clear. First, it is not generally clear whether the focus is on economic development, or sustainability, or on the Sustainable Development Goals, which are a heterogeneous mixture of goals. For example, if something has 'trade offs with sustainable development' does it mean it will make development less sustainable, or it will reduce economic development, or it will impact one or more of the SDGs? These are each different impacts, with different policy responses. Much better, and more useful to policymakers, to just describe the effect more specifically. For example on pg 6, ln 50-51, instead of writing that 'stronger mitigation requirements for 1.5 C' will 'increase pressure on land and the potential for trade-offs with sustainable development', write instead that 'increase pressure on land, leading to less food production and higher food prices' (or describe other impacts if there are others). I understand the need to discuss sustainable development, based on guidance from the panel, but it is still better to better differentiate impacts. [Nathan Gillett, Canada]	Tried to be specific about SD impacts when practical. Difficult at times as there can be many and space limitations prevent us from listing them all (as SD is much shorter while encompassing the lot), so not always practical.
10282					General comment: It would be worth focusing highly on the issue of overpopulation: to formulate more scenarios and to examine how these scenarios affect global food and energy demand and thereby climate change. It would also be useful to outline what measures should be introduced to moderate overpopulation and their feasibility would also be beneficial to examine. [Hungary]	We can only assess scenarios in the literature, so although we agree this would be worthwhile it is not within the scope of the SR1.5.
10284					General comment: It would be useful to set up a ranking of measures, depending on which one has the biggest expected mitigation benefits. It is worth considering, for example the education of women that could have a very positive impact on moderating overpopulation and thereby on reduction of global food and energy demand. [Hungary]	Not practical to provide a single ranking as the deployment of one measure affects others, so 'maximum' benefit not well defined for any one in isolation.
10286					General comment: It would be useful to have a more detailed focus on land use as a scarce resource, because food production (which may increase as a result of population growth), CO2 capture (BECCS, afforestation) and renewable energy production have large expansion demand, while available areas may be reduced by climate change. One of the key issues within this topic is the management of the conflict between food production and other land use. [Hungary]	Land-use covered in 2.4, but also more fully in Ch 4.
10288					General comment: It would be useful to discuss in more detail the non-CO2 climate forcers, such as methane, how it contributes to climate change and what measures could be taken to reduce their amounts. [Hungary]	Basics of how these work documented in AR5 (WGI, ch 8). We've added a bit more on measures that could be used (here and in Ch 4) but space limitations prevent a full discussion.
10516					It is hard to read the legend of Figures 2.19, 2.20, 2.21, 2.22. Texts are very small. They need to be redrawn for clarity. [Hong Yang, Switzerland]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
15730					(throughout chapter, where limitations are discussed) It is not clear in the discussion on the limitations of the IAMs whether the modelling of plant growth for BECCS includes feedbacks associated with nutrient removal, soil carbon depletion, hydrological impacts, or impacts of climate change (temperature, rainfall) on NPP and SOC dynamics. Please clarify in relevant discussion sections. [Australia]	Accepted - These aspects have now been clarified by a dedicated paragraph in the Technical Annex Section 2.A.2.4
15732					It would be helpful if each graph was given a unique letter that is used in the caption to make completely clear which is which as the axis labels don't always correspond with the text in caption. [Australia]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
27962					General comment: Definition and explanation of concept "greenhouse gas neutrality" is urgently needed. How will net zero emissions be measured? How can anthropogenic CO2 removals be differentiated from natural processes? What are the underlying the assumptions with regard to the CO2 absorption of natural sink with regard to the projections of 1,5°C/ 2°C carbon budgets? [Germany]	Discussed in ch 1.

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27964					We commend the authors on this high quality and comprehensive Chapter. We strongly recommend to further amplify the policy-relevance of the analysis presented through the following approach: Based on the important finding of the report that pathways exist that limit global warming to 1.5C, we would recommend to frame the analysis and presentation in this chapter more towards highlighting several "archetype" pathways and their assumptions, and the trade-offs and political challenges attached to such pathways. Such an approach would yields results that may enable decision makers to more clearly assess the choices they have and their associated risks in the context of sustainable development, as mandated by the plenary decision. This is the case especially for the case of delayed mitigation measures, e.g. the risks attached to the dependence on (late-century) large-scale negative emissions, or other sustainable development trade-offs. The report does feature a large amount of quantitative and qualitative information on trade-offs between different socio-economic development pathways (in scenarios represented by the SSP1-5) and how they determine the overall sustainable development benefits and the mitigation and adaptation challenges in this chapter as well as in Chs 4 and 5. We feel that it would benefit Chapter 2 and the synthesis in the SMP if this information could be used to present the scenario-based findings in an even more structured fashion, highlighting characteristics of different pathways and the associated policy choices, in addition to presenting the median+interquartile range across models and scenarios. This is especially true for section 2.4. It may also be helpful to highlight how policies that do not constitute directly targeted climate change responses support or counteract the mitigation and adaptation challenge, with references to Chapter 4 for specific instruments and measures. Also, the assumption that large-scale CDR will be feasible in the second half of the century seems such an important, game-changing assumption it would benefit the analysis if the assessment could be structured more clearly to allow for an informed judgment of what would happen if we assumed we had only limited CDR available, as the latest literature seems to suggest. [Germany]	Agreed, now presented with archetypes as examples (in SPM as well).
27966					We congratulate the author team of Chapter 2 for delivering a comprehensive and robust analysis of 1.5C pathways. We further strongly encourage the authors of Chapter 2 to refine their analysis in support of an informed a comparison between current NDCs and 1) best estimates for the 1.5°C budget and 2) cost-effective 1.5 and 2°C pathways. It would be extremely helpful if authors could provide guidance on the upscaling that would be necessary in the short term in order to match the NDCs with cost-effective 1.5 and 2°C pathways, drawing on material from Cross Chapter Box 4.1, and also include additional information on short-term policies that may help to bridge the gap between current NDCs and 1.5C pathways to the extent that the 1.5C target remains within reach without assuming disruptive policies post-2030. It may be useful for some of the information to framed conditional on the availability of large scale NETs. We also strongly recommend for the authors to further strengthen their analysis about common features of 1.5°C-pathways and highlight robust results in the ES and SPM. For example, what is the timeframe when 1.5°C-scenarios reach net-zero emissions, or when is unabated coal use phased out. We understand that - despite the large range of scenarios going into the assessment - some of these key indicators show very narrow windows, e.g. the timing of net-zero emissions close to 2050, which is a defining feature of 1.5C compared to 2C pathways. We encourage the authors to identify and report such robust indicators that can be helpful in guiding decisions makers. [Germany]	Agreed, we've refined the reporting to highlight the timing requirements for net zero (see also the figure on pathways in the SPM) and the phase-out of coal - two results with indeed relatively narrow ranges. We also explicitly compare the emissions under the NDCs with 1.5C levels in the ES.
27968					There are some very hard to understand figures shown in Ch 2. Especially, Figure 2.17 on page 57/143 takes much more time to digest than its insights are worth. As far as we understood, Figure 2.7 on page 32/143 illustrates basically the same information but in a much more user-friendly way. The reader should not be distracted by unnecessarily complicated illustrations. [Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
32072					This chapter predominantly draws on scenarios from energy economic models. As shown recently (Creutzig, F., Agoston, P., Goldschmidt, J. C., Luderer, G., Nemet, G., & Pietzcker, R. C. (2017). The underestimated potential of solar energy to mitigate climate change. Nature Energy, 2(9), 17140.), the pathways produced by these scenarios depend very strongly on the underlying technology assumptions. In this Creutzig study, an update to present day prices for photovoltaics alone has led to a massive boost in near term deployment of this technology. In the light of these massive changes not just in renewable prices but also storage technologies, it therefore appears to be of great importance that for each scenario used it is disclosed when technologies have last been updated. This can be done for example in an Annex. Depending on the outcome, all synthesis statements based on these scenarios should be re-assessed. For each statement, it should be qualified if it might change in the light of this rapid technology learning. This will greatly improve clarity and transparency of this assessment. [Jamaica]	We have added such an Annex and the chapter text includes additional discussion of technology assumptions (citing Creutzig et al as well as other recent work).
36400					This chapter predominantly draws on scenarios from energy economic models. As shown recently (Creutzig, F., Agoston, P., Goldschmidt, J. C., Luderer, G., Nemet, G., & Pietzcker, R. C. (2017). The underestimated potential of solar energy to mitigate climate change. Nature Energy, 2(9), 17140.), the pathways produced by these scenarios depend very strongly on the underlying technology assumptions. In this Creutzig study, an update to present day prices for photovoltaics alone has led to a massive boost in near term deployment of this technology. In the light of these massive changes not just in renewable prices but also storage technologies, it therefore appears to be of great importance that for each scenario used it is disclosed when technologies have last been updated. This can be done for example in an Annex. Depending on the outcome, all synthesis statements based on these scenarios should be re-assessed. For each statement, it should be qualified if it might change in the light of this rapid technology learning. This will greatly improve clarity and transparency of this assessment. [Snaliah Mahal, Saint Lucia]	We have added such an Annex and the chapter text includes additional discussion of technology assumptions (citing Creutzig et al as well as other recent work).

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37804					The report is largely based on IAM results and therefore depending on their model assumptions. Clearly, a range of assumptions are feeding into these model scenarios and it would go beyond the scope of this chapter to assess all of these. However, a key assumption is related to the costs of technologies and learning curves. A recent publication by Creutzig et al. 2017 has shown that updating PV costs and learning in a state of the art IAM to observed trends will increase deployment of this technology between 2-4 times by 2050, up to 50% of the global PE demand. At the same time, REs are already the cheapest source of energy in many parts of the world today. This is a game changer compared to the assessment in the AR5. Given the fundamental relevance of these updated renewable energy assumptions for stringent mitigation pathways there is a clear need for transparency and clarity. Therefore, I suggest an Annex providing an overview of all scenarios used and their underlying renewable energy assumptions. Furthermore, the findings of Ch 02 need to be critically assessed in the light of these updated dynamics. Figures and key statements in the ES need to be qualified whether or not they are potentially affected by outdated assumptions in the underlying models and, where applicable, results for up-to-date IAM assessments should be given separately. [Michiel Schaeffer, Netherlands]	We have added such an Annex and the chapter text includes additional discussion of technology assumptions (citing Creutzig et al as well as other recent work).
46352					Migration is mentioned 9 times in the chapter (including biblio) and "Displacement" 12 times it might be good to define both terms and to include them in the glossary. Nb. The SPM does not mention "Migration" but only "Displacement". The same definition should be used in chapter 3 (esp. [Etienne Piguet, Switzerland]	Noted. These are largely topics for ch 3, so will defer to their judgement.
38430					Overall, the draft Chapter presents a highly competent analysis of the best available information, which will be extremely helpful for the future users. Well done! On the other hand, the text is still very much technical, somewhere oversaturated with references and technical details. Some paragraphs are extremely lengthy, in some places 1.5-2 paragraphs may fill the whole page, making the text difficult to read and messages difficult to comprehend. Clearly, it was the authors' best intention to secure the highest degree of quality of the analysis however further thorough editing is required, esp. for the sake of improving readability. [Volodymyr Demkine, Kenya]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
49352					The figures of this chapter do not follow the same format. Also they do not have the same sime (some are very small). Make the same size for every Figure. Legends and Figures should be big enough to be reabable by everyone [Spyros Schismenos, China]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
54622					The two figures in 'Figure 2.14' should be labelled as 'a' and 'b' and discussed acorrdingly in the figure caption [Qudsia Zafar, Pakistan]	Editorial - will examine.
55442					The chapter uses uncertainty language almost exclusively in the executive summary but not in the body of the chapter. This makes the body of the chapter weaker and less authoritative than it could be, and the executive summary less well supported than it should be, especially for the statements that then end up in the SPM. I urge the authors to adhere to the uncertainty guidance and ensure that confidence assessments are developed within the body of the chapter where a transparent case can be made for the level of confidence; this will make it far more likely that the findings survive the approval process in the SPM. Approval of the SPM will place the findings under intense scrutinty, including checking back into the body of the chapter - and it really helps if the uncertainty language is consistent and traceable. [Andy Reisinger, New Zealand]	More uncertainty language included in text, particularly in areas that are elevated to SPM.
55448					This chapter very often misuses the term risk when it really intends a statement about the chance of something happening. Phrases like "the risk of X happening" and "increases the risk that …" are not using the term risk as defined in the glossary and should be replaced with "increases the chance/probability/likelihood of X happening". [Andy Reisinger, New Zealand]	Agreed. To be made consistent.
56872					The two big critiues of this chapter will be - unrealistic reliance on BECCS etc; lack of transparency round discount rates erc; are falling renewables costs etc; it is really imporrtant to head these off and say why the critiques are or are not relevant. As so many of the authors are cited it is also imprtant not to rely on "what the literature covers" as a justification. Must deal with substance [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Chapter revised to include new scenarios with little or no reliance on BECCS, and one of those included as a pathway archetype to highlight that not all (though indeed most) rely heavily on BECCS. In Annex we report on results from a questionnaire distributed to modeling groups that requested additional information on several key assumptions, including discount rates. We've also revised discussion of how quickly renewables are phased in in models and what recent studies have shown to hopefully address that the models may in fact be 'behind the curve' following very rapid changes in solar deployment/pricing in particular.
58474					a recent report by Sokolov et al (2018) suggests that carbon budgets do not hold as if CO2 emissions are at low levels, it is still possible to keep the temperature rise stable. This may be worth considering as there is little other discussion on whether the budget concept holds under deep and rapid decarbonisation scenarios https://globalchange.mit.edu/publication/16629 [Andrew Prag, France]	Topic for ch 1, which discusses these more generally whereas ch 2 gives specifics for 1.5C-consistent scenarios.
2384	1		115		Although the issues of cities (as a focal point for action) is picked up later in the chapter it is not clear now the current rate rate of urbanisation at the global level is incorporated into the scenarios analysed. [Debra Roberts, South Africa]	Section now deleted but urbanisation considered in earlier sections
35754	1		143		The impact of reduction in meat consumption on reaching 1.5 degree C target is not adequately highlighted. There may be a need to discuss the impact of per capita meat consumption. [India]	Taken into account - the contribution of less meat-intensive diets is covered in now covered in Section 2.4.4.
58118	1				An overall finding that I am largely missing in the chapter is that SSP3 and SSP4 type of scenarios can not achieve 1.5°C target. SSP3 cannot achieve well-below 2°C either. This is a very important finding for the overall achievability of the 1.5°C target. If the nation states do not find ways to cooperate and to reduce inequality then they will head towards more than 1.5°C earming, which will leade them towards a global development under which the adaptative capacity is low and therefore impacts on the societies will be more severe. [Nico Bauer, Germany]	Taken into account - This finding has now been assessed in Section 2.3.1.1 and its findings are highlighted in the ES

Comment No	From Page	From Line	To Page	To Line	Comment	Response
1568	1	1	100	70	The use of the term "pathways" in the title and throughout this chapter is highly misleading and should be changed to the term "scenarios." A "pathway" is defined in the dictionary as a "way of achieving a specific result." The scenarios that form the basis of the results in this chapter are not "ways of achieving a specific result," they are instead estimated reductions in emissions needed each year for achieving a resulting climate benefit without specifying and "way" to achieve the reduction. Actual pathways to achieve global emission reductions can be found in several papers, such as (1) Jacobson, M.Z., and M.A. Delucchi, A path to sustainable energy by 2030, Scientific American, November 2009; (2) Jacobson, M.Z., and M.A. Delucchi, Providing all Global Energy with Wind, Water, and Solar Power, Part I: Technologies, Energy Resources, Quantities and Areas of Infrastructure, and Materials, Energy Policy, 39, 1154-1169, doi:10.1016/j.enpol.2010.11.040, 2011; (3) Jacobson, M.Z., M.A. Delucchi, Z.A.F. Bauer, S.C. Goodman, W.E. Chapman, M.A. Cameron, Alphabetical: C. Bozonnat, L. Chobadi, H.A. Clonts, P. Enevoldsen, J.R. Erwin, S.N. Fobi, O.K. Goldstrom, E.M. Hennessy, J. Liu, J. Lo, C.B. Meyer, S.B. Morris, K.R. Moy, P.L. O'Neill, I. Petkov, S. Redfern, R. Schucker, M.A. Sontag, J. Wang, E. Weiner, A.S. Yachanin, 100% clean and renewable wind, water, and sunlight (WWS) all-sector energy roadmaps for 139 countries of the world, Joule, 1, 108-121, doi:10.1016/j.joule.2017.07.005, 2017 [Mark Jacobson, United States of America]	Rejected - the title is given to the authors through the IPCC approved outline and cannot be changed. The scenario literature in this chapter also actually describes the "ways" in which emissions can be limited, some of them desirable, others undesirable - as illustrated in Section 2.3 as well as Chapter 5.
61748	1	1	143	43	Congratulations for the quality of the second order draft of the chapter. I have three major concerns, and editorial issues. 1/ The traceability of key findings in the Executive Summary to the conclusions of the assessment in individual sections, as there is no conclusion in most sections, and an irregular use of the confidence language throughout the sections, making it very difficult to relate conclusions to the underlying assessment of the literature. 2/ The structure of the chapter, with an assessment of key tools provided only in the final section 2.6 (called repeatedly in the chapter). I suggest to place the introduction to the tools and methods of the assessment upfront (with also a close link to chapter 1 for their introduction to the methods of assessment), separated from the final section on knowledge gaps. This section may provide an assessment of "fit for purpose" of models informing the assessment of confidence related to the use of these models in subsequent sections. 3/ The calls to other chapters need to be clearly improved. I see little reference to Chapter 1 and rare reference to Chapter 4, some references to Chapter 5, without being explicit on the relevant section or subsection, making it impossible for a reader to find where the information is to be looked for. Finally, I note that the chapter is significantly (about 11 pages or 27%) too long compared to the initial target, so please consider shortening and sharpening aspects of the assessment, making use of supplementary online material, and reducing the length of subsections where long discussions are reported without any reference to the underlying material (scenario or publications), making it very difficult to understand what is assessed. My other general editorial comments are that there is a need to check for style (subscript for CO2 in the whole chapter; word spacing; italics for IPCC confidence/uncertainty language ...) and improve / harmonize the style of multiple figures, especially those with an Excel style. [Valérie Masson-Delmotte, France]	Taken into account - ES have now been directly linked to language and assessment in the chapter sections. The structure of the chapter has also been revised so that limitations and strengths of current scientific tools are presented more upfront instead of at the very end in a separate section. Finally, the cross-referencing to other chapters have been made more precise, up to the second subsection level. Figure style has also been harmonized, yet not necessarily greatly improved.
63100	1	1	143	60	In chapter 2, page no 4 (2-4), sentences 4-7 describe the budget issue for staying below 1.5°C. The question here is: what is the goal of budget? For mitigation finance? Or adaptation investment? To develop this budget, the SOD emphasizes on quantitative model and fails to incorporate local community concerns and issues. In 2-7, 38-47 describe the demand-side measures like per capita energy demand in areas with high consumption and private vehicle transportation per capita. This demand intervenes mitigation pathways and causes the challenges for sustainable development. The SOD agrees that this approach increases pressure on land and the potential for trade-offs with sustainable development (2-6, sentences 51-52). The major victims of these trade-offs are the marginalized people and need to be addressed in the SOD properly. [Mohammad Anwar Hossen, Bangladesh]	Taken into account - The "budget" referred to in the instances referred to is reflecting the remaining amount of cumulative carbon emissions that can still be allowed, based on geophysics, while still keeping warming to below 1.5°C. The revised chapter now ensures that this confusion is limited by consistently referred to "the remaining carbon budget".
32846	1	2	1	2	I suugest inserting"warming" between C and in [Kenya]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
10490	1	36	1	37	The title of chapter 2 is about mitigation pathway compatible with 1.5C. However in this chapter the authors refer to both 1.5C and 2C in different parts. If 2C should be addressed, there is a need to specify it in the title of the chapter. [Hong Yang, Switzerland]	Taken into account - The title of the chapter, as well as the scope of the topics discussed in it are mandated by the approved outline and scope. So the authors do not have the mandate to change the title and the fact that both 1.5°C and 2°C are discussed in the chapter.
47742	2	18	2	18	Role of non-CO2 GHGs and aerosols". Please use full forms on first application followed by abbreviations in next use onwards. This applies to all abbreviations. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
17990	2	48	2	49	In the 5% of pathways that experience the greatest warming due to non-CO2 drivers there is a 3% risk that the TPB for 1.5°C is already exhausted, and a 25% risk that the TRB for 1.5°C is exhausted. Exhausted or already exhausted? Please clarify to avoid misunderstandings. Note that TRB has not been yet defined in this chapter (while TPB had been). It would be worth to clarify both definitions and their differences. [Andrea TILCHE, Belgium]	This part of the text has been greatly revised so this is no longer applicable.
3764	2	50	2	50	Another example of SO2 warming is Xu et al. (2015). Xu, Y., J.-F. Lamarque, and B. M. Sanderson (2015), The importance of aerosol scenarios in projections of future heat extremes, Climatic Change, 1–14, doi:10.1007/s10584-015-1565-1. [Yangyang Xu, United States of America]	Noted, thank you.
47744	3	2	3	2	Kindly use "near-term". [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47746	3	16	3	16	Kindly check: "carbon capture and storage" or "Carbon Capture and Storage" [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
35756	3	42	3	43	CO2 emissions or removals from the Agriculture' to be modified to CO2 removals from agriculture, as CO2 emission from biological system is though respiration and decomopistion, essential and unavoidable process for ecosystem sutainability (Ecosystem Sustainability and Global Change By A. Monaco and Patrick Prouzet, Wiely Pub, 2014). Instead emission reduction from non-bilogical sectors may be given more emphasis. [India]	Taken into account - Throughout the chapter emissions and removal refer to anthropogenic emissions and removals. This also applies to AFOLU-related fluxes. Respiration and decomposition are hence only accounted towards these emissions if they are steered by human action.
40822	3	42	3	43	CO2 emissions or removals from the Agriculture' may be modified to CO2 removals from agriculture. Since the CO2 emission from biological system is though respiration and decomopistion, essential and unavoidable process for ecosystem sutainability (Ecosystem Sustainability and Global Change By A. Monaco and Patrick Prouzet, Wiely Pub, 2014). Instead emission reduction from non-bilogical sectors may be given more emphasis [NARESH KUMAR SOORA, India]	Taken into account - Throughout the chapter emissions and removal refer to anthropogenic emissions and removals. This also applies to AFOLU-related fluxes. Respiration and decomposition are hence only accounted towards these emissions if they are steered by human action.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
58114	4				I miss a clear statement about the achievability of the 1.5°C target. The executive summary says much about the conditions under which the 1.5°C target is not feasible, but it does not clearly state whether or not the target is still achievable. This may appear redundant from a sceintific point of view, but it is crucial for the assessment. [Nico Bauer, Germany]	Taken into account - The achievability of a 1.5°C target only emerges from the various lines of evidence presented in all in this report. In the SPM these lines of evidence are brought together.
13116	4		118		Introduce quantitative findings on potential macro-economic implications and trade-offs in regards to achieving other SDGs (e.g. on poverty, economic growth, water scarcity, land use, etc.). [Eleni Kaditi, Austria]	Taken into account - However, this FAQ now focusses on the impact of energy supply and demand, while macro-economic implications and interactions with SDGs are discussed elsewhere, for example, Section 2.5, and Chapter 5.
13118	4		118		The chapter lacks regional analysis. [Eleni Kaditi, Austria]	Agreed - However, due to the limited scope and length attributed to chapter 2, only a global perspective is provided here. Chapter 4 provides regional and local insights through case studies.
13120	4		118		Analysis should elaborate on whether issues related to historical responsibility, CBDR, and means of implementation were taken into consideration when developing and examing the different scenarios. [Eleni Kaditi, Austria]	Taken into account - the text referred to in this comment has been removed during the revision stage. Questions of historical responsibility, CBDR, and means of implementation were not part of the approved outline for Chapter 2. However, they are touched upon by the assessments in Chapters 4 and 5, which all feed into the SPM.
58388	4				The terms “peak” and “return” budgets are quite confusing since both contain a peak in temperatures. Maybe it would be clearer simply referring to these as “overshoot” and “no-overshoot” budgets? [Andrew Prag, France]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed. A reasoning and explanation of the carbon budget assessment is provided in Section 2.2. and the technical annex.
58390	4		4		It would be helpful to explain up-front why peak budgets are generally smaller than return budgets. This is mentioned on page 2-16. [Andrew Prag, France]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed. A reasoning and explanation of the carbon budget assessment is provided in Section 2.2. and the technical annex.
8318	4	1	8	17	It is suggested to add a description of the systematic transformation in the Executive Summary, one that involves all aspects rather than mere energy. [China]	Taken into account - The ES now highlights the key aspects of the transformation beyond energy, for example how resource-intensive consumption is a key impediment.
8320	4	1	8	17	There are few descriptions in the Executive Summary of challenges, opportunities and synergies for the implementation of an emission reduction pathway, which is analyzed in detail later in this chapter (as seen in Section 2.5 in this chapter, pages 85-106). It is suggested to add a relevant analysis in the ES. [China]	Taken into account - while a detailed discussion of key barriers is part of the scope of Chapter 4, the chapter 2 ES makes reference to some of these aspects and they have also been further integrated in the SPM: "In comparison to a 2°C limit, required transformations to limit warming to 1.5°C are qualitatively similar but more pronounced and rapid over the next decades (high confidence). 1.5°C implies very ambitious, internationally cooperative policy environments that transform both supply and demand (high confidence). {2.3, 2.4, 2.5} Policies reflecting a high price on emissions are necessary in models to achieve cost-effective 1.5°C-consistent pathways (high confidence). Other things being equal, modelling suggests the price of emissions for limiting warming to 1.5°C being about three four times higher compared to 2°C, with large variations across models and socioeconomic assumptions. A price on carbon can be imposed directly by carbon pricing or implicitly by regulatory policies. Other policy instruments, like technology policies or performance standards, can complement carbon pricing in specific areas. {2.5.1, 2.5.2, 4.4.5} Limiting warming to 1.5°C requires a marked shift in investment patterns (limited evidence, high agreement). Investments in low-carbon energy technologies and energy efficiency would need to approximately double in the next 20 years, while investment in fossil-fuel extraction and conversion decrease by about a quarter. Uncertainties and strategic mitigation portfolio choices affect the magnitude and focus of required investments. {2.5.2}"
17892	4	1			very good executive summary! Sometimes the language is a bit bulky, but a lot of interesting details are given, some more of them should appear in the SPM, e.g. on investment numbers; the numbers on CDR requirement; some details of Table 2.7 provide important policy-relevant indicators, but did not make it into the SPM [Brigitte Knopf, Germany]	Noted. Thank you for the supportive feedback. Also in this revised version we have attempted to keep messages clear, robust and as quantitative as the literature allows.
39114	4	1	7	56	Please write as clearly and simply as you can. Remember many policy readers are non-specialists and often reading in a second or third language. [Lindsey Cook, Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
61750	4	1	4	8	I recommend to shorten the chapter executive summary and have a more rigorous and homogeneous use of the IPCC calibrated language. The first paragraph is an introduction to the chapter, not to the executive summary or methods of assessment, and should be either removed or replaced. It would make sense to introduce upfront the tools used for the assessment, their coherency with those used in the AR5, but also their limitations. Please avoid having a full paragraph in bold, and improve the traceability of key findings to the conclusions of sections, and thus the underlying assessed literature. Please do not use the word "models" without being explicit on the type of model used. [Valérie Masson-Delmotte, France]	Taken into account - The ES has been brought within engineering rounding precision of the target length (+- 10%) and style and referencing has been harmonized with the other ES in the report.
4882	4	3	4	9	In that 1.5 C was a political choice rather than a scientific one, I would urge the chapter to also be covering the implications of stabilizing at 1.5 C versus other levels. The Paris Accord focused on limiting the maximum warming to 1.5 C, but it did not approve using 1.5 C as the long-term stabilization level, and so there really needs to be a scientific presentation of what the implications are of staying at 1.5 C or returning down to 1, 0.5, and 0 degrees above preindustrial. Omitting such information seems to me a very serious defect of the report as there is available scientific information on this important question, even if not enough for a complete assessment. In addition, a question needing to be covered is the time it takes to come back down, so the timing as well as the level are also important to be covering. [Michael MacCracken, United States of America]	Rejected - The authors are mandated to assess issues that are in the approved scope for the chapter. Also due to space constraints further temperature levels did not fit within the scope of this special report. The AR6 has the mandate to look at the full breadth of temperature outcomes.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
30866	4	3	8	17	ii) The ES does set out that non-CO2 emissions can change the TPB, but does not say by how much. Page 21 is very clear about the non-CO2 impacts – the ES should include the amounts by which the TPB could go up and down dependent on non-CO2 assumptions. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - non-CO2 influence on the remaining carbon budget is assessed and robust insights highlighted in the ES.
30868	4	3	8	17	iii) Similarly, the ES mentions (page 6, line 26) a CDR figure of 380-1130 GtCO2. It appears that this CDR figure should be used in conjunction with the TPB figure. For example, if the CDR figure were 380, then the total CO2 emissions budget could be 860 GtCO2 for a total TPB of 580 GtCO2. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable anymore as the discussion of the remaining carbon budget now draws on the concept of TCRE (see Section 2.2).
30870	4	3	8	17	It appears from chapter 2 that there are three main factors determining whether we meet a particular probability of a keeping to a 1.5 degree TEB: i) total CO2 emissions, ii) non-CO2 assumptions, iii) levels of CDR. If this is the case it needs to be made much more explicit in the ES. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - it is mainly the first two factors that determine the probability.
30874	4	3	8	17	The critical issue for meeting a given temperature goal appears to be to what extent the combination of i) CO2 mitigation, ii) non-CO2 mitigation and iii) CDR are used. The ES is not clear on this and I would strongly suggest the use of, say, something like the diagrams of alternative scenarios 1 and 5 on page 32 to illustrate this point. However, this is also not ideal as these diagrams do not cover the large possible variations in non-CO2 emissions. Could a new diagram be created for the ES which also covers non-CO2? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - the critical factors are the future cumulative carbon emissions combined with non-CO2 warming contribution.
30876	4	3	8	17	For a given TPB, the large potential for changes to the CO2 budget because of non-CO2 (plus or minus roughly 400 Gt CO2 according to Figure 2.4), and CDR (0 to around 1200 GtCO2 for BECCS, 0 to around 500 for AFOLU according to Figure 2.4) imply that there needs to be some assessment in the ES about the feasibility of these non-CO2, AFOLU and BECCS options, to give a clearer view of what is required from CO2. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable anymore as the discussion of the remaining carbon budget now draws on the concept of TCRE (see Section 2.2).
30864	4	3	8	17	The Executive Summary (ES) says it will address the question “what is the remaining budget of CO2 emissions to stay below 1.5 degrees?” I suggest that the ES needs to have clearer signposting, particularly around the critical issues of non-CO2 forcing and CDR, and in places additional text, to give a clearer answer to this critical question. For example: i) The TPB for 50% likelihood of limiting warming to 1.5oC is given as 580 GtCO2.. This is described (page 4 line 35) as “cumulative CO2 emissions”. I think that this is a net CO2 emissions budget. But the implication could be taken from page 4 is that it is just gross CO2 emissions. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The ES (and the underlying chapter) has been significantly revised to provide a clearer assessment on the estimate of the remaining carbon budget and the contributions of non-CO2 forcers. CDR requirements are also discussed in depth and highlighted in the ES:
30872	4	3	8	17	Both the non-CO2 and CDR variations are very large. Consequently, for a given TEB, what this implies for CO2 mitigation will vary to a large degree depending on non-C02 and CDR assumptions. Related to this it is confusing that the ES states (page 6, line 8) that “1.5 scenarios require deep reductions in CO2 reaching carbon neutrality around mid-century” – for example page 57 implies that a very high CDR scenario (REM-mag|SSPS-19) would have CO2 emissions of around 1400 GtCO2. In that scenario, there would be far less deep CO2 reductions than in other scenarios – the carbon neutrality would have been achieved, to a much larger degree than in other scenarios, by extensive use of BECCS. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Not applicable anymore as the discussion of the remaining carbon budget now draws on the concept of TCRE (see Section 2.2).
30882	4	3	8	17	There is widespread belief that CDR techniques could allow the prolongation of CO2 emissions for a long time. This report should assess whether this is the case. To an extent it does this. It appears that given the likely limitations of CDR deployment, and the likely need to use what CDR is possible to deal with GHG emissions that cannot be reduced to zero, there is minimal scope for CO2 emissions to continue to any large degree beyond 2050. (IS THIS AN ACCURATE READING OF THE REPORT, IF SO IT NEEDS TO BE MORE EXPLICIT IN THE ES). At the moment though, the use of high end CDR figures in the ES would give the casual reader the strong impression that there are plausible options for delaying action. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - the chapter has assessed this issue and states in its ES that "All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence). The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net-negative emissions after mid-century to return warming to 1.5°C (high confidence). The faster reduction of net CO2 emissions in 1.5°C- compared to 2°C-consistent pathways is predominantly achieved by measures that result in less CO2 being produced and emitted, and only to a smaller degree through additional CDR. Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot. Limits to our understanding of how the carbon cycle responds to net negative emissions increase the uncertainty about the effectiveness of CDR to decline temperatures after a peak. {2.2, 2.3, 2.6, 4.3.7}"
30884	4	3	8	17	Chapter 2, p57 and FAQ 2.2 p118 both cover the issue of how we stay within a TEB. The variation is enormous. MES-GLOB|LED is a no BECCS scenario which gets its low CO2 emissions from “very low energy demand” (p29, line 45). REM-Mag|SSPS-19 is by contrast high CO2 with very high BECCS. But which are the more likely achievable options? I think there needs to be greater discussion of this, summarised in the Exec Summary. Similarly, the balance of the chapter feels weighted more to discussion of CDR options, rather than options which cut CO2 or other GHG emissions. For example “dietary choices” are mentioned a lot, but with little apparent quantification of the potential GHG reductions possible. It is also not clear to what extent there is overlap between these types of option within the scenarios. For example, REM-Mag|SSPS-19 has huge amounts of BECCS. Does the land for this BE come from reductions in land used by cattle, because of dietary changes (which would lead to emissions cuts)? Or does it come from reductions in forested land (for example), which might lead to emissions rises? I think it is the former? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - the ES highlights the various ways in which warming can be limited to 1.5°C and the key contributors to a stronger reliance on CDR.
30886	4	3	8	17	There seem to be 8 critical tables or figures in this report – table ES1 p4, table 2.6 p30, table 2.7 p34, figure 2.4, figure 2.7 p32, figure 2.8 p33, figure 2.15 p53 and figure 2.17 p57. They need to be read in conjunction with each other to grasp the complexity of what is going on, and even then it is hard. I suggest that the ES needs to include some of these diagrams, close to each other, with a clear explanation of what they mean together for CO2 budgets, non-CO2 and CDR. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - unfortunately, ES are not supposed to contain any diagrams or tables.
42128	4	3			preindustrial ===> pre-industrial [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
22526	4	4			Because this is the first time that CO2 is used, perhaps it should be written in full - i.e., carbon dioxide -, followed by "CO2" in brackets, just as it is in line 13 [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
30888	4	4	4	6	the first question: “remaining budget … to stay below 1.5” implies that budgets to overshoot and return aren’t acceptable. If that’s what is intended, fine. But you could merge the first two questions to say “what is the remaining budget for staying below 1.5 degrees, or overshooting and returning to below 1.5 degrees?”. I assume that other chapters will cover in detail the relative pros/cons of the two different approaches. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The ES has been significantly revised in response to the reviewer comments and now presents the assessment of the remaining carbon budget to limit warming to 1.5°C (excluding overshoot).
45716	4	4			The term "carbon budget" should be defined for the purpose of an executive summary. [Astrid Kiendler-Scharr, Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
54778	4	5	4	6	I suggest to place the sentence on overshooting after "How is the carbon budget affected by non CO2 emissions" or even later. Overshooting should/could be treated only as a last resort alternative in case rapid and direct emissions reduction is not achieved/achievable and should come after the discussions about carbon budget and pathways without overshooting. [Marine Gorner, France]	Taken into account - The ES has been thoroughly revised between the SOD and the next version. The carbon budget discussion has also been reframed to apply to keeping warming to below a specific temperature limit.
14016	4	6	4	51	Soil carbon is not mentioned. Could add to line 28 …….”such as afforestation" and increasing soil carbon content. [Ralph Sims, New Zealand]	The ES only highlights those messages that are most robust and most central to the assessment of the chapter. Soil carbon is more within the scope of the Special Report on Climate Change and Land and is thus not highlighted here.
17622	4	7	4	7	Suggest adding "supply and demand" after "transition in energy". [Sai Ming Lee, China]	Taken into account - The ES has been thoroughly revised. We highlight both supply and demand measures, while at the same time keeping the word count down by avoiding repetition.
42130	4	7			and ===> , and [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47748	4	7	4	8	Kindly use "land-use" and "near-term". This applies to all instances throughout the text. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42132	4	9			modelling ===> modeling [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
52870	4	9	4	11	There is room for a generic statement on what is required to stablise the global temperature at any particular level [Ireland]	Taken into account - However, this would be part of the Chapter 1 assessment and hence feature in their ES. Chapter 2 highlights the TCRE concept and non-CO2 contributions, together with the remaining carbon budget.
5944	4	11			There is a very high risk that… [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
7384	4	11	4	11	How do you define current emission trajectories? Is this the same as current policies scenario? I would use current policies scenario, as this is commonly used within IEA and UNEP, as it identifies most recent, publicly available official estimates of 2020 and 2030 emissions, considering projected economic trends and current policy approaches. There is literature on current policies scenarios, see IEA, Climate Action Tracker, PBL IMAGE and POLES model, but also on national studies, as summarised in the UNEP Emissions Gap report 2015-2017 (Chapter 2). [Michel den Elzen, Netherlands]	Taken into account - This language has been adjusted and we explicitly refer to current "NDCs", so that this should be clarified.
7386	4	11	4	11	How do you define current national pledges? Are these the 2020 pledges, or the 2025/2030 NDCs? [Michel den Elzen, Netherlands]	Taken into account - it has been clarified that this refers to the NDCs until 2030.
11710	4	11	8	17	The use of the term "risk" (e.g. on page 4 lines 48, 50, page 5 lines 5, 17) is confusing. It seems to be referring to a probability/likelihood rather than a risk. The IPCC already has carefully chosen language of confidence and likelihood as noted in Chapter 1 which should be followed here. [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. The use of the term risk has been reconsidered throughout the chapter
30386	4	11	4	11	Current emission trajectories AND current national pledges ? [France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51632	4	11	4	24	These two paragraphs are exactly the kind of clarity that I've talked about needing to be expressed in the whole document. Make the rest of the document consistent with this. [Jason Donev, Canada]	Noted. We are pleased to see that the SOD ES already contained two paragraphs that were up to the level expected by the reviewer and hope that this revision has continued to improve in this direction.
34154	4	12	4	14	Please rephrase to "… deep and sustained reductions in ...". {Cross-chapter Box 1.2} [Norway]	Taken into account - The revisions clarify that CO2 emissions have to reach net zero levels.
42134	4	12			preindustrial ===> pre-industrial [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
49886	4	12	4	14	Other non-CO2 drivers like Nitrous oxide and Sulfur hexafluoride have a much higher GWP. It would not be appropriate to just cite methane which primarily comes from agricultural activities. [Himangana Gupta, India]	Taken into account - the choice to highlight methane over other species is their total radiative forcing effect, not just their radiative forcing effect per unit of emission. Methane is here the most dominant short-lived non-CO2 forcer.
3298	4	13	4	13	rapid is not quantitative enough. Other similar uses of the word "rapid" elsewhere in chapter [Francois-Marie Breon, France]	Taken into account - wherever possible, the use of the word "rapid" has been accompanied by quantitative information that provides context and clarification as what is meant with "rapid". For example: "1.5°C-consistent pathways include a rapid decline in the carbon intensity of electricity and an increase in electrification of energy end use (high confidence). By 2050, the carbon intensity of electricity decreases to -92 to +11 gCO2/MJ (minimum-maximum range) from about 140 gCO2/MJ in 2020, and electricity covers 34–71% (minimum-maximum range) of final energy across 1.5°C-consistent pathways from about 20% in 2020. By 2050, the share of electricity supplied by renewables increases to 36–97% (minimum-maximum range) across 1.5°C-consistent pathways."
22528	4	13			Accordingly with the previous comment, now "carbon dioxide" can be removed. From here onwards use only CO2 [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
30388	4	13	4	13	Rapid is not quantitative enough [France]	Noted.
40946	4	13	4	13	The phrase "deep reductions in non-CO2 drivers" can be interpreted that only drivers such as rice production, livestock products production are needed to be reduced but actually there should be emissions reduction measures and they also needed to be implemented largely. so better to be rephrased that something like "deep reductions in non-CO2 emissions as well as their drivers." [Shinichiro Fujimori, Japan]	Noted.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
42136	4	13			phase out ===> phase-out [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58100	4	13			phase out is a strange term here, because it relates to net CO2 emissions [Nico Bauer, Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58102	4	13			The term technological should be added next to economic. Both are strongly correlated, but it is the combination of low innovation and scarce economic funds and flexiblity that make higher emissions more likely. [Nico Bauer, Germany]	Taken into account - However, due to a thorough revision of the ES, this particular statement does not feature anymore.
24084	4	14			?ow economic development 'of developing counteires (?)': AR5 WG3 SPM Fig.3 illustrated per capita GDP is becoming high driver of increasing GHG emission recent decades. Executive Summary of Chapter 2 (p2-8, L3) mention minimam development is necessary to reduce GHG for developing world. . [Shuzo Nishioka, Japan]	Taken into account - The ES now includes the more precise statement that: "1.5°C-consistent pathways can be identified under a range of assumptions about economic growth, technology developments and lifestyles. However, lack of global cooperation, lack of governance of the energy and land transformation, and growing resource-intensive consumption are key impediments for achieving 1.5°C-consistent pathways. Governance challenges have been related to scenarios with high inequality and high population growth in the 1.5°C pathway literature. {2.3.1, 2.3.2, 2.5}" for which evidence is provided in the highlighted sections.
30390	4	14	4	15	« mitigation pathways are put at risk by high population growth, » Maybe "put at risk" for high population growth isn't appropriate here. [France]	Noted.
50642	4	14	4	16	Risk also arises from trade-offs between mitigation pathways and ecosystems [Jagdish KRISHNASWAMY, India]	Agreed - These risks are assessed in Chapter 3 and Chapter 4, in particular related to the wide-spread deployment of bioenergy
51244	4	14	4	15	The statement "Such ambitious mitigation pathways are put at risk by high population growth, low economic development, and limited efforts to reduce energy demand" is misleading as low economic development usually results in low emissions. Therefore, the statement needs to be modified. [Muhammad Latif, Pakistan]	Taken into account - The ES now includes the more precise statement that: "1.5°C-consistent pathways can be identified under a range of assumptions about economic growth, technology developments and lifestyles. However, lack of global cooperation, lack of governance of the energy and land transformation, and growing resource-intensive consumption are key impediments for achieving 1.5°C-consistent pathways. Governance challenges have been related to scenarios with high inequality and high population growth in the 1.5°C pathway literature. {2.3.1, 2.3.2, 2.5}" for which evidence is provided in the highlighted sections.
53972	4	14	4	15	The statement that "high population growth, low economic development" would put at risk mitigation pathways highly biased and against countries in the Global South. It is the countries with low population growth and high economic development that caused climate change, and what endangers the mitigation pathways is their absence of will to challenge the fossil fuel industry and drastically change their own privileged lifestyles. Delete the reference in lines 14 & 15, as well as similar refeferences in the rest of Chapter. [Elenita Daño, Philippines]	Taken into account - The ES now includes the more precise statement which makes no value judgment: "1.5°C-consistent pathways can be identified under a range of assumptions about economic growth, technology developments and lifestyles. However, lack of global cooperation, lack of governance of the energy and land transformation, and growing resource-intensive consumption are key impediments for achieving 1.5°C-consistent pathways. Governance challenges have been related to scenarios with high inequality and high population growth in the 1.5°C pathway literature. {2.3.1, 2.3.2, 2.5}" for which evidence is provided in the highlighted sections.
59956	4	14	4	15	This sentence is problematic. It seems to imply that "low economic development" is a barrier to climate mitigation. However, history has shown that GHG emissions are strongly associated with economic development, and that "high" economic development has so far not been a viable solution to climate change by itself. In addition, countries at lower economic development stages contribute much less to per capita emissions. This language needs to be more carefully qualified. Similarly it appears in the rest of the chapter and the report that needs to be modified accordingly. [United States of America]	Taken into account - The ES now includes the more precise statement that: "1.5°C-consistent pathways can be identified under a range of assumptions about economic growth, technology developments and lifestyles. However, lack of global cooperation, lack of governance of the energy and land transformation, and growing resource-intensive consumption are key impediments for achieving 1.5°C-consistent pathways. Governance challenges have been related to scenarios with high inequality and high population growth in the 1.5°C pathway literature. {2.3.1, 2.3.2, 2.5}" for which evidence is provided in the highlighted sections.
59958	4	14	4	16	The assertion that, "such ambitious mitigation pathways are put at risk by ... low economic development" does not appear to be supported in sections 2.3.1, 2.3.5, or 2.5.1. While low economic development can reduce the resources available for mitigation and adaptation, it can also result in lower baseline emissions, complicating the relationship between development levels and the ability to meet ambitious mitigation pathways. The asserted relationship does not appear to be supported with 'high confidence.' Suggest deleting. [United States of America]	Taken into account - The ES now includes the more precise statement that: "1.5°C-consistent pathways can be identified under a range of assumptions about economic growth, technology developments and lifestyles. However, lack of global cooperation, lack of governance of the energy and land transformation, and growing resource-intensive consumption are key impediments for achieving 1.5°C-consistent pathways. Governance challenges have been related to scenarios with high inequality and high population growth in the 1.5°C pathway literature. {2.3.1, 2.3.2, 2.5}" for which evidence is provided in the highlighted sections.
4464	4	15	4	15	Is it common understanding that low economic development will contribute to increase CO2 emissions? [Mitsutsune Yamaguchi, Japan]	It probably isn't. Therefore, this statement has been revised and now reads: "1.5°C-consistent pathways can be identified under a range of assumptions about economic growth, technology developments and lifestyles. However, lack of global cooperation, lack of governance of the energy and land transformation, and growing resource-intensive consumption are key impediments for achieving 1.5°C-consistent pathways. Governance challenges have been related to scenarios with high inequality and high population growth in the 1.5°C pathway literature. {2.3.1, 2.3.2, 2.5}"
13078	4	15	4	15	Delete the text ", and limited efforts to reduce energy demand". [Eleni Kaditi, Austria]	Taken into account - However, the reviewer provides no evidence or rationale why this statement should be removed. The ES has been thoroughly edited to reflect the scientific assessment available in the chapter.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
22752	4	15			?ow economic development '? is this 'low economic development of least developing countries'?: AR5 WG3 SPM Fig.3 illustrated per capita GDP is becoming high driver of increasing GHG emission recent decades. Executive Summary of Chapter 2 (p8, L3) mentions minimum development is necessary to reduce GHG for developing world. [Shuzo Nishioka, Japan]	Taken into account - The ES now includes the more precise statement that: "1.5°C-consistent pathways can be identified under a range of assumptions about economic growth, technology developments and lifestyles. However, lack of global cooperation, lack of governance of the energy and land transformation, and growing resource-intensive consumption are key impediments for achieving 1.5°C-consistent pathways. Governance challenges have been related to scenarios with high inequality and high population growth in the 1.5°C pathway literature. {2.3.1, 2.3.2, 2.5}" for which evidence is provided in the highlighted sections.
31384	4	15	4	15	The sentence that “Such ambitious mitigation pathways are put at risk by high population growth, low economic development, and limited efforts to reduce energy demand” could be read that low economic development would contribute to increase CO2 emissions. But this is not always true, so we would suggest to reconsider the word “low economic development” . [Japan]	Taken into account - The ES now includes the more precise statement that: "1.5°C-consistent pathways can be identified under a range of assumptions about economic growth, technology developments and lifestyles. However, lack of global cooperation, lack of governance of the energy and land transformation, and growing resource-intensive consumption are key impediments for achieving 1.5°C-consistent pathways. Governance challenges have been related to scenarios with high inequality and high population growth in the 1.5°C pathway literature. {2.3.1, 2.3.2, 2.5}" for which evidence is provided in the highlighted sections.
31386	4	15	4	17	The implication is that the 2°C target is so difficult to achieve, it will require to mobilize all existing low-carbon technologies to have a chance of achieving it; and for the 1.5°C target, there is no portfolio of technologies beyond that. So given the current level of technologies and their projected development, in order to try and implement the 1.5°C target, there is no other plan than to enhance even more the level of diffusion of each of these technologies. It would not be the role of IPCC to write such conclusions. With the phrasing as is, we worry that it sounds like to achieve 1.5°C, the same set of technologies as for the 2°C target is appropriate, and that it will require a little bit more effort, but that the hurdles are not so high.?Therefore, please add the sentence "In other words, in order to try and achieve the 1.5°C target, so far there is no other plan than to enhance further more the level of diffusion of each of these technologies which are adopted for the 2°C target." [Japan]	This statement has been considered, but no evidence was identified that would support such strong wording, particularly in light of the updates in the remaining carbon budgets.
37806	4	15	4	15	Lowering energy demand seems to be an inappropriate term as most 1.5°C scenarios show, at best, stagnating primary and final energy demand (figures 2.11, 2.12, 2.13). So, energy demand might be lower than today in per capita terms. I suggest to use higher energy efficiency or higher conversion and end-use energy efficiency instead or lowering energy demand growth [Michiel Schaeffer, Netherlands]	Taken into account - In the instance where the term "lowering energy demand" is used, this is now put in relation to 2°C pathways so that its relative character is made clear.
36942	4	15	4	17	The implication is that the 2? target is so difficult to achieve, it will require to mobilize all existing low-carbon technologies to have a chance of achieving it ; and for the 1.5? target, there is no portfolio of technologies beyond that. So given the current level of technologies and their projected development, in order to try and implement the 1.5? target, there is no other plan than to enhance even more the level of diffusion of each of these technologies. Is it not the role of IPCC to write such conclusions? With the phrasing as is, we worry that it sounds like to achieve 1.5?, the same set of technologies as for the 2? target is appropriate, and that it will require a little bit more effort, but that the hurdles are not so high. [Keigo Akimoto, Japan]	Taken into account - the revised ES makes clear that 1.5°C implies preconditions which are different from 2°C. In particular the ES states that: "In comparison to a 2°C limit, required transformations to limit warming to 1.5°C are qualitatively similar but more pronounced and rapid over the next decades (high confidence). 1.5°C implies very ambitious, internationally cooperative policy environments that transform both supply and demand (high confidence). {2.3, 2.4, 2.5}"
46438	4	15	4	15	It is here suggested that ambitious mitigation pathways are put at risk by low economic development and a reference is made to several sections. I can however not find this statement substantiated by these sections. Of course the relation between economic development and mitigation is complicated (there is a need for investments but on the other hand economic grwoth leads to higher consumption levels), so this statement probably needs some refinement and also a clearer link to the text in the report. [Göran Finnveden, Sweden]	Taken into account - The ES now includes the more precise statement that: "1.5°C-consistent pathways can be identified under a range of assumptions about economic growth, technology developments and lifestyles. However, lack of global cooperation, lack of governance of the energy and land transformation, and growing resource-intensive consumption are key impediments for achieving 1.5°C-consistent pathways. Governance challenges have been related to scenarios with high inequality and high population growth in the 1.5°C pathway literature. {2.3.1, 2.3.2, 2.5}" for which evidence is provided in the highlighted sections.
51100	4	15	4	15	Low economic development would need to be clarified in how it puts 1.5 at risk. Do you mean "development" to refer to economic growth? In that case, it would be more appropriate to state that high economic growth (rather than low economic growth) puts 1.5 at risk. Also, high economic inequality in wealth and income puts at risk ambitious mitigation pathways. [Linda Schneider, Germany]	Taken into account - The ES now includes the more precise statement that: "1.5°C-consistent pathways can be identified under a range of assumptions about economic growth, technology developments and lifestyles. However, lack of global cooperation, lack of governance of the energy and land transformation, and growing resource-intensive consumption are key impediments for achieving 1.5°C-consistent pathways. Governance challenges have been related to scenarios with high inequality and high population growth in the 1.5°C pathway literature. {2.3.1, 2.3.2, 2.5}" for which evidence is provided in the highlighted sections.
51102	4	15	4	15	the entire list basically misses the point. Given the stark differences in emissions per capita (between and within countries), it would be more appropriate to talk about lifestyles and consumption patterns rather than the absolute number of people. Also, "low economic development" obfuscates the problem of staggering economic inequality, which is the real problem, as well as wasteful production patterns. [Linda Schneider, Germany]	Taken into account - The ES now includes the more precise statement that: "1.5°C-consistent pathways can be identified under a range of assumptions about economic growth, technology developments and lifestyles. However, lack of global cooperation, lack of governance of the energy and land transformation, and growing resource-intensive consumption are key impediments for achieving 1.5°C-consistent pathways. Governance challenges have been related to scenarios with high inequality and high population growth in the 1.5°C pathway literature. {2.3.1, 2.3.2, 2.5}" for which evidence is provided in the highlighted sections.
5946	4	19	4	24	this should be rewritten as the first sentence is not clear. What does it mean that it is possible to define consistency? [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The revised ES does not feature this sentence anymore.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
27970	4	19	4	20	After "including pathways that" replace "keep" with "stabilize". Rationale: It is confusing when written that limiting warming to 1.5°C can be done by keeping temperature below 1.5°C. Using stabilize makes the difference of stabilizing as opposed to overshooting more clear and also more consistent with language in Ch 1. [Germany]	Taken into account - The ES has been thoroughly revised and this statement does not feature anymore.
36644	4	19	4	24	Is there consistency across the chapters regarding the reference period for the 1.5C of warming? [Anna Harper, United Kingdom (of Great Britain and Northern Ireland)]	Yes. The reference periods and working definitions for preindustrial are introduced in Chapter 1 and consistently applied throughout the report.
40808	4	19	4	24	This '1.5oC senario' as defined in this para should be adopted throught the report for consistancy [NARESH KUMAR SOORA, India]	Accepted - The working definition for 1.5°C-consistent scenarios, as introduced in Chapter 1, has been consistently applied and further refined in Chapter 2.
45320	4	19	4	20	I would like to see probability with this sentence (like the one in page 11 line 28-29). Otherwise this statement will be misused. [Tuomo Kalliokoski, Finland]	Taken into account - The ES has been thoroughly revised and this statement does not feature anymore.
52872	4	19	4	21	The wording could be shorter and simplier, e.g., Pathways can keep the temperure increase below 1.5C, go above 1.5C and decline to 1.5 etc [Ireland]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51106	4	19	4	24	Overshoot pathways involve additional risks of triggering tipping points in the climate system that might make it more difficult to return to climate parameters that resemble a 1.5 world (temperature, but also other parameters). Also, the damage done, and the potential irreversibility of damage done during the period of overshoot, is an important difference between overshoot and non-overshoot pathways. This difference, and the risks entailed by an overshoot, should be made explicit here. Given that the report is being written in the context of sustainable development, it should be made unmistakably clear that non-overshoot pathways are to be given strong preference. [Linda Schneider, Germany]	Taken into account - The risks and consequences of overshoot are assessed and highlighted in the ES.
55952	4	19	4	24	See comment for Ch. 1-21 above on limiting overshoot scenarios to 2100. [Pamela Pearson, United States of America]	Taken into account - The risks and consequences of overshoot are assessed and highlighted in the ES.
42138	4	20			global ===> the global [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
708	4	22	4	22	including for sustainable development.' 'including for instance sustainable development.' [Robert Shapiro, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
4880	4	22	4	24	I think that this is a very unfortunate approach. The impacts and conseqeunces of climate change very likely are more related to the peak temperature reached rather than the eventual equilibrium value, and the convention naming convention here does not make this differentiation clear. I would urge differentiating, naming the pathways that have overshoots as, perhaps, "1.5 C overshoot pathways" and the pathways that stay below 1.5 as the "1.5 C limit pathways". In addition, the report should be covering the effect of different times at which the temperature is returned to 1.5 C or below. [Michael MacCracken, United States of America]	Taken into account - The ES has been thoroughly revised and this statement does not feature anymore. The risks and consequences of overshoot are assessed and highlighted in the ES.
53164	4	22	4	24	Including also Sections 2.2.3. I do not think it is appropriate to call both overshoot and non-overshoot scenarios by the same broad name of "1.5C scenario" given the vastly different impacts they may have. I suggest keeping the distinction wherever possible, especially in the ESs and SPM. [Christopher Weber, United States of America]	Taken into account - We make a clear distinction between overshoot and non-overshoot pathways. However, only to a degree that the scientific evidence in climate response allows us to.
19486	4	25	4	25	Please clarify how the "1.5°C scenario", as defined here, relate to the 2°C threshold. Looking at the Table 2.5 at page 24, one could assume that the "1.5°C scenario" would imply at least a 85 % probability of staying below 2°C. Is this correct? Please also add a definition for the "2°C Scenario" referred to in the report. Does it, by default, refer to all scenarios that keep below 2°C with at least 50 % probability, and hence should not be read as "below 2" or "well below 2" scenarios? [Jennifer Morgan, Netherlands]	Taken into account - 1.5°C-consistent scenarios have been defined in Chapter 1 as scenarios that keep warming with about a one-in-two or two-in-three chance to below 1.5°C during or by the end of the 21st century. Additional 2°C-consistent scenarios have been defined in Section 2.1. However, due to the inherent uncertainty of probabilities, a precise statement on how they relate to each other in terms of absolute probabilities was not deemed sufficiently robust to highlight in the ES.
5948	4	26	4	30	same as before, this point is not clear. What is the key message? Is it about the temperature outcome, or the socio-economic interplay? [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The ES has been thoroughly revised and this statement does not feature anymore.
42140	4	27			and ===> , and [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51030	4	27	4	29	an important point that is not adequately reflected in the underlying report. Also, it is not merely the models that are constrained, but also the utility of the information they produce. [Doreen Stabinsky, United States of America]	Taken into account - The revised draft now highlights strengths and limitations of these models upfront, as well as in the ES:
52874	4	27	4	27	include "wider" ahead of economy [Ireland]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51108	4	30	4	31	This statement is misleading. It's not that a 66% likelihood is out of reach of the models, again it says that no 66% of the models can generate pathways that achieve a given result, i.e. it's a matter of distribution of results across the models. Since they do not all have the same likelihood of being true (see comment 3), the more important question is which model is more accurate in its assumptions,. Hence, the indicated statement that cannot truthfully be made. [Linda Schneider, Germany]	Unclear - The indicated page and line numbers to not refer to a statement on the likelihood of achieving a specific temperature outcome.
19116	4	32	4	52	It is counterintuitive to me that the TRB are generally smaller than the TPB at least for the 2°C scenarios. Carbon sinks are stronger in an overshoot scenario because the fertilisation effect over land and the solubility effect over ocean win over the temperature effect, at least for small T changes. The additional C that is sequestered eventually returns the atmosphere but this may take a long time, so the budgets on a multidecadal timescale should be larger in the case of overshoot for a given T target. Maybe there are other reasons for the differences (e.g. the difference in the period considered for the integral). In any case the physical reasons behind the differences between TRB and TPB should be spelled out. [Olivier Boucher, France]	Taken into account - The discussion of the remaining carbon budget has been thoroughly revised so that the TRB and TPB concepts do not have to be introduced anymore.
19118	4	32	4	52	Generally speaking there is a lack of traceability for the C budgets provided in the exec summary and in the chapter. I understand they come from MAGICC but have not been published. How reproducible are these? How traceable are these to complex models? How valid are the approximations made in MAGICC? There is a real issue of credibility for IPCC if the numbers are not traceable. [Olivier Boucher, France]	Taken into account - The discussion of the remaining carbon budget has been thoroughly revised so that the TRB and TPB concepts do not have to be introduced anymore. There is now full traceability of the budget values to the underlying chapter and additional information included in the Technical Annex.
21658	4	32	5	2	The two carbon budgets should be explained more lucidly. What do they imply to policy? Is one for the non-overshoot and one for the overshoot case? [Sweden]	Revised.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
34156	4	32	4	34	Consider including a sentence or para to make the connection between cumulative emissions and long-term climate change explicit, such as: "Because of the almost linear dependence between cumulative emissions of long lived climate forcers and long term climate change, net emissions of long lived gases, such as CO2, return to approximately zero in the long run. The ability to remove CO2 from the atmosphere with CDR technologies will be essential. In 1.5°C-scenarios with somewhat limited deployment of such technologies, CO2 emissions are reduced from the current level of 40 Gt CO2 to just 14.5 Gt CO2 in 2030, and to below zero before 2050.". These numbers are taken from Table 2.7 for the "Below 1.5C 50" scenario class. [Norway]	Refers to text that has been changed so no longer relevant.
55444	4	32			My sense is that the section on carbon budgets should come after the following section, or perhaps even at the end of the executive summary, not at the beginning. This is because of the uncertainties and dependence on definitions in those budgets. Carbon budgets are a useful diagnostic tool but I don't think the case has been made that they are the pre-eminent driving tool for policy decisions and implementation, and hence their placement needs to be considered in the executive summary (and the SPM). [Andy Reisinger, New Zealand]	Moved later in ES.
8322	4	34	4	42	The 'remaining carbon budget' still involves many uncertainties as mentioned in the specific analysis later in the report, while the assumptions made by the different studies differ a lot (as seen in lines 9-25, p16: Precise comparison of TRBs and TPBs is complicated due to their different definitions). Therefore, it is suggested to add a paragraph to this sentence, indicating that there is still much uncertainty in the analysis of the remaining carbon budget. [China]	Accepted - In the revised assessment of the remaining carbon budget, the key uncertainties have been assessed and highlighted in the ES.
34684	4	34	4	42	Seccion 1. It requires to be clearer in the statements and comparisons that are made for example says: "Current emissions are ~40 GtCO2 yr-1, which means budgets from 2019 onwards will be ~120 40 GtCO2 lower than counting from the start of 2016" Suggestion: "Current emissions are ~40 GtCO2 yr-1, which means budgets from 2019 onwards will be ~120 40 GtCO2 lower than counting from the start of 2016 (budget from 2016 anwards will be XXX GtCO2). [Mexico]	Clarified in new draft.
39350	4	34	4	42	In the same way we have explained in our comment nº2, we propose to start this paragraph defining the Global Carbon Budget concept. [Olga Alcaraz, Spain]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions."
52876	4	34	4	47	Simplify or restructure to simplify this text e.g. better seperate non-overshoot and overshoot budgets for 1.5. and 2C [Ireland]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
59962	4	34	4	42	This paragraph describes two types of carbon budgets: "Threshold Peak Budget" and "Threshold Return Budget." Elsewhere in the literature, and previously on this page (page 4, lines 22-23), these types of scenarios are described as "non-overshoot" and "overshoot." Suggest clarifying the relationship between TPB/TRB and 'non-overshoot'/'overshoot' scenarios. [United States of America]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions."
59960	4	34	4	47	Avoid the use of a variable end-point for the definition of a carbon budget (same comment made in SPM). The budget should be defined with a fixed end-point (such as 2150). A variable end-point means that a stricter threshold that takes a long time to reach its peak can have a larger budget than a looser threshold that happens to peak quickly: see, for example, Table SPM1, where the threshold peak budgets for 2°C are larger than the threshold return budgets, when intuitively one would expect that allowing the climate to exceed a target and return should be less difficult to achieve. For an artificial example: imagine two scenarios that reach 1.9°C in 2050. In the first, the temperature peaks to 2°C in 2060, and then falls back to 1.9°C in 2070. In the second scenario, the temperature stabilizes at 1.9°C for 100 years, peaks to 2°C in 2160, and falls back to 1.9°C in 2170. These two scenarios are practically identical, but based on a budget definition that is defined by the date on which the temperature peaks, in the first scenario, the budget would be defined by the emissions until 2060, and in the second scenario, the budget would be defined by the much larger emissions until 2160. This discrepancy in budgets between two nearly identical scenarios suggests that the variable end-point definition is likely to lead to misleading results. Table 2.6 is a much clearer summary of carbon budgets, with gross emissions and total CDR through 2100 the key pairing, and the other metrics (peak net cumulative emissions, net cumulative emissions, and the CDR breakdown) to be less central but potentially interesting supporting details. [United States of America]	Taken into account - The carbon budget assessment and discussion has been thoroughly revised so that the concepts of TRB, TPB, TEB, and TAB are not necessary anymore and therewith also the issue of variable end points. The revised assessment now provides estimates of the remaining carbon budget that can be emitted from today until global CO2 emissions reach net zero levels to still be in line with a specific temperature limit. The only scenario dependence in this assessment is the non-CO2 contribution, as indicated in the ES, Section 2.2. and the Technical Annex.
63178	4	34	4	47	Unclear regarding cummulative emissions. Do you mean gross emissions or net emissions (gross-CDR).Otherwise, why is the 1.5 case is TRB>TPB? [Greg Rau, United States of America]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions."
27972	4	35	4	35	Insert "at 1.5°C (or 2°C)" after "temperature peaks". [Germany]	Not relevant anymore due to revisions to the ES.
42142	4	35			global ===> the global [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
55622	4	35	4	35	budgets from 1 January 2016. since report will be issued in September 2018, to inform UNFCCC in late 2018 and beyond, would it be possible, at least in ES and SPM, to show remaining budgets as of 1 Jan 2019 to be more policy relevant? [David Cooper, Canada]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." A more recent start date is not possible due to lack of historical emissions data for 2018 at the time of finalisation of this report.
27974	4	36	4	37	Definition of TRB is ambiguous. As with the TPB, it should be specified, from with point in time the cumulative CO2 emissions are counted (supposedly 1st Jan. 2016). Please specify. [Germany]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions."
168	4	38	4	47	a) It is recommended that explain explicitly the meaning of likelihood in this report. b)In Table ES1?"66t%"shold be"66%". [Mingshah Su, China]	Taken into account - The concept of probabilities has been introduced in Section 2.1 and further discussed in Section 2.2. Due to inherent uncertainties related to the probability distribution a broader categorization description of scenario classes was followed. Table ES1 was removed.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
7412	4	38	4	40	please understand that for many readers it is not clear why the budgets for 1.5C for TPB and TRB are about the same, whereas for 2C these differ. I would briefly explain. [Michel den Elzen, Netherlands]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Only one budget concept is included in the ES.
348	4	39	4	40	Why give 2019? [Zong-Ci Zhao, China]	Unclear what is meant here, but 2019 is not given anymore.
30392	4	39	4	40	It could be stated for clarity that 2016 is chosen as a reference date because it is the date for which most recent data was available at the time of writing this report" [France]	Stated in chapter, no room in ES.
47750	4	39	4	40	Current emissions are ~40 GtCO2 yr-1, which means budgets from 2019 onwards will be ~120….. Kindly simplify, if possible. [Sarah Connors, France]	Taken into account - language has been edited for simplicity.
40124	4	40	4	52	Here the Executive Summary becomes unintelligible, as opposed to the preceding and following sections which are accessible and understandable. Please revisit to determine whether there is any way to make this less technical. Is it enough, for example, to include the very understandable description in P5, Lines 28-37 and delete this technical description and table? [Ko Barrett, United States of America]	Revised.
14014	4	42	6	43	At least an indication here of the land use change area required for BECCS and for afforestation should be presented. [Ralph Sims, New Zealand]	Rejected - The land areas "required" for BECCS and afforestation are not part of the core assessment in this chapter, and are hence not highlighted as one of the key messages in the ES.
5950	4	44	4	45	why is the TRB medium confidence and the TPB high confidence? Isn't the confidence related to the likelihood to meet the target? [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed.
8324	4	44	4	47	In Table ES1, the cumulative carbon footprint (TRB) when warming is controlled at 1.5? is higher than the cumulative carbon emission (TPB) when the temperature peaks. But when warming is controlled at 2?, TRB is much lower than TPB. If TRB considers the negative emission reduction technology more, it should be lower than TPB in both of these trends as we understand. It is suggested to clarify this difference. [China]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed.
14004	4	44	4	47	Would be good to explain the differences in these carbon budgets compared with data reported in AR5 WG1. [Ralph Sims, New Zealand]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions."
17896	4	44	4	46	it would be very helpful to make a bar plot out of this table. Also NDC budget and current level of yearly emissions could be added. Alternatively, a figure such as here in Figure 1 would be helpful to get an impression of the order of magnitude: http://onlinelibrary.wiley.com/doi/10.1002/gch2.201600007/full or alternatively such as here in Figure 2: http://www.economics-ejournal.org/economics/journalarticles/2017-33/version_1/count [Brigitte Knopf, Germany]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed.
27976	4	44	4	45	Table caption ES1 is unclear. It is not clear what the uncertainty language ('medium confidence' and 'high confidence') refers to here. Please rephrase the caption to clarify that Medium and high confidence pertain to the level of confidence in the assessment of the respective budgets, as explained in the chapter. [Germany]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed.
30394	4	44	4	47	Table ES1 : Unclear why the "threshold peak budget" is higher than "threshold return budget" for 2°C scenario, it would be good to have an explaination in the SPM [France]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed.
45718	4	44	4	48	It is counter intuitive that the TPB are higher than the TRB. As this is a consequence of strong requirements for periods of net-negative CO2 emissions in szenarios that overshoot 1.5°C (TRB), the fundamental underlying requirements need to be made clear in the tabel caption and related text. [Astrid Kiendler-Scharr, Germany]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions."
46388	4	44	4	47	Table ES1, Limits of TPB looks stringent for 1.5 deg. C but for 2 deg. C it is not same. [Ijaz Ahmad, Pakistan]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed.
46524	4	44	4	44	Why is this text in bold? IPCC uncertainty language should be highlighted in italic font. Please use alternative wording if not meant to be official IPCC uncertainty language or explicitly state the definition of 'likely' in this context. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47752	4	44	4	47	How is the TPB (580) lower than the TRB (590)? Please recheck. Unit of expression is missing. [Sarah Connors, France]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed.
49028	4	44	4	47	As noted for the SPM, Table ES1 may not be easily understood. It is counter-intuitive that a threshold budget for 'return' (i.e. overshoot and return) would be smaller than one for 'peak,' which does not involve overshoot. The table should be presented in a way that makes clear the cumulative gross emissios and negative emissions assumptions underlying these budgets. [David Waskow, United States of America]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed.
53166	4	44	4	44	In Table ES1, and paragraph above, it is crucial to make the connection between TPB and TRB and overshoot vs. non-overshoot. This will be obvious to some but not to many policy makers. It should be very explicit. Further, some explanation is warranted in the ES about why TPB > TRB for 1.5 but TRB < TPB for 2C. Further it is important to explain the "N/A" value for TPB/1.5C/66%. I personally find the TRB very difficult to visualize and understand. [Christopher Weber, United States of America]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed.
55842	4	44	4	44	Chapter 2 authors have done a very impressive job under extraordinary time constraints, and I also appreciate the rationale for using analytical tools consistent with those used in AR5. [Myles ALLEN, United Kingdom (of Great Britain and Northern Ireland)]	Noted and appreciated.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
55844	4	44	4	44	My key concern, reflecting the previous comment, is the exclusive reliance on the Meinshausen et al implementation of the MAGICC6 model for all quantitative scenario and budget calculations in this chapter. By simple geometry, the current level and rate of warming determines both the time to reach 1.5C if current CO2 emissions and trends in non-CO2 radiative forcing are sustained, and the number of years of current emissions in the outstanding carbon budget (assuming non-CO2 RF stabilises on the same timescale that CO2 emissions are reduced to zero). Allen et al (2018) and Leach et al (2018) make this point if simple geometry is insufficient. The level of warming in 2006-2015 in the MAGICC6 simulations is consistent with the working definition given in Chapter 1 (by construction, because they are expressed relative to 1986-2005), but the current rates of warming in these simulations are high: e.g. 0.32, 0.36 & 0.45C per decade in 2017 for the 50th, 66th and 90th percentiles under a scenario in which CO2 emissions decline linearly from 11GtC per year in 2020 to zero around 2060. These rates contrast with the AR5 assessed range for the warming rate between 1986-2005 and 2016-2035, which includes internal variability and the recovery from Pinatubo, of 0.1-0.23C per decade, and are also not consistent with Haustein et al (2017). [Myles ALLEN, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The revised chapter uses several lines of evidence to estimate the temperature outcome of mitigation pathways. See section 2.1, 2.2, and Technical Annex.
55848	4	44	4	44	The reasons for these very rapid rates of warming in the MAGICC6 simulations appear to be (a) a current CO2 airborne fraction of 0.55, which is 20% higher than the current best-estimate from the Global Carbon Project and (b) non-CO2 forcing increasing faster than observed. Regarding (b), the chapter notes that methane RF has been revised upwards, suggesting the MAGICC6 RF estimates should be an underestimate, but nevertheless the rate of increase of non-CO2 RF in the current decade is still higher than observed, suggesting the use of pre-AR5 aerosol forcing estimates may be responsible. There may also be some contribution from the adjustment of MAGICC6 from concentrations-driven to emissions-driven mode. It is very important, since this MAGICC6 set-up will be used in SR1.5 for consistency with AR5, that the reasons for these very rapid rates of current warming are understood and documented in the Final Draft. [Myles ALLEN, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The revised chapter uses several lines of evidence to estimate the temperature outcome of mitigation pathways. See section 2.1, 2.2, and Technical Annex.
55852	4	44	4	44	Given it is too late for a wholesale re-calibration of MAGICC6, the best way to address this problem would be to give a range of alternative interpretations of the 50th and 66th percentiles based on different lines of evidence. For example, it might be more consistent with assessment of current forcing and warming rates to regard the median estimate as closer to a 66th percentile. If possible, budgets based on different, traceable simple climate models, such as FAIR and the CICERO model, could also be provided. [Myles ALLEN, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The revised chapter uses several lines of evidence to estimate the temperature outcome of mitigation pathways. See section 2.1, 2.2, and Technical Annex.
59964	4	44	4	47	Units are missing from the table. They are in the title only and should be after TRB and TPB as well. [United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
62902	4	44	4	47	It would be good to give an interpretation here of what N/A means. [Sabine FUSS, Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
710	4	45	4	45	Table 2.4' should be 'Figure 2.4' [Robert Shapiro, United States of America]	Noted. Cross-references have been checked and corrected where necessary.
19490	4	45	4	47	Looking at the Table ES1, one can't help but asking: why for the 2°C threshold, is the return budget smaller than the threshold budget, when it's the other way around for 1.5°C? It would be good to explain this. [Jennifer Morgan, Netherlands]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed.
4460	4	46	4	47	I don't understand why threshold peak budget is bigger than threshold return budget (overshoot path) in case of limiting warming to 2 degree C. In case of 1.5 degree, the former is smaller that the latter. Is this correct? If yes, explanation of the reason why is necessary. [Mitsutsune Yamaguchi, Japan]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed.
4462	4	46	4	47	Based of AR5, global climate strategies to limit temperature increase to 2 degree or less meant to achieve this goal with the probability of 66-100% (defined as "likely". In Table SPM 1 of 1.5SR, both 50 and 66% probabilities are shown for 1.5 and even for 2 degree target. This may complicate readers understandings, especially for the readers accustomed to AR5. Those two targets (probability of 66% and 50%) in SR 1.5 report are very different one from the expression of probability used in AR5. It is definitely necessary to inform policymakers of this difference to avoid their misunderstandings, as they may not care about the probability of achieving certain target. Also for 1.5 degree target, basic case should be 66% and not 50%. Also we need explanation of what does 66% (or 50%) liklihood mean? In AR5 likely (66%) probability meant >66% and 50% probability was divided into two, one more likely than not (>50-100%) and as likely as not (33-66%). In this connection, whether 66% likelihood correspond to "likely" in AR 5 and whether 50% likelihood correspond to >50-100% or 33-66% or not? Or 66% (50%) probability is quite different category than what were in AR5? Please make this point clear. This is a very important point. [Mitsutsune Yamaguchi, Japan]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed. Moreover, due to the imprecise distribution of uncertainties surrounding the various factors contributing to the ultimate temperature response, likelihood distributions are inherently uncertain. This has been introduced in Chapter 1, and further discussed in Section 2.1, 2.2, as well as the Technical Annex.
13466	4	46	4	46	inTPB, is 66% likelihood real'y 'N/A' or is it missing? [Sergio Aquino, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
27978	4	46	4	47	As it seems unintuitive that the TPB is bigger than the TRB, it would be helpful to include a short explanation close to the table or even in the caption, in addition to the reference to the underlying sections. Also, it would be helpful to complement the lengthy explanation in section 2.2.2. by a short box / FAQs where the new budgets' concept is explored in a meaningful and concise manner. As the ES is going to be lifted to the TS, please also provide a short explanation as to why the budget concept has been changed compared to AR5. [Germany]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed. A reasoning and explanation of the carbon budget assessment is provided in Section 2.2. and the technical annex.
31388	4	46	4	47	It is difficult to understand difference between Threshold Return Budget and Threshold Peak Budget with current text. It would be helpful to explain the significance of using this distinction, in addition to showing simply the ranges in budget. [Japan]	Taken into account - The carbon budget assessment and ES messages have been thoroughly revised. We now clarify that "The remaining carbon budget is defined here as cumulative CO2 emissions from the start of 2018 until the time of net-zero global emissions." Table ES1 has been removed. A reasoning and explanation of the carbon budget assessment is provided in Section 2.2. and the technical annex.

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34686	4	46	4	47	Seccion1: The behavior of TPB is not clear enough or is not well described for a Executive Summary TPB is lower in the "50% likelihood- 1.5 ° C" scenario than TRB TPB is higher in the scenario "66% likelihood - 2 ° C" than TRB Also, it is not clear because the scenario "66% likelihood - 1.5 ° C" is not available [Mexico]	Refers to text that has been changed so no longer relevant.
349	4	48	4	51	It should give rate of CO2 and non-CO2 [Zong-Ci Zhao, China]	This statement does not feature anymore in the revised ES.
8326	4	48	4	50	This statement is very unclear. One is that the meaning of '5% of pathway' is not clear. The second is that the meaning of '3% risk' is not clear either. It is suggested to reformulate this sentence so that readers can fully understand it. [China]	This statement does not feature anymore in the revised ES.
17992	4	48	4	48	Please check risk values. As the TRB is bigger than TPB, the likelihood of TRB having been exhausted should be smaller. [Andrea TILCHE, Belgium]	This statement does not feature anymore in the revised ES.
21660	4	48	4	51	What is the significance of discussing 5% of pathways? This may be overly specific for the Executive Summary. Or, rephrase so that the choices do not sound arbitrary. [Sweden]	Revised.
30396	4	48	4	49	This would be worth explaining, as it is not straightorward why TRB is lower than TPB. [France]	Refers to text that has been changed so no longer relevant.
31390	4	48	4	51	The message of the sentences in bold letters is not clear. After several readings, the reader understands that it is meant to show both extremes in terms of scenarios regarding non-CO2 warmers: the 5% with more warming, the 5% with more mitigation. The first sentence mentions both the TPB and the TRB, so why does the second only mention the TRB? [Japan]	This statement does not feature anymore in the revised ES.
34158	4	48	4	51	The two sentences about emission pathways and non-CO2 driver are challenging to grasp. Please consider rephrasing and splitting up the sentences to clarify the message. Alternatively, consider replacing this technical sentence with a similar, but simplified, statement. [Norway]	This statement does not feature anymore in the revised ES.
34688	4	48	4	52	It requires to be clearer in your statements and comparisons. [Mexico]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
37808	4	48	4	49	This is is an extremely confusing statement. Normally, one expects that TRBs should be higher than TPBs and the opposite should be true for the respective exceedance probabilities. If the point of this statement is to say something about the more extreme (in the sense of non-CO2 emissions) scenarios, this needs way more elaboration for which the ES is hardly the right place. Since it does not really serve the overall messaging of the ES, it seems appropriate to remove this and rather elaborate on the lack of 66% 1.5°C TPB in table ES1, which is due to models not being able to find a solution, not due to physical constraints. [Michiel Schaeffer, Netherlands]	This statement does not feature anymore in the revised ES.
37810	4	48	4	49	The logic of this statement does not stack up. If a 1.5°C budget were exhausted already, warming should have already reached 1.5°C, or have returned to 1.5°C (for TRB). Since observations tell us that is not the case, the underlying scenarios are effectively invalidated by this statement. [Michiel Schaeffer, Netherlands]	This statement does not feature anymore in the revised ES.
52878	4	48	4	51	Too many percentages for clarity; try and simplify [Ireland]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
55446	4	48	5	2	I often find myself disagreeing with the authors what deserves to be bold text and what is additional explanation and example. Here, I would have bolded the currently non-bold text (with some revisions) and offer the (rather dense and difficult to understand) quantification that is currently in bold as specific substantiation. It would be good if the authors could seek advice from communications experts in the TSU (who may of course disagree with me and agree with the authors) to ensure that the general message is in bold and examples/demonstrations etc are in non-bold following the general point. [Andy Reisinger, New Zealand]	Revised.
59966	4	48	4	51	The percentages associated with the levels of risk are totally meaningless as is the assessment of medium confidence. (high confidence) [United States of America]	This statement does not feature anymore in the revised ES.
62962	4	48		49	Are the non-CO2 forcings considered consistent with stopping CO2 emissions now? It may not make sense to say that we have already exceeded the TPB, and hence by implication that if we stopped emitting CO2 today, we would exceed 1.5C warming, if this is based on a scenario of non-CO2 forcings which are not consistent with stopping CO2 emissions today. [Nathan Gillett, Canada]	This statement does not feature anymore in the revised ES. However, the assessment of remaining carbon budgets takes into account consistent non-CO2 warming at the time scenarios reach net zero CO2 emissions, that is, at the time cumulative emissions are effectively capped to a specific value.
17898	4	52			it would be good to give the exact year and the range of years between the models, when emissions get net negative and not only "…after mid century". And the somehow abstract numbers of the budgets would be translated into a policy-relevant indicator. [Brigitte Knopf, Germany]	This statement does not feature anymore in the revised ES. However, in the revised ES, both the central estimate and the range of net zero timings is given based on various lines of evidence.
17994	4	52	4	52	net zero and "net negative" should be defined before or when first used. It should be clear whether it refers to all fluxes to/from the atmosphere, or just anthropogenic ones. If the latter, it should be clear how those are separated from natural fluxes, in particular for land use. [Andrea TILCHE, Belgium]	This statement does not feature anymore in the revised ES. However, a definitions box in the SPM includes definitions so that which includes the concept of net zero CO2 emissions.
27980	5	4	5	11	The fact that uncertainties in the Earth system are expected to rather increase than decrease the risk of exceeding 1.5°C should be lifted to the SPM section on Carbon budgets. [Germany]	Noted, we agree, choice based on space constraints.
34160	5	4	5	11	Consider including ranges or qualitative statements that clarify how significant these uncertainties might be. [Norway]	Taken into account - The impact of Earth System uncertainties has been assessed and are mentioned in the context of remaining carbon budgets.
52880	5	4	5	5	Suggest "Uncertainties with respect to the response of the climate system to GHG warming etc", [Ireland]	Insufficient room to include this explanation in ES.
57728	5	4	5	11	To appreciate the points made, helpful to include a text characterizing the effects on feedbacks of > 1.5 deg C futures. [Steven Rose, United States of America]	Given the scope of this report and chapter, an extensive discussion on these feedbacks for warming higher than 1.5°C was not included. AR6 might provide more insights here.
62964	5	4		11	The text states that remaining uncertainties, including feedbacks and radiative forcings, increase the risk of exceeding 1.5C warming, but it is not clear what these are 'remaining' from. For example the text lists saturation of carbon sinks as one such uncertainty, but this effect is modelled in all ESMs, and EMICs too. Some feedbacks, not listed, reduce the warming as a function of emissions, such as the Stefan-Boltzmann feedback or the logarithmic dependence of CO2 radiative forcing on the concentration increase. If this statement is made with reference to the CMIP5 simulations, this is not the case based on a comparison of past simulated and observed warming. IPCC AR5 WGI pg 884 notes 'Overall there is some evidence that some CMIP5 models have a higher transient response to GHGs and a larger response to other anthropogenic forcings... than the real world (medium confidence).' Additional clarification is required. [Nathan Gillett, Canada]	Taken into account - Section 2.2. now clearly highlights the various contributions to the overall uncertainty in its Table 2.2. Also the uncertainty in the distribution of TCRE is included here as one of the key uncertainties.

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46560	5	6	5	7	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
46526	5	7	5	7	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
29492	5	11	5	11	Suggested addition (bold red): Compared with GHG emissions reported by countries to UNFCCC, an additional uncertainty in the remaining carbon budget is related to what is considered "anthropogenic" sink (e.g., 2.2.2.2) [Giacomo GRASSI, Italy]	Taken into account - This point has been included where land-use emissions are reported in the chapter (e.g. Section 2.3.3).
47754	5	11	5	11	Brief mention about non-CO2 forcers might work better [Sarah Connors, France]	Taken into account - also non-CO2 forcers are mentioned.
34162	5	13	6	4	Consider revising this section of the summary to reflect the different groups of scenario classes identified later in the chapter. The differences between scenarios with or without extreme deployment of CDR are the most policy relevant in our view. Please consider to focus less on the scenarioes with extreme deployment of CDR technologies, or at least make it very clear for policymakers what kind of risks that are associated with such scenarios. [Norway]	Taken into account - the ES now also highlights how CDR use can be limited.
55450	5	13	6	4	I'm missing a statement in this section that says "most 1.5 scenarios in the literature overshoot 1.5 degrees before returning to this warming level by 2100. Only the most ambitious scenarios, characterised by rapid CO2 emission reductions and [… etc.] manage to avoid an overshoot." [Andy Reisinger, New Zealand]	Noted. However, given the uncertainty in climate response, it is hard to make such a firm statement.
57734	5	13	5	13	Avoid policy prescriptive wording - "requirements for urgent action." Also, should avoid refering to scenario results as "requirements." In AR5 Ch6, we described results as "consistent" with such and such. [Steven Rose, United States of America]	Taken into account - However, given that the policy target that is being assessed has been decided by the panel (i.e. a 1.5°C target) the authors feel that one can speak about requirements for urgent action in the context of mitigation pathways consistent with limiting warming to 1.5°C.
4884	5	15	5	37	It needs to be noted that, in making these statements, the potential role SRM to limit warming (peak-shaving) is not being considered. [Michael MacCracken, United States of America]	Taken into account - We highlight this in the introductory section of the Chapter, Section 2.1
19494	5	15	5	26	This is a very important paragraph, but as such, way too technical for an executive summary. It must be rewritten with a policymaker in mind. The message on the inadecuacy of the NDCs should be at least as clear as it is in the UNEP emission gap report, and it needs to discuss the gap both in relation to 1.5°C and 2°C. For comparability, the UNEP Emission Gap Report 2017(Executive Summary. XIV) communicates the same thing like this: "Looking beyond 2030, it is clear that if the emissions gap is not closed by 2030, it is extremely unlikely that the goal of holding global warming to well below 2°C can still be reached. Even if the current NDCs are fully implemented, the carbon budget for limiting global warming to below 2°C will be about 80 percent depleted by 2030. Given currently available carbon budget estimates, the available global carbon budget for 1.5°C will already be well depleted by 2030." [Jennifer Morgan, Netherlands]	Taken into account - The paragraph has been rewritten, also in light of other reviewer comments and now reads: "Under emissions in line with current pledges under the Paris Agreement (known as Nationally-Determined Contributions or NDCs), global warming is expected to surpass 1.5°C, even if they are supplemented with very challenging increases in the scale and ambition of mitigation after 2030 (high confidence). This increased action would need to achieve net zero CO2 emissions in less than 15 years. Even if this is achieved, temperatures remaining below 1.5°C would depend on the geophysical response being towards the low end of the currently-estimated uncertainty range. Transition challenges as well as identified trade-offs can be reduced if global emissions peak before 2030 and already achieve marked emissions reductions by 2030 compared to today.1 {2.2, 2.3.5, Cross-Chapter Box 9 in Chapter 4}"
30398	5	15	5	15	« countries' pledges » Better use "Parties' pledges" as the EU is not a country [France]	EU made up of countries, so not accurate.
27982	5	15	5	26	We strongly suggest to highlight even more clearly to which extent, collectively, the ambition of NDCs would have to be raised in order to keep the global emissions on a track that would allow for 1.5C maximum temperature increase, as this is of great interest to policymakers. Therefore, if quantification is available as shown here, we strongly suggest to lift this information to the SPM, and possibly also include information on the ambition gap concerning 2 degree in comparison. In line with other comments we have submitted, we'd like to stress that the double risk as a consequence of failure to adopt and implement near-term ambitious reduction measures - the increased risk of failure, as described here (too steep and abrupt to be feasible), and the risk of increasing reliance on unproven CDR technologies that may come with severe SD-trade-offs, and may or may not be feasible at the scale required - should be highlighted in this context. Please also ensure this information is consistently presented here and in CC Box 4.1 [Germany]	Taken into account - The ES now more clearly states that: "Under emissions in line with current pledges under the Paris Agreement (known as Nationally-Determined Contributions or NDCs), global warming is expected to surpass 1.5°C, even if they are supplemented with very challenging increases in the scale and ambition of mitigation after 2030 (high confidence). This increased action would need to achieve net zero CO2 emissions in less than 15 years. Even if this is achieved, temperatures remaining below 1.5°C would depend on the geophysical response being towards the low end of the currently-estimated uncertainty range. Transition challenges as well as identified trade-offs can be reduced if global emissions peak before 2030 and already achieve marked emissions reductions by 2030 compared to today.1 {2.2, 2.3.5, Cross-Chapter Box 9 in Chapter 4} Limiting warming to 1.5°C depends on greenhouse gas (GHG) emissions over the next decades, where lower GHG emissions in 2030 lead to a higher chance of peak warming being kept to 1.5°C (high confidence). Available pathways that aim for no or limited (0–0.2°C) overshoot of 1.5°C keep GHG emissions in 2030 to 25–30 GtCO2e yr-1 in 2030 (interquartile range). This contrasts with median estimates for current NDCs of 50–58 GtCO2e yr-1 in 2030. Pathways that aim for limiting warming to 1.5°C by 2100 after a temporary temperature overshoot rely on large-scale deployment of Carbon Dioxide Removal (CDR) measures, which are uncertain and entail clear risks. {2.2, 2.3.3, 2.3.5, 2.5.3, Cross-Chapter Boxes 6 in Chapter 3 and 9 in Chapter 4, 4.3.7} Limiting warming to 1.5°C implies reaching net zero CO2 emissions globally around 2050 and concurrent deep reductions in emissions of non-CO2 forcers, particularly methane (high confidence). Such mitigation pathways are characterized by energy-demand reductions, decarbonisation of electricity and other fuels, electrification of energy end use, deep reductions in agricultural emissions, and some form of CDR with carbon storage on land or sequestration in geological reservoirs. Low energy demand and low demand for land- and GHG-intensive consumption goods facilitate limiting warming to as close as possible to 1.5°C. {2.2.2, 2.3.1, 2.3.5, 2.5.1, Cross-Chapter Box 9 in Chapter 4}."

Comment No	From Page	From Line	To Page	To Line	Comment	Response
30894	5	15	5	26	I think this section should be clearer that 48 GtCO2e in 2030 is associated with huge amounts of CDR in later years (and also large amounts of overshoot – eg Kriegler is 1.8 degrees peak). I think the use of interquartiles here needs to be very carefully explained – what is the cause of the large range: for example, the "interquartile range of 14 to 48" appears to be a combination of two interquartiles in Table 2.7 – first, a "below 1.5 C 50%" interquartile of 13.6-33.6, and second a "return 1.5 C 50%" interquartile of 31-48.3". A different way of presenting such information would be to say a range of 22-37 , with 22 being the median for the 50% TPB, and 37 for the median for the 50% TRB. I think the latter approach seems clearer. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The revised ES clearer states that "Limiting warming to 1.5°C depends on greenhouse gas (GHG) emissions over the next decades, where lower GHG emissions in 2030 lead to a higher chance of peak warming being kept to 1.5°C (high confidence). Available pathways that aim for no or limited (0–0.2°C) overshoot of 1.5°C keep GHG emissions in 2030 to 25–30 GtCO2e yr-1 in 2030 (interquartile range). This contrasts with median estimates for current NDCs of 50–58 GtCO2e yr-1 in 2030. Pathways that aim for limiting warming to 1.5°C by 2100 after a temporary temperature overshoot rely on large-scale deployment of Carbon Dioxide Removal (CDR) measures, which are uncertain and entail clear risks. {2.2, 2.3.3, 2.3.5, 2.5.3, Cross-Chapter Boxes 6 in Chapter 3 and 9 in Chapter 4, 4.3.7}"
52882	5	15	5	17	Drop "even with" and clarify what a large share is? 60% 80% also TLAs could be avoided [Ireland]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
55954	5	15	5	26	Language in some ES points needs to be simplified -- keep in mind that many policymakers will read only the ES. This point is especially difficult to follow (and an important point to be well-understood by readers), for example "interquartile range" but other main messages could be similarly simplified without changing content. [Pamela Pearson, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
57732	5	15	5	37	Need to avoid ambigous and policy prescriptive language - "fail to", "weak", "failure", "lack of near-term policy", "hinders." [Steven Rose, United States of America]	Taken into account - More neutral wording was adopted where appropriate.
61796	5	15	5	17	Do the evaluations of NDCs include the implications of the decision of the 2nd largest emitting country to step back from the Paris Agreement? Is there literature on this issue which is available for assessment? [Valérie Masson-Delmotte, France]	It could, but this chapter can only rely on the published literature in this regard. Furthermore, this chapter relies on the NDC assessment from the cross-chapter NDC box and is fully consistent therewith.
19120	5	16	5	17	This statement is unclear. Unless it is specified how large is large, it is hard to talk about a level of confidence. What is the alternative? All of the budget is exhausted or only a small share? Likewise what is a "high" risk? Is this meant to translate into a probabilistic term? [Olivier Boucher, France]	Taken into account - This section of the ES has been edited for clarity. The ES now more clearly states that: "Under emissions in line with current pledges under the Paris Agreement (known as Nationally-Determined Contributions or NDCs), global warming is expected to surpass 1.5°C, even if they are supplemented with very challenging increases in the scale and ambition of mitigation after 2030 (high confidence). This increased action would need to achieve net zero CO2 emissions in less than 15 years. Even if this is achieved, temperatures remaining below 1.5°C would depend on the geophysical response being towards the low end of the currently-estimated uncertainty range. Transition challenges as well as identified trade-offs can be reduced if global emissions peak before 2030 and already achieve marked emissions reductions by 2030 compared to today.1 {2.2, 2.3.5, Cross-Chapter Box 9 in Chapter 4} Limiting warming to 1.5°C depends on greenhouse gas (GHG) emissions over the next decades, where lower GHG emissions in 2030 lead to a higher chance of peak warming being kept to 1.5°C (high confidence). Available pathways that aim for no or limited (0–0.2°C) overshoot of 1.5°C keep GHG emissions in 2030 to 25–30 GtCO2e yr-1 in 2030 (interquartile range). This contrasts with median estimates for current NDCs of 50–58 GtCO2e yr-1 in 2030. Pathways that aim for limiting warming to 1.5°C by 2100 after a temporary temperature overshoot rely on large-scale deployment of Carbon Dioxide Removal (CDR) measures, which are uncertain and entail clear risks. {2.2, 2.3.3, 2.3.5, 2.5.3, Cross-Chapter Boxes 6 in Chapter 3 and 9 in Chapter 4, 4.3.7} Limiting warming to 1.5°C implies reaching net zero CO2 emissions globally around 2050 and concurrent deep reductions in emissions of non-CO2 forcers, particularly methane (high confidence). Such mitigation pathways are characterized by energy-demand reductions, decarbonisation of electricity and other fuels, electrification of energy end use, deep reductions in agricultural emissions, and some form of CDR with carbon storage on land or sequestration in geological reservoirs. Low energy demand and low demand for land- and GHG-intensive consumption goods facilitate limiting warming to as close as possible to 1.5°C. {2.2.2, 2.3.1, 2.3.5, 2.5.1, Cross-Chapter Box 9 in Chapter 4}."
61752	5	16	5	16	median confidence does not exist; medium confidence should be italicized [Valérie Masson-Delmotte, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
17624	5	17	5	17	Suggest adding "very" before "high risk". [Sai Ming Lee, China]	This statement has been edited and does not feature anymore in the revised ES.
42144	5	17			high ===> a high [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
46562	5	17	5	17	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47756	5	17	5	17	Please use medium confidence [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51634	5	17	5	17	I think you mean medium not median. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
59968	5	17	5	20	Medium confidence but high risk? [United States of America]	This statement has been edited and does not feature anymore in the revised ES.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
7388	5	18	5	18	What do you mean with current commitments? A continuation of durrent efforts under a full implementation of the 2020 pledges? Or the 2030 NDC targets, or do you mean a current policies scenario? [Michel den Elzen, Netherlands]	Implementation of current NDCs is meant, in line with the assessment in Crosschapter box on NDCs.
17626	5	19	5	19	According to Section 2.3.5, the GHG emissions resulted from NDC should be about 49-58 GtCO2-eq yr-1 in 2030. [Sai Ming Lee, China]	Taken into account - The NDC emissions ranges have been cross-checked and made fully consistent with the assessment in the cross-chapter box on NDCs.
19114	5	19	5	19	There is a false sense of consensus in the IAM literature as to where the Paris Agreement will take us in terms of emissions and commitment. We project a wider range and larger best estimate based on a strict interpretation of the NDCs alone. See Benveniste, H., O. Boucher, C. Guivarch, H. Le Treut, and P. Criqui, Impacts of nationally determined contributions on 2030 global greenhouse gas emissions: uncertainty analysis and distribution of emissions, Environmental Research Letters, 13, 1, doi:10.1088/1748-9326/aaa0b9, 2018. [Olivier Boucher, France]	Taken into account - This study has been included in the assessment of NDC projections. However, a key limitation of this study is that it does not account for any of the non-emission-related targets that are also an integral part of the NDCs.
27984	5	19	5	19	Different ranges on emissions under the assumption of NDC implementation: Ch. 2 p. 5, line 19: 49-56 GtCO2eq vs. <-> p. 60, line 34-35: 49-58 GtCO2eq. Please clarify this inconsistency. [Germany]	Taken into account - The NDC emissions ranges have been cross-checked and made fully consistent with the assessment in the cross-chapter box on NDCs.
30892	5	19	5	21	a reader would be tempted to think “we could stick to 1.5 with 48. Deliver NDCs and that’s 49. Only 1 to go. So when they say “if current pledges are followed to 2030, there are no model scenarios in which average warming is kept below 1.5 degrees” it doesn’t really need much improvement to current pledges to deal with that”. This sentence seems to undercut the urgency message throughout the rest of the report. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Noted - The revised ES provides a clear account of the assessment of the implications of choosing to follow either higher or lower emissions in 2030.
49888	5	19	5	20	Is it consistent with UNFCCC sythesis reports? Have these values come after excluding the NDCs of US? [Himangana Gupta, India]	These values are based on the published literature, including the UNFCCC synthesis report and do not include yet the stated intention of the US to withdraw from the Paris Agreement. However, they do include a wide range of uncertainty sources.
55624	5	19	5	22	To improve understanding and consistency of presentation (eg with Figure 2.15, as well as ~40 GtCO2/yr figure in p40 l39), would be useful to clarify relationship of CO2 to total GHG (CO2-eq). [David Cooper, Canada]	Taken into account - The ES has been edited for clarity and now does not make reference anymore to annual emissions of CO2.
11712	5	20	5	21	In contrast, 1.5°C scenarios available to this assessment show an interquartile range of 14 to 48 GtCO2-eq yr-1 in 2030 - this contradicts the range given in 2.3.5 of 25-41 (line 39 page 60) [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The NDC and pathway ranges of emissions ranges have been cross-checked and made fully consistent with the assessment in the cross-chapter box on NDCs and other chapter sections.
21662	5	20	5	20	interquartile range is a rather technical expression. Please consider rewording. [Sweden]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
19498	5	20	5	21	In contrast, 1.5°C scenarios available to this assessment show an interquartile range of 14 to 48 GtCO2-eq yr-1 in 2030. 48 GtCO2e scenarios assume a large overshoot, irreversable climate impacts and need for huge CDR afterwards. It is not supported sufficiently here and elsewhere in Chapter 2 that these extreme high overshoot and CDR scenarios are realistic without sunbstantial irreversible impacts considering 1. sustainable development and SDRs; 2. technical difficulties, social-ethical-economic issues around potential CDR technologies. Here we question the additional risks from such high level overshoot and CDRs - general overshoot risks are mentioned. Allowing such high level emissions (and tryng to fix them later) also seems to be in contradiction with conclusions on page 6 lines 10-15: "Compared to 2°C pathways, 1.5°C pathways generally rely more on additional emissions reductions than on additional CDR, reflecting limitations in scaling up CDR. This leads to only modest CDR deployment increases over the century in 1.5°C pathways compared to 2°C pathways." [Jennifer Morgan, Netherlands]	Taken into account - Both the "realism" or "feasibility" of specific scenarios requires input from the assessments in chapters 4 and 5. Chapter 2 in isolation can hence not support such a statement.
30890	5	20	5	20	says interquartile range is 14 to 48 GtCO2e and compares it to the NDC range of 49-56. I assume this former figure comes from table 2.7. Is it correct to compare this interquartile range with the NDC range? Are they the same type of range? (is the NDC an interquartile too?) [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - both the scenario set available to this assessment as the studies providing NDC estimates represent ensembles of opportunity. Interquartile or other ranges from these sets thus simply provide descriptive statistics of these sets. It seems to be perfectly fine to compare such numbers.
34164	5	20	5	21	This text covers all 1.5 scenarios and therefore gives a very broad range that seems not to be very useful. Therefore consider to expand this text especially because the decision in Paris COP (see para 17 in dec. 1/CP.21; fccc/cp/2015/10/add.1) asked IPCC to address the level of GHG emissions in 2030 which will be consistent with a 1.5 degree global warming. Since this decision also refer to the emission level that are consistent with below 2 degree warming it will be important that IPCC also update the number for 2 degrees to make them comparable. We suggest that you present information from this Table 2.7 in the Executive Summary e.g. those numbers that are most relevant to the Paris agreement for example 2030 and 2050 annual emissions (median or mean values) for Kyoto GHG for "Return 1.5 66" and "Below 2C 66". You may also consider to include numbers for CO2. [Norway]	Taken into account - The range presented in the ES is now based on scenarios that limit warming to 1.5°C with limited or no overshoot only. The values for 2°C consistent scenarios were not reiterated.
40126	5	20			Can you interpret "interquartile" for the reader? [Ko Barrett, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
59970	5	20	5	21	Too specific. Describe interquartile in layman's terms. [United States of America]	Insufficient room to include this explanation in ES.
4466	5	21	5	22	I will be better to add what will be the result under current pledges if we are to achieve 2 degree target with likely (or 66%) probability. Is it possible? [Mitsutsune Yamaguchi, Japan]	Taken into account - However, this particular question is not part of the assessment in the report so was not highlighted in the ES.
7390	5	21	5	21	I would use NDCs instead of pledges, if linked to the Paris Agreement. [Michel den Elzen, Netherlands]	Taken into account - both terms are now used and clarified in the ES: "Under emissions in line with current pledges under the Paris Agreement (known as Nationally-Determined Contributions or NDCs), global warming is expected to surpass 1.5°C, even if they are supplemented with very challenging increases in the scale and ambition of mitigation after 2030 (high confidence)."
31392	5	21	5	22	In the sentence, “If current pledges are followed to 2030, there are no model scenarios in which average warming is kept below 1.5°C.”, information for the case of 2°C should be added. [Japan]	Taken into account - However, the assessment in the body of this chapter focusses on 1.5°C so this information was not highlighted in the ES.
34166	5	21	5	22	Please clarify if this statement is correct, e.g. "no model scenarios". Does the statement cover the whole range of scenarios or only the 25th and 75th percentiles which is given in Table 2.7. Furthermore, please clarify in the end of the sentence that this is about 1.5 scenarios without overshoot. [Norway]	This statement is not present anymore in the revised ES.
40948	5	21	5	21	The phrase "no model scenarios" is a bit confusing. In this report, the term model is used sometimes as IAMs and sometimes ESMs, which would make me an impression that the term "model" would be better to be specified everywhere it appears. [Shinichiro Fujimori, Japan]	Revised to clarify.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
53168	5	21	5	23	These sentences fail to explicitly make the connection to overshoot as they could. Suggest "is kept below 1.5C without overshoot" and "return warming to below 1.5C with temporary overshoot" [Christopher Weber, United States of America]	Revised to clarify.
59972	5	21	5	22	This is a key point that should be pulled forward into the SPM. [United States of America]	Noted. Robust and relevant messages have been incorporated in the SPM.
59974	5	21	5	22	And then held constant? [United States of America]	Taken into account - this wording was imprecise and has been clarified in the revised ES.
21664	5	23	5	23	In line with NDCs appears unclear. Extrapolation from current NDCs? Or present NDCs without further ambition? [Sweden]	Revised to clarify.
42146	5	23			reduce ===> reductions [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
17628	5	24	5	24	Suggest adding "very" before "high risk". [Sai Ming Lee, China]	Noted. However, the sentence does not feature anymore in the revised ES.
34168	5	24	5	24	Please consider to delete the word "even" in this sentence in order to make the text policy neutral. [Norway]	Taken into account - The statement was reworded. "Even" still features, but is used in a way that the authors consider policy neutral.
52884	5	25	5	26	Elements of the text on feasability could be included in the headline [Ireland]	Taken into account - However, the discussion of feasibility can only be integrated at the level of the SPM, as it requires information from Chapter 1, 2, 4, and 5.
712	5	26	5	26	Table 2.7' should be 'Figure 2.7' [Robert Shapiro, United States of America]	Noted.
42148	5	26			is ===> are [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42154	5	27			varies ===> vary [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
3282	5	28	5	29	Need to say clearly what is delayed action and weak near term policy [Xiu Yang, China]	Taken into account - this wording was imprecise and has been clarified in the revised ES.
13080	5	28	5	29	Delete the text "and stranded investment in fossil-based capacity". [Eleni Kaditi, Austria]	Taken into account - this text does not feature anymore in the revised ES:
17630	5	28	5	28	Suggest adding ", lock-in into carbon intensive infracstructure such as coal-fired power plant" after "risk of exceeding 1.5oC". (Section 2.3.5) [Sai Ming Lee, China]	Taken into account - However, this statement does not feature anymore in the revised ES.
31394	5	28	5	29	Fossil-based capacity can be stranded asset in terms of 1.5°C target, but it also could have implication that investment toward global warming of 1.5°C can be stranded with the significance of the challenge to realize 1.5°C target in the real world. Therefore, before debating on which asset should be stranded or not, it would be good to define what a stranded asset is in the report. [Japan]	Taken into account - the text on stranded capacity was not sufficiently balanced and elaborated for the ES, and has not been included in its revised version.
36944	5	28	5	29	If we assume that the 1.5? target is implemented, it is possible that it would then "increase (…) the amount of stranded investment in fossil-based capacity" but, if we take into account the difficulty of implementing this target in our present society, other investments are likely to be stranded as well. [Keigo Akimoto, Japan]	Accepted - However, as this is not assessed in depth in the chapter, these aspects are not highlighted anymore in the revised ES.
37076	5	28	5	29	It is dubious to argue that "delayed action or weak near-term policies increase the risk of… stranded investment in fossil fuel capacity". One of the major reasons for such delay is economic burden of pursuing 1.5 degree pathway. If that is the case, it is questioable whether far more rapid and costly mitigation policies are suddely come to be taken. Since there is no reference to stranded investment in fossil fuels, "and stranded investment in fossil fuel capacity" should be deleted. [Jun Arima, Japan]	Taken into account - the text on stranded capacity was not sufficiently balanced and elaborated for the ES, and has not been included in its revised version.
49890	5	28	5	29	Does near term refer to current NDCs or also the pre-2020 targets? This is very relevant in the context of facilitative dialogue [Himangana Gupta, India]	Accepted - The revised ES now avoids imprecise references to "early" or "near term".
52886	5	28	5	29	Suggest including costs at the end of this point. [Ireland]	Taken into account - However, the cost implication of this particular item are not explicitly assessed and can thus not be added.
56442	5	28		29	Add the word “ignored” as in “Ignored stranded investment in fossil-based capacity” Because fossil based capacity is not the problem, all fossil capacity has to burn fossil fuel in a climate neutral way with mandatory CCS or CCS2. CCS2 captures CO2 and converts it to a solid substance with Olivine, in a Gravity Pressure Vessel (TRL3) [Henk Daalder, Netherlands]	Noted. However, this section was edited based on the review comments and this editorial comment is not applicable anymore.
59976	5	28	5	29	Stranded investments are a certainty when meeting the goal of 1.5°C. The statement implies that they are a risk, but not necessarily inevitable. The value of fossil fuel assets will inevitably fall on a path to 2°C or less. This point needs to be conveyed. [United States of America]	Taken into account - However, the chapter does not provide an assessment for this issue and it was hence not possible to include this in the ES.
62080	5	28	5	29	The part of the sentence "and stranded investiment in fossil-based capacity" seem to imply that with fast action there will be no stranded investment. This contradicts the text of the chapter which shows that tranded investment (e.g. coal plants) is common to all 1.5° scenarios. It would be preferrable to mention instead "avoidable stranded investment" or "excessive stranded investment". [Antoine Bonduelle, France]	Taken into account - the text on stranded capacity was not sufficiently balanced and elaborated for the ES, and has not been included in its revised version.
17996	5	29	5	29	stranded investment would not be limited to fossil-based capacity, but also to a range of other technologies, most notably to bioenergy that does not deliver at a rate necessary for 1.5 degrees (low efficiency, high land use cost, such as biofuels and biomass from dedicated energy crops). [Andrea TILCHE, Belgium]	Taken into account - the text on stranded capacity was not sufficiently balanced and elaborated for the ES, and has not been included in its revised version.
4468	5	30	5	31	How about the case of 2 degree? Better to add this information that will be policy relevant. [Mitsutsune Yamaguchi, Japan]	Taken into account - However, this chapter and thus the ES focusses on the question of 1.5°C.
31396	5	30	5	31	In the sentence, “Historical emissions and policies already mean that pathways with at least a 66% likelihood of holding global warming below 1.5°C are out of the reach of models”, information for the case of 2°C would be added. [Japan]	Taken into account - However, this chapter and thus the ES focusses on the question of 1.5°C.
53170	5	30	5	31	Out of reach' is an imprecise term that may be understood many ways. Given the many model uncertainties and problems discussed in Section 2.6 I suggest removing this without much more discussion of how IAMs define and constrain the maximum rate of change allowed. [Christopher Weber, United States of America]	Taken into account - The revised ES provides clearer wording of the implications of NDC emissions by 2030.
27986	5	31	5	31	Maybe add "….global warming below 1.5°C through the 21st century." [Germany]	Taken into account - The ES has been heavily revised and this statement doesn't feature anymore.
45758	5	31			Does 'out of the reach of models' need to be changed - it is not the models that experience warming. [Mark Howden, Australia]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42150	5	32			afterwards ===> afterward [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
59978	5	32	5	34	of what? [United States of America]	Taken into account - It has been clarified in the revised ES that this applies to the emissions reductions.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
15734	5	33	5	34	carbon neutrality is not a helpful term - it is understood differnetly by diferent people, in different contexts. It is commonly applied in the debate on bioenergy. If it is intended to mean global net zero CO2 emissions, it is better to use that term, to avoid misunderstanding. It is also not clear whether it refers to CO2 alone or perhaps all long-lived GHGs (p116 line 30-31) [Australia]	Taken into account - It is still used in the ES, but now also clarified in the FAQ.
2068	5	34	5	34	srm omitted [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	That is correct.
27988	5	34	5	34	If CDR really will work and can be implemented, which (side) effects it will have - esp. on a large scale is rather speculative and there still are a lot of open questions. This problem and uncertainty of the "CDR-concept" as for the real potential should be expounded more clearly. So far CDR is rather a "concept" that allows to move CO2-budgets on the timeline than an existing technology that offers real options. See also our comment on p6 ln 29 [Germany]	Taken into account - Chapter 2 already discusses some of these aspects in its sections 2.3, 2.4, and 2.5. However, it is only together with the assessments of Chapters 3, 4, and 5 that this can be brought together, which has been achieved in the SPM.
51032	5	34	5	35	qualify "requirement." There are clear biogeophysical, socioeconomic and other limits that will constrain what may be "required." [Doreen Stabinsky, United States of America]	Taken into account - The revised ES uses the term "requirement" solely to denote geophysical limits.
714	5	39	5	42	It would be helpful to provide actual numbers for the carbon pricing. [Robert Shapiro, United States of America]	Due to space constraints and the indicative nature of the level of carbon pricing, the relative increase compared to 2°C pathways was maintained in favour of listing the absolute values.
3284	5	39	5	43	Carbon pricing is important option reduction, but not to be "necessary" [Xiu Yang, China]	Taken into account - Based on the assessment of 1.5°C-consistent pathway modelling literature and elicitations of the contributing modelling frameworks, we have clarified this statement to now only apply to model results. Its combination with the assessment of policies in Chapter 4 can provide a further integrated view in the SPM.
7680	5	39	6	4	This three messages separatly may be missleading. Adding a message on the importance to link them, in particular enphasize more that carbon markets only can only complement!. [Maria Jose Sanz Sanchez, Spain]	Taken into account -. The messages are still kept separate in line with the form guidelines for the ES. However, the revised ES now states that: "Policies reflecting a high price on emissions are necessary in models to achieve cost-effective 1.5°C-consistent pathways (high confidence). Other things being equal, modelling suggests the price of emissions for limiting warming to 1.5°C being about three four times higher compared to 2°C, with large variations across models and socioeconomic assumptions. A price on carbon can be imposed directly by carbon pricing or implicitly by regulatory policies. Other policy instruments, like technology policies or performance standards, can complement carbon pricing in specific areas. {2.5.1, 2.5.2, 4.4.5}"
11052	5	39	5	43	Three to seven times is unlikley, as prices only need to be in the range $100-$200 to bring emissions to net-zero. Rather, in the 1.5C case, the time to reach $100+ must come years earlier than in the 2C case. [Wilfried Maas, Netherlands]	Taken into account - The range of carbon price increase is based on scenario pairs that are identical in all aspects but their climate target. Section 2.5. provides the evidence available in the literature on this topic, which supports continued use of an updated statement stating that carbon prices are three to four times higher in 1.5°C compared to 2°C scenarios
9692	5	39	5	40	The statement that carbon pricing mechanism achieves most cost-effective emissions reductions is based on the underlining assumption of complete and efficient markets. In reality when markets are incomplete and under the presence of varying sources of distortions carbon pricing may not lead to cost-effectiveness. Hence, carbon pricing may not niether be necessary nor sufficinet for cost effectiveness to get to 1.5c. [Mustafa BABIKER, Sudan]	Taken into account - This message was rephrased so that it is clear that it reflects insights from models only: "Policies reflecting a high price on emissions are necessary in models to achieve cost-effective 1.5°C-consistent pathways (high confidence). Other things being equal, modelling suggests the price of emissions for limiting warming to 1.5°C being about three four times higher compared to 2°C, with large variations across models and socioeconomic assumptions. A price on carbon can be imposed directly by carbon pricing or implicitly by regulatory policies. Other policy instruments, like technology policies or performance standards, can complement carbon pricing in specific areas. {2.5.1, 2.5.2, 4.4.5}"
11156	5	39	5	43	I think the expression "Strong carbon pricing mechanisms are necessary in 1.5°C scenarios to achieve the most cost-effective emission reductions" is policy relevant. Moreover, there are several sentences that contradict to this message. For example, the sentences from line 23 in page 2-85 to line4 page 2-86 say that "the carbon price is often used as a proxy of climate policy costs.....,in practice, the feasibility of a global carbon pricing mechanism deserve careful consideration. The sentences from line 2-20 in Page 2-19 say that "there is an emerging body of studies that focuses on the interaction and performance of various policies.....Assuming a global implementation of regional existing policies mixes and a 'moderate' carbon pricing, early action mitigation pathways are generated..." The carbon pricing is a proxy and one of effective policies, but it is necessary to implement many other policies to achieve 1.5°C warmer world. I recommend to rephrase the message. [mikiko Kainuma, Japan]	Taken into account - This message was rephrased so that it is clear that it reflects insights from models only: "Policies reflecting a high price on emissions are necessary in models to achieve cost-effective 1.5°C-consistent pathways (high confidence). Other things being equal, modelling suggests the price of emissions for limiting warming to 1.5°C being about three four times higher compared to 2°C, with large variations across models and socioeconomic assumptions. A price on carbon can be imposed directly by carbon pricing or implicitly by regulatory policies. Other policy instruments, like technology policies or performance standards, can complement carbon pricing in specific areas. {2.5.1, 2.5.2, 4.4.5}"
13082	5	39	5	43	Delete the text "Strong carbon pricing mechanisms are necessary in 1.5°C scenarios to achieve the most cost-effective emissions reductions (high confidence). Discounted carbon prices for limiting warming to 1.5°C are three to seven times higher compared to 2°C, depending on models and socioeconomic assumptions (medium confidence). Carbon pricing can be usefully complemented by other policy instruments in the real world. For example, technology policies can also have an important role in the near term. {2.5.1, 2.5.2}". [Eleni Kaditi, Austria]	Taken into account - This message was rephrased so that it is clear that it reflects insights from models only: "Policies reflecting a high price on emissions are necessary in models to achieve cost-effective 1.5°C-consistent pathways (high confidence). Other things being equal, modelling suggests the price of emissions for limiting warming to 1.5°C being about three four times higher compared to 2°C, with large variations across models and socioeconomic assumptions. A price on carbon can be imposed directly by carbon pricing or implicitly by regulatory policies. Other policy instruments, like technology policies or performance standards, can complement carbon pricing in specific areas. {2.5.1, 2.5.2, 4.4.5}". The reviewer provided no evidence as to why this statement would not be supported by the literature.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
31398	5	39	5	40	Strong carbon pricing mechanisms are necessary in 1.5°C pathways to achieve the most cost-effective emissions reductions. Are not "most-cost effective emission reductions" necessary for any emission reduction pathway? [Japan]	That would not necessarily be the case. One can also envisage approaches that are less cost-effective from a climate mitigation point of view but allow to achieve other societal objectives. The statement has been revised and now reads: "Policies reflecting a high price on emissions are necessary in models to achieve cost-effective 1.5°C-consistent pathways (high confidence). Other things being equal, modelling suggests the price of emissions for limiting warming to 1.5°C being about three four times higher compared to 2°C, with large variations across models and socioeconomic assumptions. A price on carbon can be imposed directly by carbon pricing or implicitly by regulatory policies. Other policy instruments, like technology policies or performance standards, can complement carbon pricing in specific areas. {2.5.1, 2.5.2, 4.4.5}"
36946	5	39	5	40	Strong carbon pricing mechanisms are necessary in 1.5 C pathways to achieve the most cost-effective emissions reductions. Are not "most-cost effective emission reductions" necessary for any emission reduction pathway? For 1.5? pathways, if you want to emphasize that carbon prices are "strong", then would it not be better to write the actual level of prices that are expected? Besides, such prices may be necessary to achieve the 1.5? target, but the feasibility of implementing them in the real world should be discussed as well. [Keigo Akimoto, Japan]	Taken into account - We have edited the statement to provide the most robust quantitative information available, that is, the relative increase in carbon prices between 2°C and 1.5°C pathways.
37078	5	39	5	40	It is true that strong global carbon pricing equalizing marginal abatement cost across the globe would achieve the most cost effective global emissions reduction. However, this is far from the reality. For example, country A would find it hard to take strong carbon pricing while its competitor country B is taking very weak carbon pricing. In other words, strong carbon pricing could be most cost effective only when employed in globally harmonized manner. To present this context clear, line 39-40 should be modified "Strong and globally harmonized carbon pricing mehanisms employed are necessary in 1.5 degrees scenarios to achieve the most cost effective global emissions reductions.." [Jun Arima, Japan]	Taken into account - The reviewer is correct. We have clarified the statement in the ES so that it now explicitly states that this is a model-derived insight and not necessarily the only option available in reality. The harmonized nature of these prices is also correct but was not included in the ES due to space constraints.
40950	5	39	5	43	I think the word "necessary" in the phrase of "strong carbon pricing mechanisms are necessary" is too much to say, because no IAM scenarios tried other real policy instruments such as direct emissions regulations. What we know right now is carbon pricing can work and it is not the necessary condition but sufficient condition to reduce emissions. For example, if we could impose emissions regulations such as sulfur, it is theoritically possibie to reduce the CO2 emissions. so my suggestion is rephasing like "strong carbon pricing mechanisms must play an important role to reduce emissions". [Shinichiro Fujimori, Japan]	Taken into account - This message was rephrased so that it is clear that it reflects insights from models only: "Policies reflecting a high price on emissions are necessary in models to achieve cost-effective 1.5°C-consistent pathways (high confidence). Other things being equal, modelling suggests the price of emissions for limiting warming to 1.5°C being about three four times higher compared to 2°C, with large variations across models and socioeconomic assumptions. A price on carbon can be imposed directly by carbon pricing or implicitly by regulatory policies. Other policy instruments, like technology policies or performance standards, can complement carbon pricing in specific areas. {2.5.1, 2.5.2, 4.4.5}"
42152	5	39			in ===> for [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51636	5	39	5	41	I agree with this statement, but this is inconsistent with what's talked about in chapter 5 [Jason Donev, Canada]	Taken into account - The range of carbon price increase is based on scenario pairs that are identical in all aspects but their climate target. Section 2.5. provides the evidence available in the literature on this topic, which supports continued use of an updated statement stating that carbon prices are three to four times higher in 1.5°C compared to 2°C scenarios. Chapter 5 highlights that if a more sustainable societal development path is followed mitigation costs can be lowered significantly. This message is included in the SPM messages to complement messages from Chapter 2.
52888	5	39	5	43	Suggest that this includes two high level messages: 1 on carbon pricing and 2 on the need for other real world policies; include some examples of these [Ireland]	Taken into account - Real-world examples of these policies are part of the Chapter 4 assessment and hence not included in the Chapter 2 ES. The carbon pricing point has been rephrased.
53172	5	39	5	40	This sentence is policy prescriptive. There are many mechanisms other that carbon pricing to reach any type of temperature target. Just because carbon prices are how most models parameterize policy, it does not mean it is the only way to achieve such targets. [Christopher Weber, United States of America]	Taken into account - This message was rephrased so that it is clear that it reflects insights from models only: "Policies reflecting a high price on emissions are necessary in models to achieve cost-effective 1.5°C-consistent pathways (high confidence). Other things being equal, modelling suggests the price of emissions for limiting warming to 1.5°C being about three four times higher compared to 2°C, with large variations across models and socioeconomic assumptions. A price on carbon can be imposed directly by carbon pricing or implicitly by regulatory policies. Other policy instruments, like technology policies or performance standards, can complement carbon pricing in specific areas. {2.5.1, 2.5.2, 4.4.5}"
53878	5	39	5	43	I think it is important to note that carbon pricing alone will most likely not lead to the rapid deep emissions reductions needed for the 1.5°C target (ie. Not "Carbon pricing can be usefully complemented" but "Carbon pricing will need to be complemented by other policies"). See http://www.nature.com/articles/d41586-017-08578-7 [Grandin Jakob, Norway]	Taken into account - The updated ES now highlights the model-dependency of the carbon pricing statement as well as the fact that other measures can usefully complement carbon pricing. An in-depth analysis of the applicability of carbon pricing is part of the Chapter 4 assessment.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
53974	5	39		40	Delete any recommendation on carbon pricing in this page and the rest of the chapter . It is not part of the mandate of IPCC to prescribe policies and there is nothing scientific in this proposal. Carbon pricing is a highly controversial proposal that serves only the interest of the fossil fuel industry and financial speculators. Not strange that it comes up in the chapter where representatives of ExxonMobile and Saudi Aramco are among the authors/contributors, as denounced by 108 international civil society organizations (http://etcgroup.org/sites/www.etcgroup.org/files/files/ipcc_conflict_of_interest_letter_final.pdf). If the point is to reflect the real cost of carbon that is externalised and imposed on society, it should be carbon TAX and not refered to as a "necessity", but as possible policy option. Carbon pricing is a market mechanism for business, not for public welfare or to combat climate change. Reference: http://www.thecornerhouse.org.uk/sites/thecornerhouse.org.uk/files/carbonDDIow.pdf [Elenita Daño, Philippines]	Accepted - Any recommendations have been removed. Only findings based on the pathway and other literature have been retained.
54780	5	39	5	40	Specify in a few key words the key characteristics implied by "strong" when talking about carbon pricing mechanisms, especially that: - Global scale agreement is needed and all major world regions need to actively participate - Strong/appropriate CO2 targets need to be in place - Any other key characteristic of a successful carbon pricing mechanism [Marine Gorner, France]	Taken into account - The wording of this statement was imprecise. It has been reworded. This chapter mainly assesses the literature of mitigation pathways consistent with 1.5°C and thus mainly derives insights from these. This caveat has now been made clear in the statement. Integration with other characteristics of successful carbon pricing mechanisms would draw upon integration with insights from the Chapter 4 assessment and can be achieved at the level of the SPM.
56444	5	39		40	strong carbon pricing mechanisms are not the only solution: "strong CO2 pricing mechanisms or mandatory CO2 capture technology and competition are necessary..." [Henk Daalder, Netherlands]	Taken into account - This message was rephrased so that it is clear that it reflects insights from models only: "Policies reflecting a high price on emissions are necessary in models to achieve cost-effective 1.5°C-consistent pathways (high confidence). Other things being equal, modelling suggests the price of emissions for limiting warming to 1.5°C being about three four times higher compared to 2°C, with large variations across models and socioeconomic assumptions. A price on carbon can be imposed directly by carbon pricing or implicitly by regulatory policies. Other policy instruments, like technology policies or performance standards, can complement carbon pricing in specific areas. {2.5.1, 2.5.2, 4.4.5}"
57736	5	39	5	43	Policy prescriptive to say carbon pricing mechanisms are necessary. Shouldn't be advocating a instrument. Better to describe what is cost-effective, and what is not. Should discuss welfare cost metrics, and other levels of limiting warming? Also, this discussion should include consideration of infeasible scenarios (infinite carbon prices?). [Steven Rose, United States of America]	Taken into account - This message was rephrased so that it is clear that it reflects insights from models only: "Policies reflecting a high price on emissions are necessary in models to achieve cost-effective 1.5°C-consistent pathways (high confidence). Other things being equal, modelling suggests the price of emissions for limiting warming to 1.5°C being about three four times higher compared to 2°C, with large variations across models and socioeconomic assumptions. A price on carbon can be imposed directly by carbon pricing or implicitly by regulatory policies. Other policy instruments, like technology policies or performance standards, can complement carbon pricing in specific areas. {2.5.1, 2.5.2, 4.4.5}"
58194	5	39	5	42	Some models suggest that the costs for the 1.5C scenario may not be substantially higher than the 2C (i.e. not three to seven times higher, but simply "higher"), particularly if one focuses on higher behavioral changes (e.g. low meat consumption, etc.). See, for instance, the cost analysis provided by the Global Calculator model (www.globalcalculator.org). [Alexandre Strapasson, Brazil]	Taken into account - The range of carbon price increase is based on scenario pairs that are identical in all aspects but their climate target. Section 2.5. provides the evidence available in the literature on this topic, which supports continued use of an updated statement stating that carbon prices are three to four times higher in 1.5°C compared to 2°C scenarios.
59980	5	39	5	40	Strong carbon pricing mechanisms are necessary in 1.5°C scenarios to achieve the most cost-effective emissions reductions. Wording is unnecesarialy convoluted. Better would be "Carbon pricing mechanisms are the most cost-effective means of achieving the reductions in emissions necessary in 1.5°C scenarios." [United States of America]	Revised.
59982	5	39	5	51	The points in here about the nature of policy mechanisms are not really supported by the underlying chapter text. And they border on policy-prescriptive. [United States of America]	Taken into account - These statements have been thoroughly revised and where appropriate amended so that it is clear that these statements draw on modelling results. Their combination with information from Chapter 4 will allow to provide a balanced view in the SPM.
4470	5	40	5	41	Cost information is almost completely lacking in the executive summary except for marginal abatement cost. In addition here no absolute figures are shown (it says only MAC is 3 to 7 times higher compared to 2 degree in 2050 and no indication in 2100. Whereas, in Table SPM.2 (p. 15) and Figure 6.21 in AR5/WG3, there are plenty of information on costs, including consumption and GDP losses and carbon prices in 2030, 2050 and 2100. Cost information is one of the critically important and policy relevant information for policymakers and one of the indexes to judge feasibility of targets and policies. From this persepective, current information on cost is quite poor and it will be impossible for policymakers to evaluate 1.5 degree target. Therefore costs of carbon price, consumption and GDP losses in 2030, 2050 and 2100 both for 1.5 and 2 degree should definitely be shown in the executive summary of this important chapter. Of course, it will be necessary to add that the calculation of costs are based on uniform carbon tax, availability of all technologies and immediate participation of all countries, and therefore actual cost will be much higher. In addition, from the description of page 99, I am not sure whether MACs for 1.5 will be 3 to 7 times higher than those for 2 degree. The lowest MAC is $30 for below 2 degree with 50% probability and the highest one is $240 for below 1.5 with 50% probability. Where "7 times" comes from? Isn't it 8? [Mitsutsune Yamaguchi, Japan]	Taken into account - The reviewer is correct in noting that cost information does not feature extensively in the SOD ES, with carbon price increases providing the main insights here. In the FGD, this now has been expanded with indications of the level by which investments should increase to be in line with limiting warming to 1.5°C. The relative increase of (updated) three to four times of carbon prices in line with 1.5° and 2°C is derived from scenario pairs that are identical in all but the stringency of their climate targets in order to reduce sampling bias to a minimum.
8328	5	40	5	42	This sentence shows that the carbon price at 1.5? rather than at 2? would rise by 3-7 times, which illustrates the importance of carbon pricing as well as the substantially increased marginal cost of emission reduction. A description of the substantial increase in marginal abatement costs should be added in this sentence. At the same time, it is suggested to add a statement to this sentence, indicating that the impact, which differs from country to country, would be felt more strongly in some developing countries (as seen in lines 18-23, p100 in this chapter). [China]	Taken into account - The FGD still provides an assessment of the increase in carbon prices between 1.5°C and 2°C, although marginal abatement costs have not been assessed. Chapter 2 does not assess distributional impacts of carbon pricing in its chapter corpus. Also the country-level analysis that was available in the SOD version of the chapter has been removed for the FGD. The second suggestion could hence not be implemented

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30400	5	40	5	41	« Discounted carbon prices for limiting warming to 1.5°C are three to seven times higher compared to 2°C, depending on models and socioeconomic assumptions » This information is hard to interpret without concrete numbers. Maybe we could add the price mentionned p99 line 7 : "For scenarios that can return global warming to 1.5°C with a greater than 50 and 66 percent probability, carbon prices range from 90–105USDUSD2010 tCO2 –1 in 2050". However, these prices intuitively seem far from the numbers we see in the policy making context (the 2017 Stern/Stiglitz report mentions prices between 50 and 100€ already in 2030) [France]	Insufficient room to include this in ES.
31400	5	40	5	41	We would request to add more cost information in executive summary, because there seems to be no cost information except carbon price. It is clearer to describe carbon price figures instead of “three to seven times higher” In “three to seven times higher”, could you tell us where “seven” comes from? $30 is described as the carbon price for below 2°C with 50% probability and $240 is that for below 1.5°C with a greater than 50 percent. The correct number seems to be “eight”, not “seven”. [Japan]	Taken into account - The reviewer is correct in noting that cost information does not feature extensively in the SOD ES, with carbon price increases providing the main insights here. In the FGD, this now has been expanded with indications of the level by which investments should increase to be in line with limiting warming to 1.5°C. The relative increase of (updated) three to four times of carbon prices in line with 1.5° and 2°C is derived from scenario pairs that are identical in all but the stringency of their climate targets in order to reduce sampling bias to a minimum.
37080	5	40	5	41	Concrete carbon price range (should be presented together with "three to seven times higher compared to 2 degrees" As discussed many times in my comments, cost information is the most important information which policy makers are expecting. [Jun Arima, Japan]	Taken into account - We have considered providing a concrete carbon price range. However, given the large spread in carbon price estimates and the understanding that these are optimal carbon prices in absence of any other supporting policies and a global harmonized adoption, the relative increase is considered to be the more robust insight here. At the same time, a statement on the increased investments in low-carbon energy technologies has been added to the ES.
37812	5	40	5	40	Please re-phrase "Discounted carbon prices", since not clear for non-expert readers, certainly not in this particular context and meaning [Michiel Schaeffer, Netherlands]	Insufficient room to include this explanation in ES.
40128	5	40			For the non-economist, please describe why it is important to include the term "discounted" here. Maybe something like "Discounted carbon prices for limiting warming to 1.5C, [describe what this means], are three to seven times….." [Ko Barrett, United States of America]	Insufficient room to include this explanation in ES.
59984	5	40	5	41	Discounted carbon prices for limiting warming to 1.5°C are three to seven times higher compared to 2°C, depending on models and socioeconomic assumptions. Suggest that this conclusion does not rise to the level of 'medium confidence' due to the sampling bias in the scenarios that achieve 1.5°C. Compared to the literature on 2°C scenarios, there are fewer models that have run 1.5C scenarios. Furthermore, though scenarios in the 2°C literature with limited technology options (e.g., no CCS, limited bioenergy, no BECCS or CDR) may resolve with high carbon prices, the equivalent limited technology scenarios for a 1.5°C carbon budget may be infeasible (or be reported as infeasible due to excessively high carbon prices). Excluding these types of limited technology scenarios from the 1.5°C scenarios used to make the comparison here will bias these results downward. [United States of America]	Taken into account - The carbon price increase range has been revised by only drawing on scenario pairs that are identical in all but their climate target stringency. The updated range results in the three to four times increase in carbon prices.
27990	5	43	5	43	Not only technology policies are important. Even more important are policies stimulating R&D and innovation - especially when it comes to reach the ambitious 1.5 goal and to get longer term impacts. The underlying chapter highlights the lack of knowledge and should please be mentioned in the ES as well. [Germany]	Taken into account - The revised statement now makes clear that the example policies are illustrative only. An in-depth assessment of policies is part of the Chapter 4 scope and can be integrated in the SPM.
19502	5	45	5	46	The formulations here, "Adopting a 1.5°C rather than 2°C pathway", and "The shift from 2°C to 1.5°C" are confusing and misleading. "Adopting a 1.5°C rather than a 2°C pathway" sounds like there was a choice to be made between these two, but governments made that choice already in the Paris Agreement, by agreeing on a pahtway that keeps well below 2°C and aims at 1.5°C. And the shift we need to make now is not from 2°C to 1.5°C but from 3°C plus to 1.5°C. So please adjust the wording here. [Jennifer Morgan, Netherlands]	Taken into account - These statement does not feature anymore in the revised ES.
52890	5	45	5	46	Could a quantification of "faster" be provided e.g. in years [Ireland]	Taken into account - The use of imprecise terms like "faster" or "stronger" has been limited in the revised version of the ES.
30402	5	46	5	46	« The shift from 2°C to 1.5°C » One does not want to "shift" from 2°C to 1.5°C. Better use "Limiting warming to 1.5°C instead of 2°C" [France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
13468	5	47	5	47	cooperative, and transformative [Sergio Aquino, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
59986	5	48	5	49	This is ambiguous to time. When might 1.5°C be reached? What is "short term"? What does "within reach" mean? [United States of America]	Taken into account - The use of imprecise terms like has been limited and hopefully fully avoided in the revised version of the ES.
13084	5	49	5	51	Delete the text "beyond carbon pricing. Pathways that assume stringent demand-side policies, and thus lower energy intensity and limited energy demand, reduce the risks of exceeding 1.5°C. {2.5, 2.5.1, 2.5.2}". [Eleni Kaditi, Austria]	Taken into account - This sentence does not feature anymore in the revised ES.
8330	5	49	5	51	This sentence is not comprehensive enough since the 1.5? warming needs the synergy of various measures rather than just the contribution of demand-side policies. The policy assumptions section in this chapter also mentions the contribution of different policy combinations in areas such as renewable energy and energy efficiency (as seen in lines 29-31, P90 in this chapter). Therefore, it is suggested to reformulate this sentence to describe the synergetic effect of multifaceted measures needed to achieve 1.5? from a more comprehensive and balanced perspective. [China]	Taken into account - This particular statement was thoroughly revised. The revised ES has the following statement which covers this issue in part "In comparison to a 2°C limit, required transformations to limit warming to 1.5°C are qualitatively similar but more pronounced and rapid over the next decades (high confidence). 1.5°C implies very ambitious, internationally cooperative policy environments that transform both supply and demand (high confidence). {2.3, 2.4, 2.5}"
53976	5	49			Delete "beyond carbon pricing" [Elenita Daño, Philippines]	Taken into account - No rationale for this deletion was provided despite the literature supporting the statement. The key finding on carbon pricing has been thoroughly revised.
9698	5	53	5	56	Is the required investment range of 1.4-3.8 annually incremental to the investment cost of 2c? What the cost range for 2c? [Mustafa BABIKER, Sudan]	This statement was thoroughly revised and this range does not feature anymore.
59988	5	53	5	54	Should this not have a probability caveat (e.g., increasing the likelihood of limiting warming from 50% to XX % or holding the liklihood to greater than 66% …)? [United States of America]	Given the spread in estimates and the level of precision at which information is provided here, no further likelihood statement was included here.

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21666	5	56	5	56	Are these investments in addition to projected investments in absence of climate targets? [Sweden]	Taken into account - These investment are expressed relative to estimated levels today. They are hence not expressed relative to an hypothetical baseline. The revised ES makes this clear by stating: "Limiting warming to 1.5°C requires a marked shift in investment patterns (limited evidence, high agreement). Investments in low-carbon energy technologies and energy efficiency would need to approximately double in the next 20 years, while investment in fossil-fuel extraction and conversion decrease by about a quarter. Uncertainties and strategic mitigation portfolio choices affect the magnitude and focus of required investments. {2.5.2}"
35758	6		6		The total amount of CDR projected in 1.5 degree C scenarios is of the order of 380-1130 GtCO2 over the 21st century CDR of 380-1130 GtCO2, is unrealistic, given that the construction of this high capacity of CDR will require substantial emission. Probably afforestation/ reforestation may be given priority (to the extent mitigation potential from this sector allows), which is currently missing. [India]	Accepted - The revised ES now presents the various CDR options considered in integrated in a more balanced way. In particular, the revised section now reads: "CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
9694	6	1	6	4	It is critical that mobilization of existing and new financial sources to investment in mitigation activities has also to take into account adaptation and be approached in the context of sustainable development and poverty eradication prirorities. [Mustafa BABIKER, Sudan]	Accepted - However, as the approved scope of Chapter 2 only focusses on mitigation this integration will have to happen at the level of the SPM, based on input from Chapters 2, 3, 4, and 5.
56446	6	2		3	particularly on the demand side. I would like to read this "…particularly on the demand side.. IE. power consumers that generate their own renewable power, at cost price. And have the benefit from that. Using the grid as a public road, enabling a mass consumer market for de-central renewable generation. Because this section is too much a investors perspective, and not enough a mass market perspective, think of how mobile communications was introduced. De-central renewable generation, can have the same mass growth, with power users that benefit from their investment themselves. [Henk Daalder, Netherlands]	Rejected - The ES can only highlight findings that are supported by the assessment in the chapter's body. The additional aspects have not been assessed and could hence not be included.
13086	6	3	6	4	Delete the text "Limiting warming to 1.5°C carries the risk of fossil-based asset stranding, indicating the need for financial stress tests for future energy infrastructure. {2.5.2}". [Eleni Kaditi, Austria]	Taken into account - Although the reviewer provides no rationale for removing this particular text, it does not feature anymore in the thoroughly revised ES.
57738	6	3	6	3	The literature shows that expencations about future policy will moderate asset stranding, e.g., Bosetti et al, and Blanford et al. [Steven Rose, United States of America]	Noted. This statement does not feature anymore in the revised ES.
53174	6	4	6	4	Stress test is policy prescriptive, and it is not clear that stress tests are the best financial policy mechanism to avoid fossil asset stranding. There are no existing stress test mechanisms to do so; suggest replacement with 'scenario analysis' in line with the FSB TCFD. [Christopher Weber, United States of America]	Taken into account -This statement does not feature anymore in the revised ES.
22754	6	6	6	51	Risk of too much dependency to CDR is well described. Keep it. [Shuzo Nishioka, Japan]	Noted. The CDR section and robust insights of the chapter on this topic have been kept.
31402	6	6	6	6	For 1.5°C pathways, further consideration should be taken into the future carbon price levels. if you want to emphasize that carbon prices are "strong", then it would be better to write the actual level of prices that are expected. Besides, such prices may be necessary to achieve the 1.5°C target, but the feasibility of implementing them in the real world should be discussed as well. When you mention the carbon price, please indicate its uncertainty. [Japan]	Taken into account - The revised ES tries to avoid any reference to imprecise language like "strong" and provides quantitative information instead.
34170	6	6	6	52	This section of the summery seems overly long and thorough, compared to other parts of the executive summary. Consider a shorter summary of this issue, coupled to a statement about CDR feasibly and scale (In addition to relevant parts of the SR1.5, se European Academies of Science Advisory Council, 2018: "Negative emission technologies: What role in meeting Paris Agreement targets?", EASAC policy report 35) [Norway]	Taken into account - the sections on emissions reductions and CDR have been thoroughly revised. Emissions evolutions of both CO2 and non-CO2 forcers now cover 2/3 of a page, while CDR covers slightly less than half a page.
58112	6	6			To get the numbers straight, it would be useful to highlight some basics. First, 100 EJ/yr bioenergy, which is the amount not rejected unsustainable in any publication that I am aware of, can serve as the basis for about 4.5 to 9 GtCO2/yr CDR. This number is discussed in Bauer et al. (2017). It would also be useful to relate this number to corpland area required and/or relate it to residues estimates. Moreover, it would be useful to mention the potential of afforestation CDR and how much land area is required for this option. [Nico Bauer, Germany]	Rejected - the sustainability assessment of bioenergy and CDR is part of the Chapter 3 and 4 assessments.
4886	6	8	6	30	With so much discussion about the potential role of CDR, the description of potential options in Chapter 1, at least, is very limited. That this chapter contains a quite comprehensive update of options needs somewhat clearer mention here, referring back to the secion on this. [Michael MacCracken, United States of America]	Taken into account - This has been forwarded to the SPM, which provides an overview for the entire report.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
11714	6	8	6	15	Made the same comment on the SPM, but it applies equally here - I think greater care needs to be made in communicating this point or else it might be misleading about the scale of the impact of the additional CO2 removal. It's important to recognise that the balance when shifting to 1.5 is greater towards mitigation than removal, but the extra removal required is still significant in absolute terms. This is made clear in chapter 5 (section 5.4.3.2, page 35). Don't downplay the implications of the additional CO2 removal required. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - Both points are still highlighted in the revised ES: "The role of Carbon-Dioxide Removal (CDR) All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence). The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net-negative emissions after mid-century to return warming to 1.5°C (high confidence). The faster reduction of net CO2 emissions in 1.5°C- compared to 2°C-consistent pathways is predominantly achieved by measures that result in less CO2 being produced and emitted, and only to a smaller degree through additional CDR. Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot. Limits to our understanding of how the carbon cycle responds to net negative emissions increase the uncertainty about the effectiveness of CDR to decline temperatures after a peak. {2.2, 2.3, 2.6, 4.3.7} CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
17998	6	8	6	8	the term "carbon neutrality" should be avoided altogether, or at least defined before it is used. If it means "net zero" [and/or "net negative"], then it would be better to use those terms only and consistently (but they must also be defined). [Andrea TILCHE, Belgium]	Taken into account - net zero emissions as well as carbon neutrality are being defined in the SPM as "Net-zero CO2 emissions: Conditions in which any remaining anthropogenic carbon dioxide (CO2) emissions are balanced globally by anthropogenic CO2 removals. Net-zero CO2 emissions are also referred to as carbon neutrality."
30900	6	8	6	15	I *think* I understand the report to be saying that although large amounts of CDR are needed, in meeting “carbon neutrality around mid-century”, the overwhelming majority of the work in getting to carbon neutrality by mid-century is through cuts in CO2, rather than CDR. I strongly suggest you have some graphs illustrating this(eg use material on page 29) [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - Although graphs can be included in the chapter and the SPM, they cannot be included in the chapters' ES.
52892	6	8	6	10	Check consistency with statements in CH1. Also can levels of CDR requriments be stated? [Ireland]	Taken into account - All statements have been checked across chapters. The absolute levels of CDR are indicated in the sections on characteristics of the energy system.

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59990	6	8	6	15	Regarding the role of CDR, this paragraph states that, "Compared to 2°C pathways, 1.5°C pathways generally rely more on additional emissions reductions than on additional CDR, reflecting limitations in scaling up CDR." An important point that is missing from this discussion is that since the 1.5°C scenarios are utilizing these additional emissions reductions relative to the 2°C scenarios, the 1.5°C scenarios are more reliant on CDR. This is because the 1.5°C scenarios are utilizing these additional emissions reductions and CDR, whereas the 2°C scenarios have room to turn to these additional emissions reductions in cases where CDR is more expensive or not available. [United States of America]	Taken into account - The discussion of CDR in the ES has been thoroughly revised to highlight the use of CDR in 1.5°C scenarios. The sections pertaining to CDR now read: "The role of Carbon-Dioxide Removal (CDR) All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence). The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net-negative emissions after mid-century to return warming to 1.5°C (high confidence). The faster reduction of net CO2 emissions in 1.5°C- compared to 2°C-consistent pathways is predominantly achieved by measures that result in less CO2 being produced and emitted, and only to a smaller degree through additional CDR. Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot. Limits to our understanding of how the carbon cycle responds to net negative emissions increase the uncertainty about the effectiveness of CDR to decline temperatures after a peak. {2.2, 2.3, 2.6, 4.3.7} CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
17632	6	9	6	9	Suggest adding ", a technology still at its infancy today, " after CDR. (FAQ 2.1) [Sai Ming Lee, China]	Taken into account - Although the precise wording suggested by the reviewer does not apply anymore to the revised ES, the following statement was included that conveys the point to some degree: "Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot."
63188	6	9	6	10	Unclear: "Rapid and stringent mitigation as well as upscaling of CDR deployment occur simultaneously." Yet in 1, pg 43 line 7-8, CDR is included in mitigation. So what exactly do you mean by "mitigation" here? CDR earlier define as part of mitigation chap 1 pg 43 line 7-8. [Greg Rau, United States of America]	Taken into account - this wording was imprecise and has been clarified in the revised ES. It now reads: "The role of Carbon-Dioxide Removal (CDR) All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence). The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net-negative emissions after mid-century to return warming to 1.5°C (high confidence)."
17634	6	10	6	10	Suggest replacing "occur" by "are required". [Sai Ming Lee, China]	Rejected - However, the revised statement now reads: "All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence)."
19506	6	10	6	10	Please add, after the bolded sentences, the following finding, which is of high relevance for policymakers: Pathways that assume limited or no contribution of BECCS imply at least halving global fossil fuel and industrial CO2 emissions by 2030. (Source: Chapter 2. Figure 2.7 and Figure 2.15) See also corresponding comments to the SPM and Chapter 2, page 32, line 7. [Jennifer Morgan, Netherlands]	Rejected - Due to space constraints such message could not be added to the ES.
54782	6	10	6	11	Good message; it is very important to pass this message clearly. [Marine Gorner, France]	Noted.
57740	6	10	6	11	Limitations on scaling up CDR is a function of the modeling of CDR. The CDR limitations observed in the current modeling is an artificate of what is modeled and how. This statement should have low confidence and the authors should consider revising it to one they can have higher confidence in. [Steven Rose, United States of America]	Taken into account - This statement has been altered to read: "The faster reduction of net CO2 emissions in 1.5°C- compared to 2°C-consistent pathways is predominantly achieved by measures that result in less CO2 being produced and emitted, and only to a smaller degree through additional CDR."
4888	6	11	6	12	That CDR would not be further scaled up is because there is an acceptance of a 1.5 C long-term warming, something that is not really indicated in the Paris Accord. Given all the consequences that would result in a 1.5 C world, this opens up CDR as a way to hopefully get the global average temperature back to less than, say, 0.5 C above preindustrial, which is what the world should, in my view, be the world should be aiming to do. Mentioning this I would suggest is warranted. [Michael MacCracken, United States of America]	Rejected - The mandate of the Chapter is to assess 1.5°C-consistent mitigation pathways. Other issues, while potentially still important, have not been taken up in the ES.
63180	6	11	6	11	limited CDR upscalling potential - what is the basis for this belief and how confident are you that it is true? [Greg Rau, United States of America]	Taken into account - This statement has been reworded to clearer and better reflect the state of knowledge on this topic.
2070	6	12	6	18	ignores technologies such as power-to-fuels, which have the capacity for co2-neutral fuelling for hard-to-mitigate applications (eg avgas) [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The CDR statements have been reworded to focus on the most robust findings only.

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47758	6	14	6	14	ca. 600 GtCO2 CO2….Please delete: repeating CO2 . [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
53784	6	14	6	14	In "ca. 600 GtCO2 CO2 reduction", is the second "CO2" here redunant or is this to make a point that non-CO2 is excluded? I suggest to remove the second "CO2", also since this paragraph is about CDR, so non-CO2 should naturally be excluded anyways. [Patrik Winiger, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58196	6	14	6	14	It might be appropriate to double check if there is no double counting of AFOLU and CDR based on afforestation/reforestation, bioenergy and land use, and perhaps clarify this issue in the text and graphs. This was not clear on page 29 (line 32-52) either, although the main CDR technologies were very briefly mentioned on p.54, whilst also suggesting Chapter 4 for further readings. [Alexandre Strapasson, Brazil]	Accepted - There is no double counting here as the emissions from land-use change are attributed to land-use CO2, while those in the energy sector to BECCS. Figure 2.5 further clarifies this.
58280	6	14	6	14	Remove "CO2" prior to "reductions by the end" [Peter Marcotullio, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
9696	6	17	6	24	Does this paragraph imply that CDR is necessary to 1.5c pathways. [Mustafa BABIKER, Sudan]	Accepted - It indeed does. The revised ES makes this point more unambiguously: "All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence)."
17636	6	17	6	17	Suggest adding ", a technology still at its infancy today, " after CDR. (FAQ 2.1) [Sai Ming Lee, China]	Taken into account - Although the precise wording suggested by the reviewer does not apply anymore to the revised ES, the following statement was included that conveys the point to some degree: "Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot."
27992	6	17	6	30	As stated in our comment to Table 2.6, the information provided here is not very helpful without further context. The quasi-probabilistic presentation (interquartile range showing that a spread of 25-85% of a range of 380-1130 Gt cumulative CDR is used over the 21st century to neutralize emissions for which no mitigation measures can be identified) does not provide information required to make an informed judgment about the risks and feasibility of certain pathways. [Germany]	Taken into account - The revised ES now focusses on the most robust CDR insights only. The specific ranges have not been removed.
51110	6	17	6	17	Statement is untrue. See Holz et al. 2017, van Vuuren et al. 2017, Grubler et al. 2017 for 1.5°C pathways that do not rely on CDR, and in the case of Bertram et al. and Holz et al.'s limCDR scenario, that require limited amounts of CO2 drawn from the atmosphere. [Linda Schneider, Germany]	Rejected - All of the publications listed by the reviewer deploy some level of CDR.
53176	6	17	6	19	Suggest aligning this messaging better to separate the need for overshoot drawdown and the need for neutralizing hard to mitigate emissions. Rather than just saying "25-85% used to neutralize" I suggest a wording closer to "in scenarios with strong overshoot, most CDR Is used to alleviate said ovesrhoot; however CDR is still required in non-overshoot scenarios to neutralize hard to mitigate emissions". THis makes the relationship clearer. [Christopher Weber, United States of America]	Taken into account - The ES has been edited for clarity.
54784	6	17	6	24	It is important to clearly stress the point, maybe as a last sentence to this paragraph, that reducing any reliance on overshooting and on the use of CDR is an absolute priority, given the uncertainty and risks that the option of overshooting + heavy CDR entails [Marine Gorner, France]	Taken into account - While this chapter and the IPCC cannot set priorities, the ES does spell out the implications of overshoot in a policy-neutral way.
59992	6	17	6	19	Is this identified or quantified in the models? Not sure options can be identified; may be non-commercial today, thus not in the models. Caveat this statement. [United States of America]	Taken into account - The revised ES makes clear that it are not necessarily sources for which no mitigation options "can be" identified, but that it are sources for which no mitigation options "have been" identified.
57742	6	20	6	21	no mitigation measures can be identified is ambiguous. It needs to be defined properly. Theoretically, society could always stop consuming. [Steven Rose, United States of America]	Taken into account - This has been reworded to mitigation measures that "have been" identified.
7682	6	23	6	24	Not only remains a gap, but also poses a huge uncertainty on the contribution of such measures compara to other mitigation options, in particular when it refers to natural negative emissions. [Maria Jose Sanz Sanchez, Spain]	Agreed - The revised ES text highlights these caveats appropriately: "CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
7684	6	26	6	30	Last sentence is an extremly important message and should be put up front, including for natural CDRs [Maria Jose Sanz Sanchez, Spain]	Noted. This message has been retained in the revised ES.
27994	6	26	6	26	cf.: Ch 1, p5, ll11-16: (Is there a contradiction regarding messages on overshooting 1,5°C?: Ch 1, p. 5 and 34: If emissions would be frozen at today's level, 1.5°C would be crossed in 2040s <-> Chapter 2, p. 9 (line 52-56): With NDCs emission budgets will be depleted before 2030. Is this due to rising emissions under NDCs? If so, it would be helpful to underline this assumption.) [Germany]	Taken into account - The assessment of carbon budgets has been cross-checked with other chapters.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
30878	6	26	6	26	On the CDR value, I cannot find a justification for the 380-1130 GtCO2 figure. I am clearly missing something, but in table 2.6 page 30, it looks as though the three lines under the “Total CDR 2016-2100” should sum to 380-1130, but they do not – they sum to 160-1530. This 380-1130 figure seems pretty critical – further clarity seems necessary. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The CDR statements have been reworded to focus on the most robust findings only. In particular: "The role of Carbon-Dioxide Removal (CDR) All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence). The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net-negative emissions after mid-century to return warming to 1.5°C (high confidence). The faster reduction of net CO2 emissions in 1.5°C- compared to 2°C-consistent pathways is predominantly achieved by measures that result in less CO2 being produced and emitted, and only to a smaller degree through additional CDR. Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot. Limits to our understanding of how the carbon cycle responds to net negative emissions increase the uncertainty about the effectiveness of CDR to decline temperatures after a peak. {2.2, 2.3, 2.6, 4.3.7} CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
35480	6	26	6	27	The given CDR appears highly unlikely in practice since it represents about 10 to 30 years of global emissions. [Ashok Sreenivas, India]	Noted. Chapter 2 does not make any statements on the likelihood of scenarios. No further action undertaken.
30880	6	26	6	26	The 1130 figure also appears to be enormous. Chapter 4 notes the “substantial uncertainty about the feasibility of timely upscaling” (p36, line 5) of CCS, needed for BECCS. I suggest that some greater exploration of this issue is needed in chapter 2. For example the only pathway in chapter 2 which has CDR at the 1130 level is REM-mag|SSPS-19, page 57, which has around 1000+ GtCO2 of BECCS. This is an average of 13 GtCO2/yr from 2016-2100. However, chapter 4 page 35, line 33 says “most of the literature agrees on a BECCS potential range of 1.5-5.8 GtCO2/yr”. Doesn’t this contradict the 1130 figure? Why is 1130 given as a plausible figure? It seem to be extremely speculative, Even a mid-point for this figure 3.6 MtCO2, even if the land implications were manageable (millions of hectares of pasture converted to energy crops, eg see p58, line 48: “implementing such large scale changes in land use would pose significant governance challenges”), appears to need 3,600 new “at-scale” BECCS power plants (according to footnote 4 page 36, chapter 4). [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	See response to Comment ID 30878
49030	6	26	6	30	It would be important to note here that integrated models do not incorporate some potentially very important approaches to CDR. As demonstrated in Table 2.8, measures such as reduced land degradation, forest restoration, agroforestry, and to some degree soil carbon practices, have not been considered in integrated models. The potential for such measures to address the overall need to reduce GHG, and for CDR in particular, should be noted in this section of the SPM. Moreover, while these approaches for CDR have not been undertaken at the scale needed, they have been shown to work at significant scales. [David Waskow, United States of America]	Taken into account - Strengths and limitations of integrated models have now been highlighted upfront in the ES. They are not repeated thereafter.

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51034	6	26	6	27	These are fantastical numbers. Reword the sentence to make it less misleading. Just because a model comes up with the number 1130 GtCO2 doesn't mean that it is in any way a rational or feasible on this particular planet pronouncement. Qualify the discussion so it's clear that this scale of CDR is infeasible. Cross reference the discussion in chapter 4 (page 4-21-22, line 53-8) on sustainable bioenergy potentials. [Doreen Stabinsky, United States of America]	Taken into account - The CDR statements have been reworded to focus on the most robust findings only. In particular: "The role of Carbon-Dioxide Removal (CDR) All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence). The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net-negative emissions after mid-century to return warming to 1.5°C (high confidence). The faster reduction of net CO2 emissions in 1.5°C- compared to 2°C-consistent pathways is predominantly achieved by measures that result in less CO2 being produced and emitted, and only to a smaller degree through additional CDR. Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot. Limits to our understanding of how the carbon cycle responds to net negative emissions increase the uncertainty about the effectiveness of CDR to decline temperatures after a peak. {2.2, 2.3, 2.6, 4.3.7} CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
58108	6	26		30	The paragraph only refers to the cumulative figures. However, the requirement regarding annual flow of CDR is equally important for the assessment of 1.5°C target achievability. Strefler et al. (2018) It should be mentioned that the numbers mentioned here are not necessarily the minimum requirement for achieving the 1.5°C target, but the models' realization. These models go beyond the required CDR amount due to economic factors. [Nico Bauer, Germany]	Taken into account - The CDR statements have been reworded to focus on the most robust findings only. In particular: "The role of Carbon-Dioxide Removal (CDR) All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence). The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net-negative emissions after mid-century to return warming to 1.5°C (high confidence). The faster reduction of net CO2 emissions in 1.5°C- compared to 2°C-consistent pathways is predominantly achieved by measures that result in less CO2 being produced and emitted, and only to a smaller degree through additional CDR. Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot. Limits to our understanding of how the carbon cycle responds to net negative emissions increase the uncertainty about the effectiveness of CDR to decline temperatures after a peak. {2.2, 2.3, 2.6, 4.3.7} CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"

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59994	6	26	6	30	This paragraph emphasizes the wrong point resulting in a tone that is too technical. The salient point that should be emphasized here is that, "CDR deployed at scale is unproven and reliance on such technology is assessed to be a major risk in the ability to limit warming to 1.5°C." This should be a topline conclusion in the whole report. The current topline bolded statement of this paragraph, "The total amount of CDR projected in 1.5°C scenarios is on the order of 380-1130 GtCO2 over the 21st century" should be a technical supporting detail. Elevating this to the topline statement in the Executive Summary of Chapter 2, instead of the alternative suggestion above, contributes overly technical tone of the report that shies away from communicating the monumental scale of the challenge. [United States of America]	Taken into account - The CDR statements have been reworded to focus on the most robust findings only. In particular: "The role of Carbon-Dioxide Removal (CDR) All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence). The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net-negative emissions after mid-century to return warming to 1.5°C (high confidence). The faster reduction of net CO2 emissions in 1.5°C- compared to 2°C-consistent pathways is predominantly achieved by measures that result in less CO2 being produced and emitted, and only to a smaller degree through additional CDR. Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot. Limits to our understanding of how the carbon cycle responds to net negative emissions increase the uncertainty about the effectiveness of CDR to decline temperatures after a peak. {2.2, 2.3, 2.6, 4.3.7} CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
18000	6	28	6	29	BECCS should not be compared with "terrestrial CDR measures", as it is a quintessential terrestrial CDR method. Its presumed performance depends entirely on land-based removals (perhaps ocean-based, but that is so unlikely that it is not even mentioned), and the land-use element of BECCS is inseparable from other land-based methods (as BECCS will compete for the same space, soil and water resources, and will have impact on soil and biomass C stocks just the same as vegetation management without BECCS). [Andrea TILCHE, Belgium]	Rejected - The difference between BECCS and AFOLU CDR measures is that the former stores carbon in a geological formations, while AFOLU CDR measures don't.
13358	6	29	6	30	Support strength of statement, but perhaps implies that CDR is proven at small e.g. national scales which with only a single BECCS facility, few pilot DAC globally is not supported. [Scott Vivian, United Kingdom (of Great Britain and Northern Ireland)]	Noted. This statement has been retained in the revised ES.
17638	6	29	6	30	Suggest highlighting the sentence "CDR deployed at scale is unproven and reliance on such technology is assessed to be a major risk in the ability to limit warming to 1.5oC." [Sai Ming Lee, China]	Taken into account - also responding to other reviewer comments the CDR section in the ES has been thoroughly revised.
19508	6	29	6	30	CDR deployed at scale is unproven and reliance on such technology is assessed to be a major risk in the ability to limit warming to 1.5°C. Please clarify that this holds true for the 2°C scenarios too, as most of them assume CDR deployed at scale - not because it's the only way to get to below 2°C, but because of the conservative model assumptions. So the risks of heavy reliance on 'fairy dust' are relevant to those 2°C scenarios too. [Jennifer Morgan, Netherlands]	Taken into account - The statement continuous to refer to 1.5°C only, however, as the ES focusses on issues relevant to 1.5°C and due to tight space constraints.
27996	6	29	6	29	Insert "Carbon Dioxide Capture and Storage" in front of "CCS", because it is mentioned here for the first time. [Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
27998	6	29	6	30	If CDR really will work and can be implemented, which (side) effects it will have - esp. on a large scale is rather speculative and there still are a lot of open questions. This problem and uncertainty of the "CDR-concept" as for the real potential should be expounded more clearly. So far CDR is rather a "concept" that allows to move CO2-budgets on the timeline than an existing technology that offers real options. In order to put more emphasis to the uncertainties and possible trade-offs attached to CDR technologies we suggest, to start the last sentence of this para with "However". [Germany]	Taken into account - CDR side effects are discussed in Chapters 3, 4, and 5. The CDR section of the ES has been thoroughly revised to only highlight the most important and robust insights.
51112	6	29	6	30	For the sake of consistency, stringency and clarity within the chapter argumentation, if large-scale deployment is unproven and reliance on such technology is assessed to be a major risk in the ability to limit warming to 1.5°C, Chapter 2 should not include scenarios that involve large amounts of CDR. [Linda Schneider, Germany]	Taken into account - The chapter highlights the full spread of 1.5°C scenarios, including those with large-scale CDR and those which rely much less on these measures.
53178	6	29	6	30	This sentence is unclear, suggest rewording to something like "Relying ton CDR to be deployed at this scale is highly risky given the major uncertainties and sustainability implications with known CDR options". This aligns better with 2.3.1 and 2.6.4. [Christopher Weber, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
54592	6	29	6	29	CCS' has not been defined [Qudsia Zafar, Pakistan]	Taken into account - This has now been defined upon first use.
19512	6	30	6	30	Please add here a key finding from page 51, lines 15-18, that in addition to afforestation and reforestation, the AFOLU sector provides further potential for active terrestrial carbon storage, for example via land restoration and improved land management which so far have not been adequately represented in the mitigation scenario literature. [Jennifer Morgan, Netherlands]	Considered - While correct, this statement was not included due to space constraints.
58106	6	31			Bioenergy demand is already considerable in 2°C scenarios and also less stringent scenarios. Most model scenarios show not much sensititivty in total biomass feedstock production in the year 2100, when the stringency of emission reduction requirements is increased. The cross model ranges also indicate that bioenergy use in Baseline scenarios without any additional cliamte policies in some models can exceed bioenergy use in well-below 2°C scenarios. Only for the 1.5°C scenarios bioenergy demand is strictly higher than in Baseline scenarios. These results are discussed in Bauer et al. (2017) [Nico Bauer, Germany]	Taken into account - The revised ES states that "Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use."

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2072	6	32	6	38	needs to make clear that BECCS affordability is linked to the cost of energy generation more generally. Renewables prices are falling precipitously, and there is an ever-widening gap between the cost disadvantages assumed for BECCS and the reality on the ground. It is important not to allow BECCS to be used as figleaf for BAU, or to assume that BECCS is an economically, socially, or geophyisically plausible approach to CDR at scale. [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - While not necessarily untrue, such statement cannot be made based on the assessment available in the chapter.
11718	6	32	6	38	The point being made in this paragraph is not very clear - e.g. Is 0.1 GtCO2 yr-1 in 2030 a lot? Needs contextualising [United Kingdom (of Great Britain and Northern Ireland)]	Revised to clarify.
18002	6	32	6	38	The trade-offs related to BECCS and bio-energy should be clearly presented all along the report, as well as references to policies to reduce their negative impacts. This is particularly important when in p.54, lines 43-45, it said that "Despite the evolving capabilities of IAMs in accounting for a wider range of CDR measures, this assessment will have to rely on the more consolidated research concerning the role of BECCS and afforestation / reforestation in 1.5°C pathways" (i.e. research still not conclusive). [Andrea TILCHE, Belgium]	Taken into account - The trade-offs of bio-energy have been assessed in Chapters 2, 3, 4, and 5 and integrated in the SPM.
18004	6	32	6	51	Just in line with ref in p. 43 and 118, and considering the larger sink in forest land compared to afforested land in GHG inventories, the Panel may wish to add here 'forest management', with the associated reasoning. Same may apply for section 2.3.3.3 (p 51-52), 2.3.4.1 (from p. 54 on), etc. [Andrea TILCHE, Belgium]	Rejected - As this chapter did not focus on land-related issues in light of the forthcoming IPCC Special Report on Climate Change and Land, this suggestion was not implemented.
28000	6	32	6	38	Biomass energy with carbon capture and storage (BECCS) and afforestation are considered in most 1.5°C pathways as a cost-effective way to achieve CDR. Such scenarios deploy BECCS at about 0.1 GtCO2 yr-1 in 2030, but other scenarios do not use BECCS at all. Assuming that such scenarios relates to all cost-effective 1.5°C pathways, why is 0.1 GtCO2 in 2030 given as the only number? It may be more relevant to understand the order of magnitude of BECCS applied throughout the century, so why not provide information on e.g. 2050 and 2100 as well (rising to xx Gt and y Gt in 2050 and 2100 respectively)?. Please include these numbers and revise the section. Please include information on the relative contributions of afforestation and BECCS. [Germany]	Rejected- The CDR statements have been reworded to focus on the most robust findings only. In particular: "The role of Carbon-Dioxide Removal (CDR) All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence). The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net-negative emissions after mid-century to return warming to 1.5°C (high confidence). The faster reduction of net CO2 emissions in 1.5°C- compared to 2°C-consistent pathways is predominantly achieved by measures that result in less CO2 being produced and emitted, and only to a smaller degree through additional CDR. Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot. Limits to our understanding of how the carbon cycle responds to net negative emissions increase the uncertainty about the effectiveness of CDR to decline temperatures after a peak. {2.2, 2.3, 2.6, 4.3.7} CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
34172	6	32	6	33	Soil Carbon Sequestration, including biochar, may be cost effective and also bears important co-benefits. Why is these options not dealt with in the same manner as bioenergy with carbon capture and storage, regarding both cost-effectiveness, e.g. effects of possible delay in mitigation action (discounted climate action) and their potential? Please discuss this with the Ch. 4 authors. Why is BECCS cost-effective versus less complicated CDR technologies like biochar and afforestation in the models? Is this due to the possible delay in investment and mitigation action? According to IPCC AR5 biochar has a larger potential (130 Gt C). [Norway]	The statements in the Chapter 2 ES focus on insights drawn from the integrated scenario literature. This has now been clarified. Soil carbon does not feature strongly in that literature.
40130	6	32	6	34	The inclusion of an assessment of high confidence in this placement is strange. Should the confidence statement only apply to the the first sentence of the paragraph? [Ko Barrett, United States of America]	Revised.
37184	6	32	6	33	The currently used text "Biomass energy with carbon capture and storage (BECCS) and afforestation are considered in most 1.5°C pathways as a cost-effective way to achieve CDR." could be misinterpreted. It is not clear whether "and" means "BEECS combined with afforestation" or "BECCS, or afforestation, or both". Wouldn't it be better to say " In most 1.5°C pathways, a combination of biomass energy with carbon capture and storage (BECCS) and, to some extent, afforestation is selected as a cost-effective way to achieve CDR. [Thomas Bruckner, Germany]	Taken into account - The CDR assessment in the ES has been thoroughly revised. It now highlights that "Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use."
51036	6	32	6	34	These sentences are highly misleading. There are two CDR technologies -- BECCS and afforestation -- available as options in the bulk of the IAMs. A small number of people carry out the modeling. A small number of people are dictating to the world that BECCS is the way to go by hiding substantial assumptions. You are hiding substantial assumptions about technology cost, discount rate, and the assumption that these are the only two CDR technologies that can be assessed. Remove this paragraph and replace it with a paragraph that explores the constraints posed by these very limiting assumptions. [Doreen Stabinsky, United States of America]	Taken into account - The revised chapter provides an overview of the mitigation measures considered by the IAMs providing scenarios underlying the chapter's assessment. An in-depth assessment of technological assumptions would fall outside the scope of this Special Report but might be taken up by the AR6.

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53260	6	32	6	34	relevant to "Cost of BECCS" This statement says BECCS and afforestation are considered in most 1.5 degree pathways as "cost-effective" ways to achieve CDR. This is simply not the case. This statement is not compatible with the literature, which tends to estimate BECCS costs as being much higher than afforestation costs. For instance, in the Fuss et al 2017 review that is cited in this report, it states regarding afforestation/reforestation,"A common finding to all the selected studies is the low cost of implementing AR compared to that of the other NETs. For instance, (Strengers et al 2008) estimated that about 50% of the potential would be available at costs below 55 US$/tCO2 while (Humpenoder et al 2014) not that AR starts at carbon price as low as 6 US$/tCO2. In terms of policy costs, AR carn decrease the costs of mitigating climate change by about US$3 trillion (Tavoni et al 2007). THe distributional effects of carbon pricing at the regional level are particularly interesting. Developing countries located in the tropical belt would gain particularly substantial revenue from AR under such a policy regime." And, in any case, how can BECCS be considered as *any* mitigation, much less "cost-effective" mitigation, if scenarios only deploy it at 0.1 Gt per year in 2030, as this section states? Obviously it would be possible to scale afforestation up much faster than that, making afforestation a clearly more "cost-effective" choice. [Mary Booth, United States of America]	Rejected - Even if afforestation cost estimates are lower than BECCS cost estimates, this does not mean they cannot both be considered in cost-effective mitigation portfolios. The revised ES has reworded this statement, however, to now read: "CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
53978	6	32			The inclusion of BECCS and afforestation ignores that the adverse ecological and social impacts and limitations involved are too high. BECCS is furthermore not even proven to be viable or feasible. Add as referebce: http://www.biofuelwatch.org.uk/wp-content/uploads/BECCS-report-web.pdf The inclusion of BECCS as mitigation should be deleted. [Elenita Daño, Philippines]	Taken into account - While the assessment of these side-effects has been carried out in Chapters 3, 4, and 5, also the Chapter 2 ES now states that: "CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
55628	6	32	6	38	terminology: (1) can we repalce references to "afforestation" by "AFOLU measures" or "ecosystem-based measures" or, at least "afforestation/reforestation"? (2) distinquishing BECCS from "land-based CDR" is confusing, since, as stated below (p6 l42-43), "Both BECCS and afforestation require land ..." [David Cooper, Canada]	Taken into account - The ES continues to use the terms the authors considered most specific. BECCS and afforestation both require land. However, their differences lie in the storage of carbon in a geological formation or elsewhere.
57744	6	32	6	51	Need to note that direct capture is not typically included, which is a significant omission. The chapter and ES needs to comment on the potential role and implications (cost, sustainability, etc.) of direct capture from the literature that is available. [Steven Rose, United States of America]	Rejected - Due to space constraints and the limited literature on this topic, this has not been highlighted in the ES.
58104	6	32		38	The paragraph considers the exclusion of BECCS and the substitution by afforeastion. The paragraph, however, misses the crucial point that bioenergy original used with BECCS will be reallocated to alternative conversion routes without CCS. The paragraph suggests that bioenergy demand would be reduced without any reallocation effect. However, the reallocation effect can be very strong, and by 2050 bioenergy demand could be even higher. The study by Bauer et al. (2017) based on EMF-33 scenarios highlights this point and refers explicitly to findings already mentioned in IPCC's AR5. [Nico Bauer, Germany]	Accepted - The revised ES makes this point more robustly: "CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use."

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59996	6	32	6	34	Confusing. Are authors "highly confident" that some scenarios deploy BECCS and some do not (which is obvious) or that the magnitude of deployment will be between 0 and 0.1 GtCO2 per year (which is an interesting result)? [United States of America]	Rejected- The CDR statements have been reworded to focus on the most robust findings only. In particular: "The role of Carbon-Dioxide Removal (CDR) All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence). The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net-negative emissions after mid-century to return warming to 1.5°C (high confidence). The faster reduction of net CO2 emissions in 1.5°C- compared to 2°C-consistent pathways is predominantly achieved by measures that result in less CO2 being produced and emitted, and only to a smaller degree through additional CDR. Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot. Limits to our understanding of how the carbon cycle responds to net negative emissions increase the uncertainty about the effectiveness of CDR to decline temperatures after a peak. {2.2, 2.3, 2.6, 4.3.7} CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
59998	6	32	6	33	Biomass energy with carbon capture and storage (BECCS) and afforestation are considered in most 1.5°C pathways as a cost-effective way to achieve CDR. While this is likely true at present, the qualifier 'at present' should be added to account for the imperfectly predictable nature of technological development. [United States of America]	Taken into account - The CDR assessment in the ES has been thoroughly revised. It now highlights that "Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use."
21668	6	33	6	34	The meaning of "such scenarios" and "other scenarios" is not totally clear. [Sweden]	Taken into account - The CDR message in the ES have been thoroughly revised for clarity and robustness.
30896	6	33	6	33	It is confusing and misleading to say that 1.5 degree pathways deploy BECCs at 0.1 GtCO2/yr in 2030. This figure, apparently derived from table 2.7, is correct, but, i) it confuses the reader because the previous paragraph talks of up to 1130 CDR – and there are scenarios with >1000 BECCS – implying on average 10 Gt/yr over the century. That's a factor of 100 higher than the 0.1 figure. It would be far less misleading to quote more fully from table 2.7, and say "such scenarios deploy BECCs at about 0.1 GtCO2/yr in 2030, 6GtCO2 in 2050, and 14 GtCO2 in 2100. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. The discussion of CDR has been significantly revised in the ES.
37186	6	33	6	34	Such scenarios deploy BECCS at about 0.1 GtCO2 yr-1 in 2030, but other scenarios do not use BECCS at all. should be better replaced by a consideration of the role of BECCS in 2050. [Thomas Bruckner, Germany]	Taken into account - The CDR statements have been thoroughly revised. Absolute values of CDR have not been highlighted, in favour of more robust insights. However, The range of bioenergy with carbon capture and storage found in 1.5°C from the literature is still included.

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32666	6	33	6	34	Other places in the report give numbers for BECCS deployment in 2050 and 2100, and they should be mentoined here as well, to give the reader an idea of the scale up that will be required. [Jasmin Kemper, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The CDR statements have been reworded to focus on the most robust findings only. In particular: "The role of Carbon-Dioxide Removal (CDR) All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence). The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net-negative emissions after mid-century to return warming to 1.5°C (high confidence). The faster reduction of net CO2 emissions in 1.5°C- compared to 2°C-consistent pathways is predominantly achieved by measures that result in less CO2 being produced and emitted, and only to a smaller degree through additional CDR. Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot. Limits to our understanding of how the carbon cycle responds to net negative emissions increase the uncertainty about the effectiveness of CDR to decline temperatures after a peak. {2.2, 2.3, 2.6, 4.3.7} CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
51118	6	33	6	35	Holz et al. 2017 show that early/premature decline of fossil fuel infrastructure, including oil and gas, comes with great additional mitigation potential. This opportunity should be highlighted as it provides a better and more adequate representation of mitigation options. [Linda Schneider, Germany]	Rejected - The Holz et al scenario comes without a resolved energy system evolution that supports how their emissions reduction would be achieved.
55626	6	33	6	34	BECCS at about 0.1 GtCO2/yr is this correct? [David Cooper, Canada]	Taken into account - The CDR statements have been thoroughly revised. Absolute values of CDR have not been highlighted, in favour of more robust insights. However, The range of bioenergy with carbon capture and storage found in 1.5°C from the literature is still included.
17640	6	34	6	34	Suggest adding ", while current NDCs are estimated to result in greenhouse gas emissions of ~49-58 GtCO2-eq yr-1 in 2030" after "2030". (Section 2.3.5) [Sai Ming Lee, China]	Rejected - This section has been thoroughly revised and this inclusion does not fit in the revised text.
53786	6	34	6	34	Move the dot after the sentence behind "(high confidence)" [Patrik Winiger, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
63182	6	34	6	34	high confidence in BECCS yet it has never been proven at scale. I would say "medium confidence". [Greg Rau, United States of America]	Taken into account - The CDR section of the ES has been thoroughly revised to reflect insights from the integrated pathway literature, with appropriately updated confidence statements.
716	6	36	6	36	give an example of 'CO2-producing infrastructure' [Robert Shapiro, United States of America]	This does not feature anymore in the revised ES.
11716	6	37	6	38	Other CDR options, such as direct air capture and storage, are currently not by default included in model scenarios for limiting warming to 1.5°C. What is the implication of this? Is there recent research which suggests that these technologies may be viable in time to contribute to mitigation? [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - This statement, which was not very clear and only supported by limited literature, has been removed from the revised ES.
53180	6	37	6	38	not by default very poor wording. [Christopher Weber, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
7182	6	40	6	41	Be clear what these 'fundamentally different consequences" are, and for whom. The non-bold text underneath does not specify in any way. [Petra Tschakert, Australia]	Accepted - This language was unclear and has been removed.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
28002	6	40	6	51	Please add the magnitude of land being necessary for BECCS - to underline the problems and challenges. [Germany]	Rejected- The CDR statements have been reworded to focus on the most robust findings only. In particular: "The role of Carbon-Dioxide Removal (CDR) All analysed 1.5°C-consistent pathways use CDR to some extent to neutralize emissions from sources for which no mitigation measures have been identified and, in most cases, also to achieve net-negative emissions that allow temperature to return to 1.5°C following an overshoot (high confidence). The longer the delay in reducing CO2 emissions towards zero, the larger the likelihood of exceeding 1.5°C, and the heavier the implied reliance on net-negative emissions after mid-century to return warming to 1.5°C (high confidence). The faster reduction of net CO2 emissions in 1.5°C- compared to 2°C-consistent pathways is predominantly achieved by measures that result in less CO2 being produced and emitted, and only to a smaller degree through additional CDR. Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot. Limits to our understanding of how the carbon cycle responds to net negative emissions increase the uncertainty about the effectiveness of CDR to decline temperatures after a peak. {2.2, 2.3, 2.6, 4.3.7} CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
33578	6	40	8	8	In order to increase the coherence between the different chapters it would be good to mention that the carbon neutrality of bioenergy is highly disputed, as concluded in Chapter 4 (p. 36. See for example Searchinger, T., Beringer, T. and Strong, A., 2017. Does the world have low-carbon bioenergy potential from the dedicated use of land? Energy Policy 110; 434 - 446). This uncertainty about the actual climate change mitigation potential of bioenergy has significant consequences for the role and CDR potential of bioenergy, and BECCS, in 1.5C pathways. If the expanding body of research that concludes that bioenergy has more negative impacts on climate change than most fossil fuels (especially within the timeframe the 1.5C pathway needs to be reached) is correct, the validity of any 1.5C pathway that includes an expansion of bioenergy and/or BECCS is questionable. [Simone Lovera-Bilderbeek, Paraguay]	Rejected - The ES can only highlight findings that are supported by the assessment in the chapter's body. The additional aspects have not been assessed and could hence not be included.
42156	6	40			deployment, ===> deployment [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51114	6	40	6	51	This paragraph should mention the risks and social as well as ecological impacts of BECCS. [Linda Schneider, Germany]	Taken into account - The revised ES mentions that "Limitations on the speed, scale, and societal acceptability of CDR deployment also limit the conceivable extent of temperature overshoot." Further details are provided by the assessment of other chapters.
51038	6	40	6	51	Any discussion of CDR measures should consider the full range of CDR measures, including ecosystem and forest restoration. Conclusions about "CDR measures" that then only discuss BECCS and afforestation reflect the inappropriate bias of the IAMs. This paragraph begins by talking about CDR measures and then just makes conclusions about BECCS, as if that is the only technology available. It is simply wrong to make statements such as "More BECCS is required ..." without a significant disclaimer about the huge limitations of models that rely on only 2 CDR technologies. Best to remove. [Doreen Stabinsky, United States of America]	Taken into account - The scope of this chapter is to assess the mitigation pathway literature in relation to 1.5°C. While these other CDR measures have been assessed in Chapter 4, they do not feature strongly in the integrated pathway literature. This is an important caveat, which is highlighted in the chapter's assessment and the measure table in the Technical Annex.
53182	6	40	6	52	This discussion is better placed in Chapter 4. Suggest streamlining between the two chapters ES on issues of BECCS/afforestation and land and water implications. [Christopher Weber, United States of America]	Noted. The revised ES focusses on key robust insights from Chapter 2.
53980	6	40		50	Delete whole paragraph (and section 2.4.4) for the reasons explained in the line above. See http://www.biofuelwatch.org.uk/wp-content/uploads/BECCS-report-web.pdf [Elenita Daño, Philippines]	Rejected - Important trade-offs are no reason to remove information from a scientific assessment. This ES makes no recommendations but reflects the assessment of the scientific literature.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
58110	6	40		51	The paragraph does not address social issues, but only environmental concerns. The availability of CDR drastically reduces the costs to achieve the 1.5°C target, if it is considered achievable at all. If the target is not achievable, then stronger climate impacts will emerge that may have relatively more severe consequences for poorer households and countries. This is not the point here, but merits mentioning in this comment. What is important, however, is the following. If CDR is not available energy prices increase much more to achieve the 1.5°C target. This impact will be strongly felt for transportation fuels. Rural areas are much more dependent on individual transport and have lower incomes. Hence, these household groups will be affected much more. CDR is frequently related to land, which the paragraph highlights. However, the paragraph completely misses the point that land based CDR may serve as a source of income in these regions. At a global level we are currently observing that structural economiic change leads people to move from rural to urbane areas. Strong climate policies are expected to accelarte this trend, because rural areas will be more sensitive to energy price increases and increasing production costs for agriculture. Land-based CDR can potentially buffer some of these effects by generating new sources of income. This has to be considered in this summary because it is relevant for policy makers. Indeed there is not much literature on this issue, but it is highly important. If rural areas only feel the downsides of strong climate policies and no new opportunities for income will be developed (and CDR is one big potential for that), then we must expect strong political resistance in these areas. The liiterature is strongly biased towards environmental sustainability issues and does not pay attention to social issues related to to urban-rural deistributional impacts. In my opinion these distributional issues are much more severe for the political feasibility of the 1.5°C target than public acceptance issues related to CDR options like BECCS. [Nico Bauer, Germany]	Taken into account - The in-depth assessment of synergies and trade-offs of specific mitigation measures and development is carried out in Chapter 5. In Section 2.5 this information is integrated with information from the pathway literature. However, key insights on the interaction between bioenergy deployment and development can only result from the chapter 5 assessment.
51270	6	41	6	41	“less economically risky” may be changed to “economically less risky” [Muhammad Latif, Pakistan]	This sentence does not feature anymore in the revised ES.
53788	6	41	6	41	Move the dot after the sentence behind "(medium confidence)" [Patrik Winiger, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
18006	6	42	6	42	It is good that it is recognised here that afforestation and BECCS compete for the same land and resources. It is unfortunate that this is not reflected in most parts of the document. BECCS and land use are considered mostly in isolation, without clarifying their interaction. [Andrea TILCHE, Belgium]	Accepted - The revised ES now makes the point explicitly: "Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand."
32668	6	42	6	43	True for afforestation but BECCS can use a variety of feedstocks: forest biomass, energy crops, marine biomass, plus wastes and residues. [Jasmin Kemper, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - The revised ES does not make this point anymore.
37814	6	42	6	43	Trees are not the only potential source for BECCS. Should "trees" be replaced by "vegetation" or some other more generic term? [Michiel Schaeffer, Netherlands]	Accepted - The revised ES does not make this point anymore.
17642	6	43	6	43	Suggest adding "large areas of" before "land". [Sai Ming Lee, China]	This statement does not feature anymore.
18008	6	43	6	43	The word "sustainable" should be deleted. It is not defined or explained in this context (and also in this report), and it appears twice in the executive summary, although in the body of the chapter it is only mentioned once. Rather that using the general/broad term "sustainable", the chapter should clarify the assumptions behind the use of bioenergy, in particular whether/how its impacts on terrestrial carbon are taken into account. Given that emissions from the combustion of biomass are clearly ignored in the report, it would be essential to show that the land use impacts (including foregone sequestration and lost services from biomass products diverted to energy) are considered. [Andrea TILCHE, Belgium]	Accepted - The statement was imprecise and does not feature anymore.
28006	6	43	6	43	(certain) = (very high confidence)? Unclear please specify using calibrated confidence language [Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
28004	6	43	6	45	This paragraph is unintuitive, as it raises the question how can bioenergy, wind and solar be on the same level as fossil fuels in 2050, assuming that the energy system will be fully decarbonized? Is this due to CCS? If so, in what dimension would CCS be deployed? Please address the two following points in revising this paragraph: 1) If Biomass contribution is approximately the same as wind and solar, but half of fossil, what follows would be that in 2050, fossil energy still contributes as much as (wind+biomass+solar) - at the same time, the report states that net carbon emissions reach zero at around 2050; this means, that either we are looking at Fossil with CCS only or at considerable amounts of CDR in 2050 - it may be helpful to add (CCS) in brackets behind "Fossil Energy" if the former is the case. Also, this seems to be not completely in line with the statement on p7 l 27-30. 2) Again this seems an example where information about the median of models may not be incredibly helpful to portray the scope of the challenge; there are models with much larger shares of modern renewable energy in 2050, but the statement makes it seem like all models have a substantial fossil contribution in 2050 - which then raises the question of: why, with PV, wind + storage prices falling as they have, should we be looking at such a comparatively small share of RE in 2050 in the most ambitious mitigation scenario available - and this again points to the influence of CDR assumptions on the outcome of the IAMs (cf. Obersteiner et al. 2018 NCC). [Germany]	Taken into account - This statement was confusing and has been removed. Moreover, the section that highlights the insights from the energy system now provides ranges instead of medians.
45914	6	43	6	45	Please rephrase this sentence as it becomes confusing to compare numbers that are only qualitatively described. [Deger Saygin, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
53236	6	43	6	45	relevant to *Role of bioenergy* Here the report makes clear that bioenergy is assumed to play a really large role in most scenarios, stating “Across 1.5°C pathways, bioenergy supplies nearly as much energy as wind and solar combined, and nearly half as much as total fossil fuel energy in 2050.” The report needs to do a better job of discussing the fuels that are actually used NOW for biomass in real life, and whether and how these differ from what the various models project. Currently, there are very few power plants that burn agricultural residues as fuel. Instead, the majority of the existing industry is fueled by wastes from papermills and sawmills; and new plants that are being built now are fueled mostly by wood, including wood pellets that are made from whole trees. Such wood pellets have a massive carbon impact that is essentially the same as a change in landuse, because forests are heavily cut or clear-cut to provide pellet feedstock (Kittler, Olesen et al. 2015). [Mary Booth, United States of America]	Taken into account - This statement was confusing and has been removed. Moreover, sustainability issues related to biofuels are taken up by Chapter 4.
53790	6	43	6	43	Coud "(certain)" be replaced with the confidence nomenclature to be consistent, or at least with the calibrate language scale of likelihood; in this case: "virtually certain"? [Patrik Winiger, Netherlands]	Accepted - This statement including its confidence statement does not feature anymore in the revised ES.

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58282	6	43	6	43	(certiain)? [Peter Marcotullio, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
60000	6	43	6	43	The authors' assessment of "certain" is silly. The sentence is a statement of the obvious. [United States of America]	Accepted - This statement including its confidence statement does not feature anymore in the revised ES.
37188	6	44	6	45	Across 1.5°C pathways, bioenergy supplies nearly as much energy as wind and solar combined, and nearly half as much as total fossil fuel energy in 2050. If this is true, this would imply that total fossil fuel use (without CCS?) is twice as high as solar and wind combined in 2050. Wouldn't this contradict the need to come up with CO2 emissions which are close to zero in 2050. At least it needs to be clarified whether or not fossil fuel use is referring to its use in combination with CCS (or without CCS). [Thomas Bruckner, Germany]	Taken into account - This statement was confusing and has been removed. The section on energy system characteristics provides a clear distinction between fossil CCS and BECCS.
3198	6	45	6	48	This sentence ignores the importance of other renewable energy options which BECCS may be competing with. i.e. if an IAM can quickly decarbonise the electricity sector with solar/wind power, then it will rely less on BECCS. I believe this is hilighted in the EMF33 scenarios and in Bauer et al 2017b [Vassilis Daioglou, Netherlands]	Taken into account - the chapter now highlights this interaction, not only due to a rapid decarbonisation of the energy sector but also due to a limitation of energy demand. This has been included in the ES.
37816	6	45	6	47	This observation holds for other land-based CDR as well. Evidence for land and water requirements is particularly strong for afforestation & reforestation, hence this must be added to this statement, in addition to bioenergy and BECCS already mentioned [Michiel Schaeffer, Netherlands]	Accepted - The revised ES statement on CDR and the various options makes this point more general: "Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand."
13088	6	47	6	47	Delete the text "More BECCS is required in 1.5°C scenarios when fossil fuels are phased-out more slowly.". [Eleni Kaditi, Austria]	Accepted - The CDR section has been thoroughly revised and this statement does not feature anymore.
18010	6	47	6	47	More BECCS is required in 1.5... should be replaced by "The models predict a higher deployment of BECCS in 1.5...". The text should not give the impression that the developments assumed/predicted by models to achieve a certain outcome represent accurately the real necessities. In this case, we do not have sufficient evidence to safely say that more BECCS would actually help compensate for slower phase-out, or would make matters worse. The models are driven by the assumptions/constraints fed to them, and they do not necessarily represent realistic, necessary or desirable outcomes. BECCS is currently an untested and unproven system, with high collateral costs that do not seem to be fully considered in this assessement (energy penalty, land use and system-wide emissions that cannot be captured, stability of storage and its opportunity costs, including cannibalising suitable storage sites from fossil CCS, which would be needed in the event of slow fossil phase-out, etc.) [Andrea TILCHE, Belgium]	Taken into account - The CDR statement has been revised to make clear that it is dependent on the state of the integrated pathway literature.
58198	6	48	6	50	Land-use change dynamics associated with bioenergy and BECCS may differ markedly between 1.5°C and 2°C pathways, depending on the assumptions taken in the model. For instance, land use may significantly change under a low meat consumption scenario versus a moderate meat consumption one, or higher crop and livestock productivity gains versus moderate gains, and so forth. See more in Strapasson et al. (2017), DOI: 10.1111/gcbb.12456 [Alexandre Strapasson, Brazil]	Noted. However, this has not been highlighted as a ES message.
28008	6	50	6	51	The expression "pressure on land" is too technical and almost cynical - considering the magnitude of land and resulting challenges and problems for e.g. food production. Therefore please add "potential conflicts with e.g. food production". [Germany]	Accepted - The CDR section has been thoroughly revised and this statement does not feature anymore.
54786	6	50	6	51	Is this sentence hinting that a 2DC target would be more aligned with sustainable development than a 1.5D target? Is it saying that 1.5D pathways should not be pursued/are not the best option for our society? Clarify and develop. [Marine Gorner, France]	Taken into account - It did not intend to make this suggestion. The section has been thoroughly edited.
56448	6	50		51	Land use may be less critical and have multiple benefits for climate refugees heading for Europe and european countries, when a 100 km area of Northern Africa coastal land is used for new agricultural activity to grow and harvest new biomass and do aforestation, with energy from sun and wind, fresh water from the mediterranian sea water for people and to bring new prosperity for many inhabitants on land not used there, and produce bio based fuel for Europe [Henk Daalder, Netherlands]	Noted. No action undertaken.
19516	6	51	6	51	The last sentence should acknowledge that 2°C warming would imply higher risks & impacts on land ecosystems and related ecosystem services. [Jennifer Morgan, Netherlands]	Rejected - Although not incorrect this does not follow from the Chapter 2 Assessment. It would, however, come from the assessment of Chapters 3 and 5.
28010	6	53	7	8	The role of non-CO2 emissions in 1.5°C compatible pathways is reflected in this subsection of the Executive Summary for Ch2. However critical issues related to enhanced bioenergy applications (reliance of may pathways on significant amounts of bioenergy) and its implications on N2O emissions and potential mitigation options for non-CO2 emissions is - compared to section 2.3.1.1 (p.35, line 1-17) - not addressed adequately, and subsequently not in the overall SPM of the report. Please modify. [Germany]	Taken into account - In as far as the chapter discusses these aspects, the ES now mentions that: "In many cases, non-CO2 emissions reductions are similar in 2°C pathways, indicating reductions near their assumed maximum potential by integrated assessment models. Emissions of N2O and NH3 increase in some pathways with strongly increased bioenergy demand."
13360	6	55	7	8	That mitigation measures will also likley reduce aerosol cooling, and therefore any warming due to lower aerosols will influence 1.5C compatible budgets, should perhaps be mentioned here. [Scott Vivian, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The co-control aspects as well as the fact that methane and influence have the strongest impact amongst non-CO2 forcers is now highlighted.
13470	6	55	6	56	this phrase is very important and needs to be highlighted in a more noble are of the report. [Sergio Aquino, Canada]	The authors are of the opinion that the chapter 2 ES is already quite a noble spot. However, this statement did not survive the thorough revisions of the SOD, and does not feature anymore.
30898	6	55	7	8	It is interesting that non-CO2 warming is presented in this way, and that non-CO2 GHG budgets are not presented. This information appears to be possible to present through the data in table 2.7. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - The budget concept applies to CO2 only, but non-CO2 warming needs to be taken into account to estimate precise values for the remaining carbon budget.
49032	6	55	7	8	It would also be important to note here the effect of non-CO2 forcers on temperature by mid-century, as noted in 2.2.2.3, and the key role they can play in addressing temperature change in the near-term, as noted in 4.3.7. [David Waskow, United States of America]	Rejected - This has not been included.
49892	6	55	6	56	pass can be changed exceed [Himangana Gupta, India]	Not applicable anymore. This statement does not feature anymore in the revised ES.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
37818	6	55	7	8	An opprtunity is missed here to link non-CO2 here to other categories of efforts, like in other paragraphs, for example P6L8-P6L15 and P7L18-P7L24. Non-CO2 efforts are also part of the overall trade-offs between efforts. It must be made clear in this paragraph that non-CO2 efforts are already very strong in 1.5°C scenarios, as they are in 2°C, alongside many of the other efforts explained in other paragraphs. This non-CO2 paragraph currently reads as if little non-CO2 effort is assumed in 1.5°C scenarios in general, and that there is large potential to lower pressure on other efforts by increasing non-CO2 effort. Also as in other paragraphs, for non-CO2 there's an interesting question how much more can be done from 2°C scenarios down to 1.5°C scenarios. How much of the additional effort could be from non-CO2? A lot? Virtually nothing? [Michiel Schaeffer, Netherlands]	Taken into account - The general evolution of non-CO2 forcers in 1.5°C and 2"C pathways is now more precisely characterised. The revised ES now states: "Non-CO2 emissions contribute to peak warming and thus affect the remaining carbon budget. The evolution of methane and sulphur dioxide emissions strongly influences the chances of limiting warming to 1.5°C. In the near-term, a weakening of aerosol cooling would add to future warming, but can be tempered by reductions in methane emissions (high confidence). Uncertainty in radiative forcing estimates (particularly aerosol) affects carbon budgets and the certainty of pathway categorizations. Some non-CO2 forcers are emitted alongside CO2, particularly in the energy and transport sectors, and can be largely addressed through CO2 mitigation. Others require specific measures, for example to target agricultural N2O and CH4, some sources of black carbon, or hydrofluorocarbons (high confidence). In many cases, non-CO2 emissions reductions are similar in 2°C pathways, indicating reductions near their assumed maximum potential by integrated assessment models. Emissions of N2O and NH3 increase in some pathways with strongly increased bioenergy demand. {2.2.2, 2.3.1, 2.4.2, 2.5.3}"
37820	6	55	7	8	Figure 2.9 shows the fundamental problem of lumping many species together under "SLCF", or even the more neutral term non-CO2 warming agents. The ES must make clear that (1) CH4 reductions in 1.5°C need to be accelerated compared to less stringent temperature limits (Figure 2.9: near-term mitigaion contributions from CH4 are larger for 1.5°C scenarios compared to less stringent scenarios, while the difference in the longer term seems to diminish), and that (2) BC shows no (statistically significant) difference between warming limits, not in the near term, nor in the long term, and therefore no useful contribution from BC is demonstrated for 1.5°C. Also no (additional) contribution will come from HFC reductions, given the fact that the "most feasible reductions" in Figure 2.9 are comparable to the levels for all temperature limits in 2030 and 2050. To stay close to evidence provided in the chapter, the authors should make the point in the ES that even for scenarios that DO NOT OVERSHOOT 1.5°C, the peaking level of warming is reduced by CO2 measures, plus a bit from CH4, and NOT from other SLCFs, compared to higher limits of peak/return warming. This is confirmed by e.g. P31L23-24, P35L20-28 and other evidence elsewhere in the chapter. [Michiel Schaeffer, Netherlands]	Taken into account - The non-CO2 statement in the ES now more clearly highlights the key contributors in terms of non-CO2 warming: methane and SO2. BC does not feature here. The other points suggested by the reviewer are not incorrect but have not been included in the ES due to space constraints.
55452	6	55	7	7	I thank the authors for clarifying and strengthening the role of non-CO2 mitigation relative to CO2 budgets. My sense is that the sentence "Every tenth of a degree of warming…" deserves to be elevated to the SPM as it is extremely policy relevant and provides very practical guidance. Also note that chapter 1 has a very similar discussion (but doesn't express its conclusions in the same way) - my suggestion would be to test and demonstrate that the conclusions from the two chapters are indeed consistent, and summarise the approach in a small box in one or the other chapter that cross-references the other chapter (i.e. a box with a practical thought-experiment to demonstrate the applicability of this relationship and how to quantify this chapter 1 uses AGWP to get to the budget equivalence). [Andy Reisinger, New Zealand]	Taken into account - In order to streamline the text of the ES, the non-CO2 impact on the remaining carbon budget was highlighted. The precise impact of one-tenth of a degree additional warming by non-CO2 forcers is equally subject to a range of uncertainties. The original, more simple statement could thus not be supported for inclusion in the ES.
61754	6	55	7	8	A more precise assessment related to non CO2 mitigation compatible with 1.5°C is needed. The text following the bold statement appears quite generic. [Valérie Masson-Delmotte, France]	Accepted - The non-CO2 statement was thoroughly revised and now reads: "Non-CO2 emissions contribute to peak warming and thus affect the remaining carbon budget. The evolution of methane and sulphur dioxide emissions strongly influences the chances of limiting warming to 1.5°C. In the near-term, a weakening of aerosol cooling would add to future warming, but can be tempered by reductions in methane emissions (high confidence). Uncertainty in radiative forcing estimates (particularly aerosol) affects carbon budgets and the certainty of pathway categorizations. Some non-CO2 forcers are emitted alongside CO2, particularly in the energy and transport sectors, and can be largely addressed through CO2 mitigation. Others require specific measures, for example to target agricultural N2O and CH4, some sources of black carbon, or hydrofluorocarbons (high confidence). In many cases, non-CO2 emissions reductions are similar in 2°C pathways, indicating reductions near their assumed maximum potential by integrated assessment models. Emissions of N2O and NH3 increase in some pathways with strongly increased bioenergy demand. {2.2.2, 2.3.1, 2.4.2, 2.5.3}"
42158	6	56			mitigation, ===> mitigation [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
63186	6	56	6	56	Add: "...land and the potential for trade-offs with sustainable development. {2.4.4}. While less-researched, use of marine-based methods (e.g. marine BECCS, ocean alkalinzation, blue carbon, ocean permaculture) could greatly increase CDR potential, speed of deploy, and hasten achievement of sustainable development, while reducing land impacts..." (see my additions to chapt 4) [Greg Rau, United States of America]	Rejected - Given space limitations the Chapter 2 ES cannot highlight notes or points being made in Chapter 4.
35764	7		7		The share of primary energy from renewables increases rapidly in 1.5 degree C scenarios, becoming the dominant source of energy by 2050 in most pathways while making this statement a cautious note should also be included that since 1990, to till date the share of fossil fuels remain constant at 80% (Source: World Bank, 2018: https://data.worldbank.org/indicator/EG.USE.COMM.FO.ZS) [India]	Taken into account - However, the assessment of the historical evolution of the energy system did not fall within the scope of this chapter. While correct, the chapter itself doe snot provide evidence to support this statement at the level of the ES. However, the ES does state that "1.5°C implies very ambitious, internationally cooperative policy environments that transform both supply and demand"
35760	7	2	7	3	Examples of fuel switch, low carbon technologies in transport and industrial sectors, low carbon refrigeration technologies, LEDs, green building technologies may be added. [India]	Taken into account - Due to strict word limits, these examples were not included here.
40810	7	2	7	3	Please consider adding example of fule switch, low carbon technologies in transport and insdustiral sectors. Low carbon refrigiration technologies, LEDs, green building technologies [NARESH KUMAR SOORA, India]	Taken into account - Due to strict word limits, these examples were not included here.
13090	7	3	7	3	Delete the text "black carbon from kerosene lamps". [Eleni Kaditi, Austria]	Accepted - This example does not feature anymore.

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14018	7	3	7	3	Black carbon comes from many more sources than kerosene lamps - see for example: http://www.stapgef.org/taxonomy/term/394 Suggest delete "from kerosene lamps" and ensure black carbon is adequately covered in the main text. [Ralph Sims, New Zealand]	Accepted - This example does not feature anymore. The ES focusses on the short-lived forcers with the most important identified effects.
28012	7	3	7	3	Insert "hydrochlorofluorocarbons" in front of "HFC", because it is mentioned here for the first time. [Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
35762	7	3	7	3	agricultural methane', may be dropped. Instead use decreasing methane from livestock, which will be consistant with next sentence on Pg 7 line 41. [India]	Taken into account - This statement has been streamlined. It still reads "agricultural methane", but now the statement also provides more context: "Some non-CO2 forcers are emitted alongside CO2, particularly in the energy and transport sectors, and can be largely addressed through CO2 mitigation. Others require specific measures, for example to target agricultural N2O and CH4, some sources of black carbon, or hydrofluorocarbons (high confidence)."
40814	7	3	7	3	consider dropping 'agricultural methane', istead use decreasing methane from livestock, that will be consitant with next sentence in pg 7 line 41 [NARESH KUMAR SOORA, India]	Taken into account - This statement has been streamlined. It still reads "agricultural methane", but now the statement also provides more context: "Some non-CO2 forcers are emitted alongside CO2, particularly in the energy and transport sectors, and can be largely addressed through CO2 mitigation. Others require specific measures, for example to target agricultural N2O and CH4, some sources of black carbon, or hydrofluorocarbons (high confidence)."
42160	7	3			for example ===> for example, [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
53792	7	3	7	3	I don't understand the example of "black carbon from kerosene lamps". Kerosene lamps are hardly the biggest source of black carbon. Better examples would be diesel engines, industrial coal, residential solid fuels, or open biomass burning; which together make up ~90% of all anthropogenic black carbon emissions (Soruce: Bond et al. 2013; doi:10.1002/jgrd.50171). Also, kerosene lamps are probably applied mostly indoors, where they are more health concern than climate forcer. [Patrik Winiger, Netherlands]	Accepted - This example does not feature anymore.
54600	7	3	7	3	HFC' should be defined here. [Qudsia Zafar, Pakistan]	Accepted - HFC are written in full.
54788	7	3	7	3	Black carbon from kerosene lamps: Is this actually a big threat to global warming compared to black carbon emissions from shipping or other industries? If not, use another, more relevant example. [Marine Gorner, France]	Accepted - This example does not feature anymore.
60002	7	3	7	3	Black carbon from kerosene lamps, while measurable and important, is a much less significant contributor to anthropogenic radiative forcing than agricultural methane and HFCs (mentioned in the same sentence), and as such should be removed from the Executive Summary. Mention of kerosene lamps should be retained in the main text. On the other hand, black carbon from the totality of sources that produce it may merit mention here. [United States of America]	Accepted - This example does not feature anymore. The ES focusses on the short-lived forcers with the most important identified effects.
60004	7	3	7	4	Remove the parenthetical "(such as the Kigali Amendment)". This reference is unnecessary since no other policies are mentioned in this section, and the topic is covered elsewhere in the report. [United States of America]	Accepted - This example does not feature anymore.
3200	7	4	7	6	I find the phrasing of this sentence a bit odd, especially the ending "increasing the risk of exceeding 1.5C". This seems like a pleonasm to me since any tenth of a degree warming (from CO2 or non-CO2) emissions increases the risk. If im not mistaken, this sentence boils down to "non-CO2 gasses have a higer warming potential", which is something that has been long established and understood, and i think that wording would make the point more clearly. [Vassilis Daioglou, Netherlands]	Accepted - This statement on non-CO2 forcers has been thoroughly reworded. It now reads: "Non-CO2 emissions contribute to peak warming and thus affect the remaining carbon budget. The evolution of methane and sulphur dioxide emissions strongly influences the chances of limiting warming to 1.5°C. In the near-term, a weakening of aerosol cooling would add to future warming, but can be tempered by reductions in methane emissions (high confidence). Uncertainty in radiative forcing estimates (particularly aerosol) affects carbon budgets and the certainty of pathway categorizations. Some non-CO2 forcers are emitted alongside CO2, particularly in the energy and transport sectors, and can be largely addressed through CO2 mitigation. Others require specific measures, for example to target agricultural N2O and CH4, some sources of black carbon, or hydrofluorocarbons (high confidence). In many cases, non-CO2 emissions reductions are similar in 2°C pathways, indicating reductions near their assumed maximum potential by integrated assessment models. Emissions of N2O and NH3 increase in some pathways with strongly increased bioenergy demand. {2.2.2, 2.3.1, 2.4.2, 2.5.3}"
53794	7	4	7	4	Move the dot after the sentence behind "(high confidence)" [Patrik Winiger, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
55956	7	4	7	4	Bit confusing formulation, suggestion,"…that comes from failure to mitigate non-CO2 emissions…" [Pamela Pearson, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
57746	7	5	7	5	Would be more helpful to provide a range for the remaining carbon budget. Currently just "~150 GtCO2." [Steven Rose, United States of America]	Accepted - The remaining carbon budget discussion has been clarified and now states a range and list the most important uncertainty contributions.
53796	7	7	7	7	Move the dot after the sentence behind "(high confidence)" [Patrik Winiger, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
55958	7	7	7	7	Add, "as well as potentially slowing regional loss of snow, ice and permafrost and related global impacts." [Pamela Pearson, United States of America]	Rejected - While not necessarily untrue, such statement cannot be made based on the assessment in the chapter's body.
28014	7	10	7	36	This section gives the impression that the described transitions will happen rather smoothly without any problems and challenges. Please clarify, in the subheading or elsewhere, that "transitions in mitigation pathways" refers to stylized/idealized model scenarios and therefore does not include the real world challenges resulting from barriers and issues such as socio-economic and political factors, availability of technology etc... [Germany]	Taken into account - The ES now clarifies upfront that this chapter derives its insights from the integrated pathway literature. The assessment of real-world factors is part of the chapter 4 assessment and will be integrated in the SPM.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
34174	7	10	7	35	This text focuses mostly on the transition in the energy sector. Please consider to also include description of transitions in other sectors. As an example, the finding on page 78, line 45-47, about crop land for food and feed production seems to be relevant to mention in the Executive Summary. [Norway]	Rejected - While not irrelevant, the ES messages were selected to focus on the main contributors for global emissions. This additional point on land surface has hence not been included.
34176	7	10	7	36	Consider revising this section of the summary to reflect the different groups of scenario classes identified later in the chapter. The differences between scenarios with or without extreme deployment of CDR are the most policy relevant in our view. Currently the range associated with the scenarios are so large that considerations regarding mean or median values are challenging (e.g 15 -87 % RE share in 2050). We believe it would give more useful information for policymakers if you in addition to the full range can separate more between the different scenario classes when summarizing results. Please consider to focus less on the scenarioes with extreme deployment of CDR technologies, or at least make it very clear for policymakers what kind of risks and assuptions that are associated with such scenarios. [Norway]	Taken into account - the ES now also highlights how CDR use can be limited.
60006	7	10	7	35	It's critical to clarify which scenario properties are necessary conditions for the scenario (requirements) and which are merely tendencies of the model projections in various pathway families. [United States of America]	Rejected - A scenario "requirement" can only be identified as the result of a dedicated scenario experiment which attempts to achieve a certain goal in absence of a particular measure. Because this assessment draws from an ensemble of opportunity, statements about requirements cannot be made on this topic.
42162	7	13			behavioural ===> behavioral [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
11026	7	14	7	15	switching to lower-carbon sources of energy (including renewables , fossil with CCS and/or nuclear) [Wilfried Maas, Netherlands]	Not applicable anymore. This statement does not feature anymore in the revised ES.
13472	7	14	7	14	specific, but [Sergio Aquino, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
13092	7	15	7	15	Delete the text "(including renewables and/or nuclear)". [Eleni Kaditi, Austria]	Not applicable anymore. This statement does not feature anymore in the revised ES.
13094	7	15	7	16	Delete the text "replacing fossil fuels". [Eleni Kaditi, Austria]	Not applicable anymore. This statement does not feature anymore in the revised ES.
14020	7	15	7	16	sources of energy is followed by a sentence on electricity. No mention of heating / cooling So add " End-use electrification and heating/cooling systems replacing fossil fuels…." [Ralph Sims, New Zealand]	Not applicable anymore. This statement does not feature anymore in the revised ES.
10492	7	18	7	18	Missing ")" [Hong Yang, Switzerland]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42164	7	18			end use ===> end-use [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
57748	7	18	7	24	Important to note that scenarios typically assume economy-wide policies, which facilitate use of low-carbon electricity to decarbonize non-electric sectors. Policy design and available technologies will affect these opportunities and cost-effectivenss as is shown in AR5 scenarios and country studies (e.g., US study of Weyant et al (2014)). [Steven Rose, United States of America]	Noted. However, it is unclear how this can be included in the ES in a compact way.
45916	7	19	7	19	It is not clear what is meant with `residual fuel mix`. Are these fossi fuels in 2C or are these the remaining fossil fuels in 1.5 after implementation of measures or does it perhaps mean fuels used in end-use sectors? [Deger Saygin, Turkey]	Not applicable anymore. This statement does not feature anymore in the revised ES.
42166	7	22			end use ===> end-use [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
53184	7	22	7	24	Suggest adding a quantitative statistic in this sentence, for instance growth rate per year in overshoot vs. non-overshoot scenarios (e.g. 5%/yr vs. 7%/yr global CO2 emissions) [Christopher Weber, United States of America]	Rejected. The ES only focusses on the most robust findings and is limited in length.
51638	7	26	7	28	Renewable is not what's important, low-carbon is the important part, be consistent. The rest of the paragraph talks about biomass and nuclear. Nuclear is an importat part of the low-GHG future. [Jason Donev, Canada]	Taken into account - the various low-carbon energy contributions are now mentioned separately for full transparency.
56450	7	26		35	It is wrong to “phase out coal” CO2 emission has to stop as soon as possible, this allows coal or natural gas intensive countries to keep their miners at work, their fossil capital at value, and still become climate neutral, just by paying for and implementing mandatory CCS2 technology. CCS means storing the gas somewhere in the earth, but CCS2 converts it to a substance with Olivine and a Gravity {Pressure Vessel, to speed up the reaction and produce a economical product from CO2, that can replace sand in concrete, or used as filler in paint and paper. The economic interests of intensive fossil countries should be addressed more honestly, in the interest of political and social acceptance. Think of Poland [Henk Daalder, Netherlands]	Noted. However, this chapter reports insights based on the integrated pathway literature. The concerns highlighted by the reviewer could emerge from the Chapter 4 or Chapter 5 assessments.
19520	7	27	7	27	After the bolded sentence, add: "Sector-based analyses explore in greater detail some options for deep reductions in GHG emissions, such as 100 % renewable energy systems, where a growing body of literature has emerged. " (Source: Chapter 2. 62. lines 27-29; and Chapter 2. page 107. lines 34-35) [Jennifer Morgan, Netherlands]	Not applicable anymore. This statement does not feature anymore in the revised ES. This suggestion was also not included in the revised ES due to space constraints.
58412	7	27	7	28	low-carbon energy (including renewable energy, sustainable biomass, Carbon Capture and Storage (CCS) and nuclear) instead of "low-carbon energy (including renewable energy, sustainable biomass and nuclear)" [Andrew Prag, France]	Not applicable anymore. This statement does not feature anymore in the revised ES.
4890	7	29	7	32	And yet, countries are still choosing to build coal-fired power plants--very depressing and likely making it very difficult to keep peak warming to 1.5 C. I think it important to note how serious it is to have new plants being built. [Michael MacCracken, United States of America]	Noted. However, this is not something which can be drawn from the assessment of this chapter, as it does not include an assessment of current trends in investments etc.
8332	7	29	7	31	Many national studies show that it is very difficult to achieve an average 4-5% annual reduction in coal consumption, or an enormous challenge that is almost impossible to be met. It is suggested to add a statement on the feasibility of a rapid coal phase-out in this section. [China]	Taken into account - Unfortunately, this chapter does not contain a feasibility assessment of annual reduction rates in coal consumption. This particular statement can hence not be included as part of the Chapter 2 ES.
19524	7	29	7	31	Coal usage is phased out rapidly in mitigation pathways consistent with 1.5°C, with annual reduction rates of 4-5% until the middle of the century. In cases where coal use is not completely phased out by 2050, 40-100% is combined with Carbon Capture and Storage (CCS). 4-5% annual coal phase-out still leads to around 200-300 GTCO2 emissions from today upto 2050 (and substantial non-CO2 emissions too) - this is a large part of the remaining carbon budgets. Why aren't more radical coal phase-out scenarios included in the summary statement, even though such scenarios (such as the IIASA LED MESSAGEix) and sectoral analysis (such as those described on page 62, lines 28-30) exist and are elaborated on in the underlying Chapter? Also the findings presented in the Table 2.14 on pages 93-95 on "Transitions and enabling conditions that need to take place in key sectors in the short term for a 1.5°C pathway" include much faster coal phase/out options. [Jennifer Morgan, Netherlands]	Taken into account - The revised ES now reports the full range across scenarios.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
19528	7	29	7	31	Coal usage is phased out rapidly in mitigation pathways consistent with 1.5°C, with annual reduction rates of 4-5% until the middle of the century. In cases where coal use is not completely phased out by 2050, 40-100% is combined with Carbon Capture and Storage (CCS). This - combined with other CCS requiements mentioned in the report, e.g. for gas requires an extremely fast build up for CCS not justified by the last decades of CCS developments. Even the industry body CCS Institute sees a very slow growth: https://hub.globalccsinstitute.com/sites/default/files/publications/201158/global-status-ccs-2016-summary-report.pdf [Jennifer Morgan, Netherlands]	Noted. No further action by the author team.
49894	7	29	7	30	It needs to be mentioned somewhere if coal phase out is feasible [Himangana Gupta, India]	Unfortunately, this falls outside the approved scope of Chapter 2. However, Chapter 4 could provide more insights into this issue
30404	7	30	7	31	« with annual reduction rates of 4-5% until the middle of the century » We encourage more quantitative statements such as this one to explain what "rapid" means [France]	Taken into account. The revised ES attempts to avoid imprecise language and favours quantitative, yet robust statements over ambiguous formulations.
45918	7	31	7	32	Is this the use of coal in the power sector or also in industry? Please clarify [Deger Saygin, Turkey]	Taken into account - It refers to total primary energy.
28016	7	32	7	32	The glossary refers to "Carbon Dioxide Capture and Storage (CCS)", please be consistent [Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
37822	7	32	7	33	Add a statement on total coal use, for example (Figure 2.19, table 2.10): "Even in scenarios that include CCS, total coal is reduced by 2050 to about a quarter of its use today." Also essential policy-relevant information is to explain what total coal use by 2050 in 1.5°C scenarios is in the electricity sector (zero?) and industry (which sub-secrtors?) [Michiel Schaeffer, Netherlands]	Taken into account - However, due to space constraints and questions of balance the revised ES discusses various energy sources more equally. The revised messages reads: "The share of primary energy from renewables increases while coal usage decreases across 1.5°C-consistent pathways (high confidence). By 2050, renewables (including bioenergy, hydro, wind and solar, with direct-equivalence method) supply a share of 49–67% (interquartile range) of primary energy in 1.5°C-consistent pathways; while the share from coal decreases to 1–7% (interquartile range), with a large fraction of this coal use combined with Carbon Capture and Storage (CCS). From 2020 to 2050 the primary energy supplied by oil declines in most pathways (–32 to –74% interquartile range). Natural gas changes by –13% to –60% (interquartile range), but some pathways show a marked increase albeit with widespread deployment of CCS. The overall deployment of CCS varies widely across 1.5°C-consistent pathways with cumulative CO2 stored through 2050 ranging from zero up to 460 GtCO2 (minimum-maximum range), of which zero up to 190 GtCO2 stored from biomass. Primary energy supplied by bioenergy ranges from 40–310 EJ yr-1 in 2050 (minimum-maximum range), and nuclear from 3–120 EJ/yr (minimum-maximum range). These ranges reflect both uncertainties in technological development and strategic mitigation portfolio choices. {2.4.2}"
54594	7	32	7	32	Carbon Capture Storage' definition of 'CCS' should be added on page 6, line 29. [Qudsia Zafar, Pakistan]	Accepted - CCS is defined upon first usage.
58414	7	32	7	32	if comment above is addressed, replace "Carbon Capture and Storage (CCS)" with "CCS" [Andrew Prag, France]	Accepted - CCS is defined upon first usage.
19532	7	33	7	35	For other fossil fuels, the mid-century picture is more differentiated. Scenarios indicate slowly declining use of oil and a wide range of natural gas usage, with varying levels of CCS. This claim is not true for all the 1.5°C scenarios assessed, such as the IIASA LED (MESSAGEix), which the Chapter 2 consideres as "an example of the important class of 1.5°C pathways characterised by deep fossil fuel emissions reductions, very limited CDR deployment and only marginal net negative CO2 emissions and overshoot"." (See Chapter 2, page 29, 49-52). For a more balanced representation of the scenarios, please clarify here that scenarios that assume no or limited use of BECCS imply a rapid phase out of all fossil fuels. It is not justified in the whole draft why only very slow oil and gas phase-out scenarios are considered. For example recent discussions about ICE, plastics and other oil/gas based products signal the potential for step-change in oil related demand reduction. Also as Chapter 2 page 28 line 43-45 says: "The expected emissions until 2020 and the committed fossil fuel emissions already depreciate a significant part of the 1.5°C TPB." [Jennifer Morgan, Netherlands]	Taken into account -. The discussion of energy system transitions has been reworded so as to provide a more balanced picture and show the full ranges. This implies that single scenarios could not be highlighted in the ES, but are forwarded to the SPM.
53186	7	34	7	35	Suggest adding more detailt to ES here. The rates of growth or decline for oil & gas are among the most critically important statistics for policy and economic forecasting. [Christopher Weber, United States of America]	Noted. The ES focuses on the most robust findings and is limited in length.
15736	7	37	7	37	Define/explain 'demand-side mitigation', 'demand-side options', 'demand-side approaches' at first use and in the glossary. If these terms are synonymous, please consistently use just one. Same issue for 'supply-side options', 'supply-side solutions' etc. [Australia]	Taken into account - The revised ES statement now provides some examples of demand-side measures that make it easier to understand them: "Demand-side measures are key elements of 1.5°C-consistent pathways. Lifestyle choices lowering energy demand and the land- and GHG-intensity of food consumption can further support achievement of 1.5°C-consistent pathways (high confidence). By 2030 and 2050, all end-use sectors (including building, transport, and industry) show marked energy demand reductions in modelled 1.5°C-consistent pathways, comparable and beyond those projected in 2°C-consistent pathways. Sectorial models support the scale of these reductions. {2.3.4, 2.4.3}"
34178	7	39	7	52	Please consider to mention the three broad mitigation approaches from SPM page 3 line 40 to 44. Furthermore consult with Ch 4 authors to avoid duplications. [Norway]	Taken into account - Overlap with Chapter 4 has been minimized. The ES statement on demand-side measures has also been revised and condensed.
39116	7	39	7	52	This is essential to highlight because most policy makers underestimate how much sustainable lifestyles - including diet, food waste, family planning, economic and social paradigm shift - can strengthen their mitigation policies. Many lack confidence to state when their countries are living unsustainably. Keep highlighting these findings, so we do not fail to look at ourselves in the mirror and sufficiently address the root causes of why global temperatures are rising. [Lindsey Cook, Germany]	Noted.
45920	7	39	7	47	what about renewable energy technologies for end-use sectors? [Deger Saygin, Turkey]	Also these play a role but less information is available here.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
57750	7	39	7	52	Important to communicate to decision-makers what is happening to commodity prices and household consumption. THe observed behavior changes are the result of changing markets among other things. Note that scenarios that simply assume other futures likely miss the true price implications. [Steven Rose, United States of America]	Rejected - We agree that these aspects could be of interest. However, they have not been assessed as part of this Special Report and are hence not included in the ES.
57752	7	39	7	39	Critica is subjective. Need a descriptive word. [Steven Rose, United States of America]	Accepted - This statement has been thoroughly revised.
18012	7	40	7	41	Much emphasis on mitigation avenues is put on livestock size/demand for animal products, and rightly so. Nevertheless, a breakdown of livestock seems elusive, with the ruminants (by far the category with highest GHG emissions) only referred to in p. 43, under 'literature review', associated with 'and so on'. This comment applies mutatis mutandis for several parts in chapter 2. [Andrea TILCHE, Belgium]	Taken into account - This statement has been thoroughly revised with less emphasis on livestock.
42168	7	40			include: ===> include [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
14022	7	41	7	41	decreases in livestock and private vehicle transportation demand per capita -Turn into two separate points as no logical linkage other than both need to decrease. But the term "decreases in livestock" is incorrect and goes against biodiversity. It should be "decrease in farmed livestock, particularly when produced for meat and milk protein." Or Better "decreased demand for meat and milk protein". [Ralph Sims, New Zealand]	Accepted - This statement has been thoroughly revised.
18014	7	41	7	41	we reccomend to replace "private vehicle transportation demand per capita" by "private motor vehicle transportation" [Andrea TILCHE, Belgium]	Accepted - This statement has been thoroughly revised, with less precise, yet more robust and balanced wording
37366	7	41	7	42	The potentials of diet changes even exceeds that of reducing food wastes. In my view it is essential to mention dietary change, in particular toward healthy diets, e.g. WHO or Harvard Medical School recommendations here. See e.g. IPCC, WGIII, AR5, ch11, and the literature cited therein (and also discussed in other chapters of the draft). [Helmut Haberl, Austria]	Taken into account - The revised ES makes this point more generally: "Demand-side measures are key elements of 1.5°C-consistent pathways. Lifestyle choices lowering energy demand and the land- and GHG-intensity of food consumption can further support achievement of 1.5°C-consistent pathways (high confidence)."
49586	7	41	7	43	improvements in end-use efficiency should also include cascadic uses of forest biomass (Bais et al. 2018, doi 10.1016/j.jclepro.2017.04.153) [Karlheinz ERB, Austria]	Accepted - However, this has not been highlighted in the ES as it is not assessed in depth in the chapter.
18016	7	42	7	44	It should be clarified (here and in general) whether/how the increased primary energy demand of CCS (especially BECCS) and renewables is considered. CCS operates with a high energy penalty, which is likely to be even hogher (at system level) with BECCS (due to the lower efficiency of bioenergy in terms of end use and other life cycle phases). Other renewables (except hydro) have a substantially lower EROEI (Energy Return On Enenrgy Invested) than the fossil energies they replace, which will necessitate higher primary energy prodcution for the same final energy use. [Andrea TILCHE, Belgium]	Rejected - This technical issue has not been clarified in the ES. It is not a 1.5°C specific issue.
42170	7	44			modelled ===> modeled [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
4892	7	45	7	45	Spelling should be "sectoral"--change appears to be needed further on in the chapter as well, so page 10, line 2, etc. Would be good to do a search and replace. [Michael MacCracken, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
34180	7	45	7	47	Here it is said that sectorial models confirm demand reductions, while in line 45-50 it is said that there will be an increase in demand from the energy sector. Please clarify what is meant with sectorial models, e.g. what sectors do they include. And also if it meant as an absolute or relative reduction. [Norway]	Taken into account - The revised statement in the ES now clarifies that it are demand reduction compared to 2°C scenarios. Sectorial models are models that model a single sector only, yet in more detail. Due to space constraints this has not been clarified in the ES.
42172	7	46			pathways, ===> pathways [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
718	7	49	7	49	The discussion is about reducing demand. Why is this significantly above 2014 levels?? [Robert Shapiro, United States of America]	Due to the projected increase in demand in developing countries.
3202	7	49	7	49	How does the increase it total final energy demand compare with per-capital energy demand projections? By simply stating that total final energy demand increases, little context is given to the readers. Also, similarly, the evolution of primary energy supply is also interesting. [Vassilis Daioglou, Netherlands]	Not applicable anymore. This statement does not feature anymore in the revised ES.
3302	7	49	7	52	This paragraph is strange. The bold sentence says one thing, and the next sentence says that the opposite is also possible. I guess there is very high confidence it is one or the other. [Francois-Marie Breon, France]	Not applicable anymore. This statement does not feature anymore in the revised ES.
10494	7	49	8	2	The message of this paragraph does not match with the bold sentence at the beginning of the paragraph. The bold sentence mentions 20%-60% increase in energy demand, but it was followed by description that energy demand lower than today is achievable. [Hong Yang, Switzerland]	Taken into account - The ES message on demand has been thoroughly revised and now reads: "Demand-side measures are key elements of 1.5°C-consistent pathways. Lifestyle choices lowering energy demand and the land- and GHG-intensity of food consumption can further support achievement of 1.5°C-consistent pathways (high confidence). By 2030 and 2050, all end-use sectors (including building, transport, and industry) show marked energy demand reductions in modelled 1.5°C-consistent pathways, comparable and beyond those projected in 2°C-consistent pathways. Sectorial models support the scale of these reductions. {2.3.4, 2.4.3}"
14128	7	49	7	52	The bold sentence indicates final energy demand in 2100 is generally 20-60% "above 2014 levels". However, the following content shows the energy demand levels "lower than today can be achieved" alongside strong economic growth. It seems there exists a contradiction between these two, and may require further clarification or correction. [Yi-Chieh Chan, China]	Not applicable anymore. This statement does not feature anymore in the revised ES.
21670	7	49	7	52	It sounds odd that, for one, 1.5 deg scenarios are associated with increased final energy demand, but also that lower energy demand levels can be achievable. What do the latter scenarios correspond to in terms of temperature rise? [Sweden]	Not applicable anymore. This statement does not feature anymore in the revised ES.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
19536	7	49	7	50	It should be acknowledged here that low energy demand is a key feature for scenarios that limit the use of CCS and/or BECCS. The following sentence could be added after the bolded statement. "At the low end is a dedicated low energy demand pathway which reduces energy demand by about 40% compared to today by mid-century, allowing for deep fossil fuel emissions reductions, very limited CDR deployment and only marginal net negative CO2 emissions and overshoot." (Source: Chapter 2, page 29, lines 50-52 and page 47, lines 8-10.) [Jennifer Morgan, Netherlands]	Taken into account - This point is made explicitly in the CDR section of the ES which reads: "CDR deployed at scale is unproven and reliance on such technology is a major risk in the ability to limit warming to 1.5°C. CDR is needed less in pathways with particularly strong emphasis on energy efficiency and low demand. The scale and type of CDR deployment varies widely across 1.5°C-consistent pathways, with different consequences for achieving sustainable development objectives (high confidence). Some pathways rely more on bioenergy with carbon capture and storage (BECCS), while others rely more on afforestation, which are the two CDR methods most often included in integrated pathways. Trade-offs with other sustainability objectives occur predominantly through increased land, energy, water and investment demand. Bioenergy use is substantial in 1.5°C-consistent pathways with or without BECCS due to its multiple roles in decarbonizing energy use. {2.3.1, 2.5.3, 2.6, 4.3.7}"
30406	7	49	7	52	This paragraph is strange. The bold sentence says one thing, and the next sentence says that the opposite is also possible. [France]	Revised
51640	7	49	7	49	This opening line is ambiguous in an unfortunate way. 'Final energy demand' is ambiguous, final energy could be either how much energy is demanded at the end of this period, or it could be the energy demanded by the consumer. For example, this could mean the demand for all energy (but primary energy) in 2100, or it could mean the demand for consumer energy (electricity, gasoline, etc.) in 2100. Since most models call on a dramatic increase in the electrification of our energy sector from non-carbon sources, this distinction must be made clear. [Jason Donev, Canada]	Taken into account - The statement on final energy has been edited.
3300	7	50	7	52	It is not clear how "more sustainable energy" may lead to a lower energy demand. It is rather clear to me that, if sustainable energy becomes available, it will increase the demand [Francois-Marie Breon, France]	Clarification - "More sustainable energy" is part of the larger phrase "more sustainable energy, material and food consumption patterns". This sentence thus referred to more sustainable energy consumption patterns.
30408	7	51	7	52	It is not clear how "more sustainable energy" may lead to a lower energy demand. [France]	This sentence was unclear and has been edited for clarity
57754	7	51	7	51	Strong is ambiguous. Relative to what? Also, what is the level of growth in the counterfactual? Likely the growth in the 1.5 scenario is less than it would have been. [Steven Rose, United States of America]	Accepted - this wording does not feature anymore in the revised ES.
42174	7	52			and ===> , and [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
4472	7	53	7	53	It would be useful to move up Figure 2.7 here. I think Scenario 1 only is enough as an example of pathways including CDR and AFOLU. The figure would be useful for policymakers who may read only executive summary to realize that massive negative emissions would be necessary to achieve the target. Then, they may want to know how those negative emissions would become possible and how and where. In addition, isn't it possible to add here BAU (or with current policy emissions) and non-CO2 emissions in CO2 terms? [Mitsutsune Yamaguchi, Japan]	Taken into account - Unfortunately, style guidelines of the IPCC do not allow us to include figure in the ES of the individual chapters.
57756	7	56	7	56	Define or change "easier." Ambigous, non-technical term. [Steven Rose, United States of America]	Term has been deleted
45922	8	1	8	1	What does lifestyle to limit population growth mean? In my view, this is a very sensitive area and not entirely sure if it is the purpose of an analytical/modeling study to suggest changing lifestyles to limit population growth. [Deger Saygin, Turkey]	Taken into account - This statement appeared to cause a lot of confusion and has been removed from the ES. Alternative wording on the same topic has been included at the start of the revised ES.
52894	8	1	8	4	Perhaps rephrase. [Ireland]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
53982	8	1	8	4	The statement that "high population growth, low economic development" would put at risk mitigation pathways highly biased and against countries in the Global South. It is the countries with low population growht and high economic development that caused climate change and what endangers the mitigation pathways is their lack of will to challenge fossil fuell industry and radically change their privileged lifestyles. DELETE all sentence AFTER sustainable development and until "have been identified" . [Elenita Daño, Philippines]	Taken into account - This statement appeared to cause a lot of confusion and has been removed from the ES. Alternative wording on the same topic has been included at the start of the revised ES.
54790	8	1	8	2	With lifestyles that … … food demand: Can this be rephrased in a way that reflects that these policies would ensure basic individual rights (e.g. no birth quotas) and satisfactory living standards, including the possiblity for personal and societal development? [Marine Gorner, France]	Taken into account - This statement appeared to cause a lot of confusion and has been removed from the ES. Alternative wording on the same topic has been included at the start of the revised ES.
57758	8	1	8	10	The chapeau statement is very strong. I can't help but wonder if the observations regarding population growth and demands are artifacts of modeling? Whether this is true or not depends on the opportunities to decouple service growth from energy growth. Likewise, the statement that the emissions transition is less expensive is a sustainably focused world depends on the counterfactual. The incremental cost achieving a low emissions future might be lower off a sustainble reference scenario, but what did it take and cost to get on that pathway? We are interested in the cost of both policies--sustainability and climate. [Steven Rose, United States of America]	Taken into account - This statement appeared to cause a lot of confusion and has been removed from the ES. Alternative wording on the same topic has been included at the start of the revised ES.
7184	8	2	8	4	This text is not appropriate as it stands. It comes across as biased, accusing poor people (esp. women) in poor countries (mainly in the global South) and their position in development trajectories as responsible for not meeting a 1.5C-compatible trajectory. Reviewers will read this as blaming the victims while obscuring the fact that systematic disadvantage is largely driven by elite capture and disenfranchisement in unequal societies. [Petra Tschakert, Australia]	Taken into account - This statement appeared to cause a lot of confusion and has been removed from the ES. Alternative wording on the same topic has been included at the start of the revised ES.
28018	8	2	8	3	The reference to "female educational attainment" is poorly phrased and may be perceived as too simplistic. Please revise language and consider to add other drivers for population growth. [Germany]	This reference has been removed from the ES.
53798	8	2	8	2	Move the dot after the sentence behind "(medium confidence)" [Patrik Winiger, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
57160	8	2	8	4	It could be made clearer that these conditions are a set of scenario properties that are considered together : "Under combined conditions of high population growth (...), low economic development, and limited efforts ...". As far as I understand those conditions have only been tested together, in the framework of scenarios based on SSP3, so it is better to say so (or clarify otherwise if I am wrong). [Philippe Marbaix, Belgium]	Taken into account - This statement appeared to cause a lot of confusion and has been removed from the ES. Alternative wording on the same topic has been included at the start of the revised ES.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
3304	8	3	8	3	It is very susprising that "low economic development" leads to higher CO2 emissions [Francois-Marie Breon, France]	Taken into account - This statement appeared to cause a lot of confusion and has been removed from the ES. Alternative wording on the same topic has been included at the start of the revised ES.
22756	8	3		10	This part is very important for arguing necessity of minimum economic developmet in developing world. But illustration is a bit complicated. [Shuzo Nishioka, Japan]	Taken into account - This statement appeared to cause a lot of confusion and has been removed from the ES. Alternative wording on the same topic has been included at the start of the revised ES.
30410	8	3	8	3	It is very susprising that "low economic development" leads to higher CO2 emissions [France]	Taken into account - This statement appeared to cause a lot of confusion and has been removed from the ES. Alternative wording on the same topic has been included at the start of the revised ES.
3306	8	5	8	5	...with poverty alleviation, improved energy security and public health. This sounds very much like wishfull thinking [Francois-Marie Breon, France]	Noted. No action undertaken.
18018	8	5	8	8	The sentences "Some risk of trade-offs exist, however. For example, increased biomass production and its use has the potential to increase pressure on land and water resources, food production, biodiversity, and to reduce air-quality improvements" are a key message that merits to be presented in the SPM. [Andrea TILCHE, Belgium]	Noted. Key messages on trade-offs have been elevated to the SPM.
30412	8	5	8	5	« synergistically with poverty alleviation, improved energy security and public health. » Not all synergies presented in Chapter 5 (eg. Figure 5.3) are mentioned here and this statement is not completely in line with SPM 4.5 [France]	Taken into account - indeed, not all synergies are mentioned here, only those that are also to some degree mentioned in Chapter 2. The revised SPM should be fully consistent with these statements.
42176	8	5			and ===> , and [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
14024	8	6	8	6	increased biomass production here seems to imply growing energy crops - but utilising crop and forest residues and converting inedible food waste to methane, has less impact on land use (other than possible soil nutrient deficiency if large volumes /ha are extracted). [It is mentioned in part on page 78, line 34] [Ralph Sims, New Zealand]	Noted. However, Section 2.4.4. also highlights that biomass is assumed to come from different sources.
15738	8	6	8	8	Suggest it is useful to add the positives of increased biomass production - eg. soil carbon storage, improved productivity, increased agricultural production per area of land. [Australia]	This statement does not feature anymore in the revised ES.
18020	8	6	8	7	This sentence implies that the mentioned biomass is only used for non-food purposes (increasing pressure also on food production): hence this should be specified, since food is also part of the biomass and its production also puts pressure on natural resources [Andrea TILCHE, Belgium]	This statement does not feature anymore in the revised ES.
42178	8	6			exist ===> exists [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42180	8	6			has ===> have [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
18022	8	7	8	8	replace "reduce air-quality improvements" with "worsen air quality" (all other factors considered equal, this is likely). [Andrea TILCHE, Belgium]	Noted. However, this statement does not feature anymore in the revised ES.
33502	8	7			include reference to ecosystems "...food production, ecosystems and biodiversity, and to reduce…" [Stephen Cornelius, United Kingdom (of Great Britain and Northern Ireland)]	This statement does not feature anymore in the revised ES.
14026	8	8	8	8	Other than here and an earlier mention of food waste, the agri-food supply is not mentioned. Given this sector (from plough to plate) uses 32% of end-use energy and produces 22% of GHGs (see http://www.fao.org/docrep/014/i2454e/i2454e00.pdf and subsequent FAO reports), producing enough food whilst having to reduce emissions and other pollutants is a major challenge. The Paris target and future mitigation goals entail the food sector having to do its share. It should therefore rate a major section in this chapter as well as a paragraph in the chapter summary. A draft paper being produced on "The Future of Food Supply for Healthy People and a Healthy Planet" for the GEF (Global Environment Facility) would be a useful source. [Ralph Sims, New Zealand]	Taken into account - However, due to limitations in scope, time, and expertise selected for the author team, an in-depth assessment of this aspect has not been included here.
35766	8	9	8	9	Add 'net' before 'negative CO2' [India]	Accepted - However, this statement does not feature anymore in the revised version of the ES.
40812	8	9	8	9	add net before ' negative CO2' [NARESH KUMAR SOORA, India]	Accepted - However, this statement does not feature anymore in the revised version of the ES.
53800	8	10	8	10	Move the dot after the sentence behind "(medium confidence)" [Patrik Winiger, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
19540	8	12	8	17	Understanding the role and limitations of Integrated Assessment Modeling in assessing the feasibility of 1.5°C is crucial. Therefore, it is very important to get this paragraph right and get it included in the SPM too. As it stands now, the bolded headline statement and the framing of this paragraph are not capturing the essential messages of the chapters 2.5.1.2; 2.6.1; 2.6.3, 2.6.4. The headline message should not be about progress in coordinating scenario development, but rather about what the reader should know about the limitations of current models and research, and what those limitations imply for the 1.5°C pathway considerations. Something along these lines (drawing from chapters 2.5.1.2; 2.6.1; 2.6.3; 2.6.4): "Limiting warming to 1.5°C could be more feasible than our current models imply, the transition could unfold in disruptive, non-linear ways and be shaped by different actors in an interplay of technical, behavioural, institutional and socio-political dimensions. Integrated Assessment Models, that lie at the basis of this assessment, convey important information about the long-term economic equilibrium of low carbon development paths in an idealised setting. Their key limitation is that climate damages, avoided impacts and societal co-benefits, that all motivate real world decision making, remain largely unaccounted for. Furthermore, the models often struggle to capture a number of hallmarks of transformative change, including disruption, innovation, and nonlinear change in human behaviour in a quickly evolving environment. There are a number of speculative, disruptive social and technological transitions that have the potential to significantly alter the shape of mitigation pathways that are not yet included in most of the modelling. Understanding from the sociotechnical transition literature needs to be usefully incorporated and compared to global integrated assessment approaches to better inform and constrain possible transition pathways." [Jennifer Morgan, Netherlands]	Taken into account - a paragraph on the tools underlying these pathways is included at the start of the ES, based on the assessment and discussion available in the chapter in Sections 2.1, 2.3, 2.5, and the Technical Annex. However, not every detail could be included in the ES. Attempts to feature these limitations strongly in the SPM have had only limited success.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
31404	8	12	8	17	Please explain what is the new information compared to AR5 as it is difficult to understand from the current text. [Japan]	Accepted - This statement has been removed from the ES, as it did not provide sufficiently specific information to the question of 1.5°C.
52896	8	12	8	14	This is a technical point [Ireland]	Noted.
53188	8	12	8	17	Given the major problems discussed in section 2.6 I would suggest considerably more caveats in this paragraph. In particular it would be useful to discuss in more detail the update frequency of IAMs and the difficulty of accounting for rapidly changing prices such as elucidated by Creutzig et al. 2017, UNEP 2017, BNEF 2017, Jacobsen et al. 2017). In particular the reasons for why IAMs do not find 100% RE as part of cost-effective portfolios should be included in the ES given that literature like Jacobsen et al. finds these futures as cost-effective. [Christopher Weber, United States of America]	Taken into account - a paragraph on the tools underlying these pathways is included at the start of the ES, based on the assessment and discussion available in the chapter in Sections 2.1, 2.3, 2.5, and the Technical Annex. However, not every detail could be included in the ES.
56452	8	12		17	Use the mass consumer market to implement mass transformations, stimulate the development of attractive mass consumer products that reduce CO2 emission. Solar panels, family size lot of a shared wind farm, shared soil based thermal heat stores to use heat from the summer in winter. Mass scale generates lower prices and competition between businesses that build or fabricate it. Regulations are essential to allow consumers to have the benefit It is the core competence to deal with uncertainties, let them handle it, with the right regulations for a fair transition [Henk Daalder, Netherlands]	Noted. No action undertaken.
61756	8	12	8	17	What is the link between this final finding and the rest of the assessment? [Valérie Masson-Delmotte, France]	It is unclear whether the reviewer is referring to the rest of the assessment in this chapter or in this report. The finding on sustainable development linkages and synergies is fully consistent with the pathway literature discussed in chapter 2 and the linkages assessed in chapter 5.
60008	8	14	8	15	Not sure how valuable this is. Where is a discussion on limitations of IAMs? [United States of America]	Taken into account - a paragraph on the tools underlying these pathways is included at the start of the ES, based on the assessment and discussion available in the chapter in Sections 2.1, 2.3, 2.5, and the Technical Annex.
4474	8	15	8	15	Please add "and trade-off" after co-benefit. [Mitsutsune Yamaguchi, Japan]	Taken into account - However, this specific wording has not been retained in the revised version of the ES. Instead the paragraph reads "Links between 1.5°C-consistent pathways and sustainable development Choices about mitigation portfolios for limiting warming to 1.5°C can positively or negatively impact the achievement of other societal objectives, such as sustainable development (high confidence). In particular, demand-side and efficiency measures, and lifestyle choices that limit energy, resource, and GHG-intensive food demand support sustainable development (medium confidence). Limiting warming to 1.5°C can be achieved synergistically with poverty alleviation and improved energy security and can provide large public health benefits through improved air quality, preventing millions of premature deaths. However, specific mitigation measures, such as bioenergy, may result in trade-offs that require consideration. {2.5.1, 2.5.2, 2.5.3}"
31406	8	15	8	15	As co-benefit and trade-off are closely related, and should be considered together, please add "and trade-off" after co-benefit. [Japan]	Taken into account - However, this specific wording has not been retained in the revised version of the ES. Instead the paragraph reads "Links between 1.5°C-consistent pathways and sustainable development Choices about mitigation portfolios for limiting warming to 1.5°C can positively or negatively impact the achievement of other societal objectives, such as sustainable development (high confidence). In particular, demand-side and efficiency measures, and lifestyle choices that limit energy, resource, and GHG-intensive food demand support sustainable development (medium confidence). Limiting warming to 1.5°C can be achieved synergistically with poverty alleviation and improved energy security and can provide large public health benefits through improved air quality, preventing millions of premature deaths. However, specific mitigation measures, such as bioenergy, may result in trade-offs that require consideration. {2.5.1, 2.5.2, 2.5.3}"
42182	8	16			modelled ===> modeled [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
53802	8	17	8	17	Move the dot after the sentence behind "(high confidence)" [Patrik Winiger, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
10496	8	19	8	19	It would be much clear if a table is added to summarize all aforementioned paragraphs' main massages and levels of confidence. [Hong Yang, Switzerland]	Unfortunately, the standard layout of the ES does not allow us to include such table. Even the table that was included in the SOD, did not make it to the Final Government Draft.
63190	8	56	9	2	Rewrite: "Limiting warming to 1.5°C by 2100 is easier in a world where policies focus on sustainable development that reduces climate impacts, such as lifestyles that limit population growth as well as energy, resource and food demand. (medium confidence).." Surely not all sustainable development will facilitate limiting warming(?) [Greg Rau, United States of America]	revised to frame as chances improved for keeping below 1.5 in worlds with the stated features (note comment was to page 7, not 8)
2464	9	1	9	1	The chapter would benefit from a high-level motivation for focusing on 1.5 degrees, even if simply in a summary sentence with reference to coverage in previous chapter. [Jared Woollacott, United States of America]	The motivation is that this was the mandate given to the report and this chapter. This motivation is provided in Chapter 1, the framing chapter.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
21490	9	1	106	14	Chapter 2 in some of its section uses the concept of "example scenarios", most notably in Section 2.3, but also (less clear) in the land-use part of Section 2.4. Utilizing this concept more consistenly throughout Chapter 2 and possibly even in other chapters that use scenario information would be beneficial. For this to happen, a more systematic introduction to this concept is needed, most likely in the beginning of Section 2.3. I could see two possibilities of doing so. The cleanest way would be to use one set of example scenarios throughout the entire Chapter 2 after having intoduced them upfront and motivate their choices very clearly (at present this has only been done for two of those scenarios (REMIND-MAGPIE-1.5C Sustainability and MESSAGE-GLOBIOM LED, see page 29, lines 38-52). I can see that a single set of scenarios may not work for showing alternative approaches to tackle 1.5 degrees across all sectors. An alternative approach could therefore be, to introduce a set of example scneario for specific sections, but also then a clear introduction to this basic ideas is needed in Chapter 2 and then the choice of example scenarios and whay they were picked for the section is needed in each section (which might end up eating up quite some space). [Volker Krey, Austria]	Taken into account - The concept of illustrative pathway archetypes has been mainstreamed throughout the chapter. They are shortly introduced in Section 2.1, and then presented in more detail in Section 2.3 after which they are used extensively in Sections 2.3 and 2.4.
53858	9	1	13	26	NOT REVIEWED [Patrik Winiger, Netherlands]	ok
61758	9	1	12	5	The introduction may be shortened. It does not fully explain the method of the assesssment nor the structure of the chapter. [Valérie Masson-Delmotte, France]	Taken into account - The introduction has been shortened but at the same time methodological parts from elsewhere in the chapter have been moved forward.
56636	9	2			Little room is given in this chapter to equity and ethics considerations [Kirsten ZICKFELD, Canada]	We've now stated that these issues are not addressed here but are covered in ch 5.
42184	9	5			preindustrial ===> pre-industrial [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47760	9	7	9	7	Kindly use: land-use instead of land use. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
18024	9	12	9	18	The gaps and limitations of modelling should crucially include: - land use emissions and removals (over and beyond land-use change, including managed forests and soil carbon) - The implications of ignoring the CO2 emissions from the combustion of biomass for energy, and the resulting risk of double-counting CO2 removals by land - a more systematic consideration of various rebound effects and indirect/displacement impacts the are generally ignored at the micro scale and in LCA approaches, but which add up and cannot be ignored at the global scale. - The impacts of the ceclining rate of EROEI coming from a variety of factors, such as the depletion of fossil resources, the shift towards renewables, the high (and increasing) reliance on bioenergy, CCS, etc. - The potential beneifts of using biomass for non-energy applications (like material substitution), and the loss of these benefits by promoting only energy use (assumed in this chapter). [Andrea TILCHE, Belgium]	Both land-use emissions and removals and CO2 released from biomass combustion are included in the models. Other issues raised here are now noted in the Annex (section A2.4).
18026	9	12	9	24	There are two important 'missing ingredients' to a typical mitigation scenario; i) accounting for avoided impacts of climate change; ii) the interactions between climate action and sustainable development. Both should be mentioned here since it is not clear that one is a more important 'mitigation side issue' than the other. Avoided impacts are within the scope of Chapter 3, while sustainable development interactions are 'context' for this chapter, as well as the subject of Chapter 5. [Andrea TILCHE, Belgium]	Agreed, both now mentioned here.
39118	9	12	9	24	It is not clear to the reader what is the priority consideration in calculations - protecting human and natural life, or money. [Lindsey Cook, Germany]	States clearly that mitigation expenditures are optimized and not impacts.
42186	9	13			gross ===> the gross [Egypt]	We don't think a 'the' is needed here.
47762	9	19	9	19	Kindly use land-use instead of land use. It should be practiced in all the instances. [Sarah Connors, France]	Editorial - copyedit to be completed prior to publication
42188	9	20			multiple ===> the multiple [Egypt]	We don't think a 'the' is needed here.
3312	9	22	9	22	There are additional references such as the 2017 OECD Report (investing in climate, investing in growth) and the IEA 2017 World Energy Outlook [Kamel Bennaceur, United Arab Emirates]	Agreed, have noted that the cited study is an example. Others referenced elsewhere.
58456	9	22	9	22	could add: "For example, the IEA has found that, with the right policies, achieving universal energy access can be achieved while reducing air pollution and simultaneously making progress on ambitous climate change goals (IEA 2017, World Energy Outlook 2017)" [Andrew Prag, France]	Similar sentence added, thank you.
60010	9	26	9	26	Delete "plausible." The scenarios are described on page 39 (lines 1-12). Not one scenario is plausible. Collectively, they define ranges within which one can plausibly think specific variables might evolve to in the future given various assumptions about key driving factors. [United States of America]	Plausible deleted.
54890	9	32	10	26	The definition for mitigation pathway and emission pathway are necessary whether two concepts are similar?? not) [Dong-Woon Noh, Republic of Korea]	The definition of pathway has been revised in consultation with ch 1 and this should clarify this issue.
3314	9	36	9	36	should add policies and trade [Kamel Bennaceur, United Arab Emirates]	Added policies. Trade part of behaviour in our opinion (and we have a word limit).
42190	9	36			behaviour ===> behavior [Egypt]	We use British spelling.
3316	9	42	9	43	should add water [Kamel Bennaceur, United Arab Emirates]	Not always considered in the models, so we'd prefer not to list this and have to explain that point as it's not central.
39120	9	43	9	45	Do you also consider sustainable agriculture practices, and if so, could you include, and if not, could you consider why this is missing? [Lindsey Cook, Germany]	That is part of terrestrial carbon management.
60012	9	45	9	46	It appears prescriptive to highlight R&D funding and subsidies among technology policy issues, and it may be simpler to not include examples here. If highlighting examples at all, there should be more balance (e.g., including policies focused on commercialization and deployment, and policy mechanisms across loans, rebates, tax credits, feed in tariffs and auctions, net metering and interconnection standards, and so on). [United States of America]	We don't believe it's prescriptive to give an example when it's clearly stated as such. Space limitations preclude a very long list such as that suggested.
42192	9	48			physical ===> the physical [Egypt]	We don't think a 'the' is needed here.
7392	9	52	9	53	I do not understand the or? there are pathways based on current policies and and current legislation, and these are clearly different than the emission pathways based on full implementation of the NDCs? In fact there is quite some literature that assess if current policies are on track to meet NDC? see IEA WEO 2017, see Rogelj et al., 2016 Nature, see den Elzen et al. 2016 (climatic change). [Michel den Elzen, Netherlands]	These are two possible 'baseline' cases, and we use 'or' as for either case the trajectory is above 1.5C.
169	9	53	9	56	There are 3 left parentheses while 4 right parentheses in the sentence. [Mingshah Su, China]	No, there are the same number.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
46528	9	53	9	53	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Agreed, altered text.
51642	9	53	9	53	The difference between NDC and INDC hasn't been explained yet, nor have the acronyms. [Jason Donev, Canada]	Written out.
54578	9	53	9	54	(UN Environment, 2017); see also Section 2.3),'…brackets in the text need to be corrected [Qudsia Zafar, Pakistan]	Corrected.
42194	9	56			chapter ===> chapter, [Egypt]	Refers to text that has been changed so no longer relevant.
42196	9	57			modelling ===> modeling [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42198	10	2			modelling ===> modeling [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
720	10	3	10	3	direct linked' should be 'directly lnked' [Robert Shapiro, United States of America]	Corrected.
13474	10	3	10	3	looks like there is an extra space before Mitigation. [Sergio Aquino, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
35768	10	3	10	3	Change - 'direct' to 'directly' [India]	Corrected.
42200	10	3			direct ===> directly [Egypt]	Corrected.
43148	10	3	10	3	The word 'direct' is suggested to be changed to 'directly'. [Muhammad Mohsin IQBAL, Pakistan]	Corrected.
57972	10	3	10	3	The word "direct" should be "directly" in the phrase "as they cannot be direct linked" to read "as they cannot be directly linked." [Siir KILKIS, Turkey]	Corrected.
57974	10	11	10	12	Chapter 1 may be given in parenthesis in the phrase "starting from Chapter 1's estimate of the anthropogenic component of historical warming through 2015 of 0.95°C" to read "starting from an estimate of the anthropogenic component of historical warming through 2015 of 0.95°C (see Chapter 1)." [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
50188	10	12	10	13	This is a key message that needs to be in the Exec Summary and the SPM [Bert Metz, Netherlands]	Noted. The SPM authors will be made aware of this comment on Ch 2.
57976	10	12	10	12	There is a missing word "that" in the phrase "temperature must be defined" to read "this means consistency with a target temperature that must be defined." [Siir KILKIS, Turkey]	No, consistency must be defined… is what's meant, not correct with a 'that'.
45720	10	14	10	16	Overshood scenarios temporarily exceed the threshold (with more than some low probability p) and return below afterwards (with higher than some probability 1-p). seems to imply that the return probability is coupled to the overshoot probability (e.g. higher reurtn probability for lower overshoot probability). It is unclear where this coupling comes from. This needs clarification. [Astrid Kiendler-Scharr, Germany]	Though these are related, this is not a key message here and so this text has been removed during revisions and we now simply refer to overshoot as a general concept here with reference to ch 1.
56638	10	14	10	21	Scenario classification inconsistent with classification in Chapter 1, section 1.2.4 [Kirsten ZICKFELD, Canada]	Revised to harmonize with section 1.2.4.
42202	10	15			afterwards ===> afterward [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42204	10	17			the timing [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
46530	10	17	10	18	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Refers to text that has been changed so no longer relevant.
63192	10	20	10	21	You mean: " As in Chapter 1, continued warming scenarios that still exceed 1.5°C by 2100 are not considered consistent with 1.5°C." (?) [Greg Rau, United States of America]	Refers to text that has been changed so no longer relevant.
42206	10	23			use ===> the use [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
52810	10	25	10	25	Consider reformulating - the general refernce to temperature is not consistent with the defintion of impacts used in this report [Iulain Florin VLADU, Germany]	Revised to avoid use of 'impact' inconsistent with definition, now says 'responses'.
13888	10	29	10	29	The Use of Scenarios to Answer Particular Questions seems particularly awkward. How about "the use of scenarios" [Natalie MAHOWALD, United States of America]	Agreed, altered text.
600	10	34	10	35	The categories (a) to (c) were not clear. Particularly, categories (a) and (c) can include scenarios other than 1.5 C. Because this report is for 1.5 C, it is better to specify that these categories target 1.5 C scenarios. [Ken'ichi Matsumoto, Japan]	Now specified that these are 1.5 and 2C scenarios.
5952	10	34			climate target? [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Added 'climate' as suggested.
5954	10	36			until 2030 with (missing space) [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
22530	10	36			Insert space between "2030with" [LUIS VALDES, Spain]	Corrected.
44132	10	36	10	36	needs space between "2030 with" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Corrected.
51644	10	36	10	36	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
57978	10	36	10	36	There is a spacing issue between the words "2030" and "with" in the phrase "INDCs/NDCs until 2030with much." [Siir KILKIS, Turkey]	Corrected.
58416	10	36	10	36	2030 with instead of "2030with" [Andrew Prag, France]	Corrected.
60014	10	36	10	36	Given the U.S. intends to withdraw from the Paris Agreement, does this analysis still assume it meets its NDC? [United States of America]	Footnote added that US pledges are included (added to previous section where NDCs first mentioned in this chapter).
60016	10	43	10	46	Include references for example targeted analyses to better qualify this statement. [United States of America]	References added.
36402	10	49	10	50	Agreed with the statement but it is obvious and thats way trends are used. Therefore another statement should be included to this line on trends [Snaliah Mahal, Saint Lucia]	Statement deleted as indeed obvious, so paragraph now begins with 2nd sentence.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
43984	10	49	11	3	I found this paragraph very important in the light of policy-relevance. It is unfortunate that adaptive pathways and their relationship with prospective pathways are not really discussed due to limited studies. Emori et al. (2018) have addressed this issue to some extent and organized ideas as follows: If the climate sensitivity is proven to be relatively high and the temperature goals are not met even when the net zero emission goal is achieved, the options left are: (A) accepting/adapting to a warmer world, (B) boosting mitigation, and (C) climate geoengineering, or any combination of these. I hope this work is cited here. (https://link.springer.com/article/10.1007/s11625-018-0530-0) [Seita Emori, Japan]	We agree that these three options are a good characterization of societal choices should goals not be achieved, but believe that that point does not really fit with the aim of this paragraph which is to describe why we use prescriptive rather than adaptive pathways. Given space limits, we have decided against expanding this paragraph to cover more topics.
42208	10	51			that ===> those [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47766	10	53	10	53	Clarke et al., 2014; Luderer et al., 2013; Rogelj et al., 2013". Kindly use proper citation as per formatting style: "Luderer et al., 2013; Rogelj et al., 2013; Clarke et al., 2014". [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42210	10	54			report ===> report, [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
13476	10	55	10	55	Simplify: not knowing what adaptation might be put in place in the future, this reports examines prospective…. [Sergio Aquino, Canada]	Simplified somewhat, but we believe important to note that there are limited studies which is a key reason we could not assess this.
56640	10	56	11	1	Sentence unclear [Kirsten ZICKFELD, Canada]	Revised and split into two parts to hopefully make clearer.
54596	11	1	11	1	UNFCCC' should be defined. [Qudsia Zafar, Pakistan]	FCCC written out.
3318	11	3	11	3	Should add a comment about delayed action [Kamel Bennaceur, United Arab Emirates]	Nothing about delayed action seems obviously relevant to us in this text.
170	11	8	12	5	It is relevent to focus on the recent publications after AR5 but it is also very important to reflect the conculsions from the references reviewed in AR5 of WGI on the study on human GHG emissions, radiative forcing and global tempature rise. [Mingshah Su, China]	Conclusions from AR5 WGI on emissions, forcing and temperature response are indeed included in this assessment. These are discussed in section 2.2.
18028	11	8	11	8	replace "chapter" with "section". "Chapter" is confusing as it suggests "Chapter 2", in its entirety. [Andrea TILCHE, Belgium]	We mean chapter 2 in its entirety.
42212	11	9			understanding ===> the understanding [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
60	11	12	11	12	Please rephrase "the integrated scenario literature for its pathway assessment". [Tommi Ekholm, Finland]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
7394	11	12	11	20	The text is not fully clear that you only account for the delayed scenarios, that assume the implementation of the 2020 pledges, or 2030 NDCs, so all sceanrios that assume cost-optimal reductions starting from 2010/2012 are excluded in the scenario database. Table 2.7 does not give insights in the 2020 emissions. [Michel den Elzen, Netherlands]	Annex now discusses how scenarios are assessed for agreement with historical emissions based on AR5 WGIII Kyoto gas emissions. Changes after that time were not screened in the database analysis (other than land-use emissions in 2020; see Annex 2.A.3).
7396	11	12	11	20	It would also be interesting for how many models the scenarios are. Are some models more represented than others? [Michel den Elzen, Netherlands]	Added to Annex (Table 2.A.8)
56870	11	12	11	12	Shoudk also mention that there are other types of literature, why (in)appropriate to given them detailed consideration [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Paragraph revised to clarify that other literature is also assessed, noting that in some cases the consistency with 1.5C cannot be fully assessed (as, e.g., the scenarios do not extend to 2100 or do not cover all emissions or sectors).
43150	11	15	11	15	It would be helpful if a hint to the 'lowest scenario category assessed in AR5' is given in brackets. [Muhammad Mohsin IQBAL, Pakistan]	Added that AR5 assessed "an ~2C scenario" as its lowest.
18030	11	20	11	20	Delete the bullet and replace with "the emission profile of different bioenergy pathways and the availability and performance of CCS". This is because the availability of bioenergy as a "technology" is not a question, it is the oldest energy technology. The question is to what extent it can deliver, given its low efficiency and the land use impacts (never fully considered and often ignored entirely, together with the combustion emissions). Availability of CCS is a question (with or without bioenergy), but it is not just the availability, but the eventual attainable performance (modelling assumptions are often considered to be biased, more optimistic than realistic). [Andrea TILCHE, Belgium]	Revised along lines similar to those suggested and taking into account the points raised here.
54590	11	20	11	20	carbon dioxide removal' should be used by its abbrerivations 'CDR' as defined on Page 6, line 6' . It needs to be modified throughout the Chapter [Qudsia Zafar, Pakistan]	As some readers may not have read the ES, we believe writing this out in section 2.1 is useful.
61	11	21	11	36	The text doesn't describe sufficiently how the uncertainty in climate sensitivity is treated in the considered scenarios. Please expand on this aspect. The text should state more clearly,that a single emission pathway meets the specified target ("Below xC" or "Return xC") only with some specified probability. There are also alternative approaches to this chance-constrained method, which should be noted here. Risk-cost analysis consideres the trade-off between added certainty to meet the targets and additional costs (e.g. Neuberschet al., Climatic Change 126, 2013), while adaptive strategies under learning can, in principle, be used to meet targets with certainty (e.g. Webster et al., Climatic Change 89, 2008; Ekholm, Climatic Change 127, 2014). The cited papers all consider a 2C limit, and hence should be noted in the discussion of the relevant literature here. [Tommi Ekholm, Finland]	The text makes quite clear that one of the three parameters used to classify scenarios is probability of keeping below the target, which depends upon climate sensitivity uncertainty (as well as other sources of uncertainty). Additional information on this topic is now added to Annex 2.4.1. The other strategies the reviewer refers to are not used in the scenarios assessed in this chapter so we believe there is inadequate space to include these in this relatively short Special Report (hopefully they can be included in the AR6).
722	11	25	11	25	or returned the value below 1.5' should be 'or returned to a value below 2.5' [Robert Shapiro, United States of America]	Agree, revised.
62	11	27	11	27	What does "Scenarios are uniquely classified, with ‘Return 1.5°C’ given higher priority than ‘Below 2°C’ " mean? Please clarify. [Tommi Ekholm, Finland]	Revised to clarify.
18032	11	27	11	28	The meaning of this sentence (which attempts to explain the difference between 'return 1.5°C' and 'below 2°C' scenarios) is not clear. Please clarify. [Andrea TILCHE, Belgium]	The sentence does not attempt to explain the difference between these, but is simply stating that if a scenario meets the definition of two classes it is put into the return class with higher priority than the 'below' class with a higher target.
36404	11	27	11	29	What about priorities between below 1.5 with 50% probability and the other scenarios which one was given priority [Snaliah Mahal, Saint Lucia]	Revised to state that both 'Below 1.5°C' and ‘Return 1.5°C’ are given higher priority than ‘Below 2°C’ in cases where a scenario would be applicable to either class.
13890	11	29	11	29	No scenarios were available that remained below the 1.5°C limit with at least 66% probability or remained below the 2°C limit with at least 90% probability. At this point, it seems appropriate to say whether you believe this means that such scenarios are difficult to achieve, or alternatively (and unlikely) they are equally likely but haven't been looked for. Or send us somewhere where you discuss this. [Natalie MAHOWALD, United States of America]	Revised to clarify this point, thank you.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
40952	11	30	11	36	SSP, CDLINKS, EMF33 and ADVANCE exercises actually implemented different constraints to estimates 1.5 degree releted scenario. I think those assumptions should be clearly stated somewhere here or table 2.2. SSP; forcing target to be 1.9W/m2 in 2100 CDLINKS; cumulative total CO2 emissions from 2011 to 2100 is 400GtCO2 EMF33; energy and industrial process cumulative total CO2 emissions from 2011 to 2100 is 400GtCO2 ADVANCE; energy and industrial process cumulative total CO2 emissions from 2011 to 2100 is 400GtCO2 [Shinichiro Fujimori, Japan]	Added to table.
57980	11	30	11	30	The plural words "scenarios exercises" may be "scenario exercises" in the phrase "These scenarios draw largely from a set of integrated scenario exercises." [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58420	11	34	11	35	please replace "International Energy Agency (IEA) Perspectives for the Energy Transition (IEA / IRENA, 2017)" with "like the "Faster Transition Scenario" in the International Energy Agency's (IEA) World Energy Outlook-2017 (IEA, 2017x)" - the Faster Transition Scenario is the same scneario as the one used in IEA/IRENA. [Andrew Prag, France]	Revised as suggested (this text now located in Annex).
724	11	35	11	35	Table 2.2' should be 'Figure 2.2' [Robert Shapiro, United States of America]	Text now in Annex, reference to table is correct.
3320	11	35	11	35	Should add the 2017 IEA Energy Technology Perspectives [Kamel Bennaceur, United Arab Emirates]	Added
63	11	38	11	38	What does " an ensemble of opportunity" mean? Please clarify. [Tommi Ekholm, Finland]	Refers to text that has been changed so no longer relevant.
58418	11	38	11	39	Suggest rephrasing as " emsemble" appearing twice is repetitive [Andrew Prag, France]	Refers to text that has been changed so no longer relevant.
64	11	40	11	41	What does "critical scenario selection based on scenario assumptions and setup" refer to? Has there been selection of scenarios from the subbmitted scenarios? Please elaborate, because it will be important to know how the approved scenarios have been selected. Is there a possibility that such selection creates some sort of bias? [Tommi Ekholm, Finland]	This text has been replaced by a more detailed discussion of the scenarios including which were available, how they were classified, and how all available in the database were assessed as well as those not in the database (to the extent possible). Discussion now begun in section 2.1 and continued in Annex.
47768	11	42	11	45	66%; 50%; 50–66%; and 66–90% are probability class values/ranges? Please mention in the table. [Sarah Connors, France]	The 2nd column of the table is labelled 'Likelihood ranges'.
44134	11	43	11	43	take out extra line [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44136	11	43	11	43	needs extra line between table and table label [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
5956	11	45			the title of the table should be above and not below the table itself [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
7670	11	45	11	45	Incomplete table leyend (Table 2.1)?. A better introduction to the mitigation pathways will be wellcome, in the table and the text. [Maria Jose Sanz Sanchez, Spain]	Caption expanded and text revised to clarify.
40816	11	45	11	45	Cosnider using this defined scenarios for entire reporty for consistancy [NARESH KUMAR SOORA, India]	We are endeavouring to indeed use the classification consistently across the entire report.
51646	11	45	11	45	Label for table goes at the top. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51648	11	45	11	45	This table isn't very clear, the label should explain more about what this table means. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
31642	12		12		IEA/IRENA 2017 is based on both WEM and ETP [Lorcan Lyons, France]	Noted.
36948	12		12		Single model studies should include a DNE21+ model study focusing on the considerations of flexibilities in emission pathways toward 1.5 C target. Akimoto, K., Sano, F., and Tomoda, T. (2017). GHG emission pathways until 2300 for the 1.5 °C temperature rise target and the mitigation costs achieving the pathways. Mitigation and Adaptation Strategies for Global Change, 1–14. doi:10.1007/s11027-017-9762-z. [Keigo Akimoto, Japan]	We have clarified that this table includes single model studies in the database. As such, we have moved it to the Annex where more information about the database is given. This study has been included as one of the scenarios not in the database but nonetheless assessed in the chapter.
37824	12		12		Table 2.2: 1) Neither Riahi et al. 2017 nor Rogelj et al. 2017a do contain specific information on the mentioned SSPx-1.9 scenarios 2) Roelfsema et al. 2017a is not specified in the references [Michiel Schaeffer, Netherlands]	Revised, see Annex
30850	12				Could Table 2.2 have a column "Methodology" as in Table 2.13? This may add clarity to the methodological approaches in the core literature behind Chapter 2. [Érika Mata, Sweden]	This table has been moved to the Annex, and although we believe the methods used cannot easily be summarized in a single added column we have instead added a large amount of additional information into the Annex to provide an explanation of methods involving several key aspects of the modeling studies.
244	12	1	12	2	Add an item to Table2.2 Single model studies Model name: Effficency-N Key focus: enhanced Nuclear production Reference Berger (2) et al. [Herve Nifenecker, France]	We have clarified that this table includes single model studies in the database. As such, we have moved it to the Annex where more information about the database is given. Berger et al is assessed with other sector-specific studies in section 2.4.
40954	12	1	12	1	AIM would have another literature about transport sector. "How transport behavior and policies can contribute to avoid mitigation cost increase." Zhang et al. ERL (in second review) The scenarios in ths paper are already in the 1.5 SR database [Shinichiro Fujimori, Japan]	Sectoral studies are addressed in section 2.4. Accepted papers with data in the database will be included there.
44138	12	1	12	1	In reference column "IEA, 2017a" can only find a 2017 in references. Either missing or 'a' should be removed. [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47870	12	1	12	2	Please check the citations in Table 2.2: Roelfsema et al. 2017a; OECD/IEA and IRENA, 2017a; IEA, 2017a……not available in reference section [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51650	12	1	12	1	Label for table goes at the top. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51652	12	1	12	1	The exponent for the unit is split across a line, bad formatting [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
57196	12	1	12	2	E[R] and AE[R] scenario from Greenpeace (scientifically lead by DLR) is fully missing in the table, but IEA and IREANA scenarios are mentioned. This ill-balanced, in particular since Greenpeace is much more aligned to reach a 1.5C to 2C target energy system. This substantial gap has to be closed in teh report. [Christian Breyer, Finland]	Table moved to Annex, now explicitly stated that this includes only scenarios included in the database rather than all scenarios potential discussed in the chapter.
58422	12	1	12	2	table 2.2 -Please replace "World Energy Outlook" with " World Energy Outlook, notably the Sustainable Development Scenario and the Faster Transition Scenario" . Note also that the reference in column 3 should be World Energy Outlook 2017 (rather than IEA/IRENA). [Andrew Prag, France]	Revised, see Annex
56570	12	2	12	2	C-Roads should be "C-ROADS" -- it is an acronym (Climate Rapid Overview And Decision Support) [Eleanor Johnston, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
5958	12	3			title should be above table [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
13478	12	3	12	3	suggestion: table titles should be on the top and figures at the bottom. [Sergio Aquino, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
30840	12	3	12	3	CAN be explored or "ARE explored"? [Érika Mata, Sweden]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
3322	12	25	12	25	Reference to IEA / WEO should also include IEA World Energy Outlook (2017) [Kamel Bennaceur, United Arab Emirates]	Noted
3324	12	26	12	26	the IEA ETP (2017a) is not in the list of references [Kamel Bennaceur, United Arab Emirates]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
17904	13		25		The whole budget approach seems to be ambiguous. The ranges are large and if I understand figure 2.4. correctly, the response uncertainty that ranges from 450-680 GtCO2 increases to -200 - 1400 GtCO2. If this is the case, the budget concept seems to be useless (or I misunderstood the figure). It would be important to get other - more policy-relevant - indicators, e.g. when net zero emissions are reached or when coal is being phased out, when the temperature maximum is reached, which level of reduction rate is needed, etc etc. Table 2.5. and Table 2.7 are in this respect a helpful first attempt, but some more policy relevant indicators would be important [Brigitte Knopf, Germany]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
350	13	1	13	40	This figure2.1 should give the references and methods. [Zong-Ci Zhao, China]	Taken into account - However, as a result of the revisions of Section 2.2, this figure was removed.
351	13	1	14	40	Figure 2.1 compare with RCPs and SRES? Suggestion is to add a table or figure to compare them. [Zong-Ci Zhao, China]	Figure 2.1 used scenarios of the SR15 database. Yet, this figure has been removed from the main text since we now focus on only one concept of carbon budgets. This concept is supported by recent literature and our explanation to calculate the remaining carbon budget are now fully developed in a technical annex.
47770	13	5	13	8	Kindly use the citations as per the proper formatting style of the report, eg. Clarke et al., 2014 should be at the end…..likewise Luderer et al., 2013 should be be at the end. [Sarah Connors, France]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
13836	13	10	13	10	Review the order of bibliographic citations [Poot-Delgado Carlos, Mexico]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
13892	13	10	13	10	First paragraph, section 2.2.1. Emissions of short lived constituents, can also impact the carbon budget through the physical climate feedbacks since warmer climates allow land and atmosphere to take up less anthropogenic carbon (e.g. Ciais et al., 2013), and through fertilizing effects onto land or ocean ecosystems (e.g. aerosols, as described in Mahowald et al., 2017). which is discussed more in section 2.6, but should be mentioned here. These impats on the carbon cycle from anthropgenic aerosols, for example can be as large a climate forcer as direct cliamte forcing from anthropogenic aerosols, so these are not second order effects. [Natalie MAHOWALD, United States of America]	We agree with reviewer suggestion. The revised text now acknowledged the impact of short lived agents on carbon budgets. Missing pieces of understanding are now better liaised with section 2.6.
47872	13	10	13	14	Please check the citations: Friedlingstein et al. 2014; Rogelj et al. 2016; Shindell et al. 2012a; Rogelj et al. 2014, 2016……..not available in reference section [Sarah Connors, France]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
56642	13	10	13	10	Include reference to Zickfeld et al., PNAS, 2009. [Kirsten ZICKFELD, Canada]	This reference is now taken into account in our assessment
57982	13	10	13	11	There is disagreement between the article usage and the plural word in the phrase "a useful geophysical constraints" that may be "a useful geophysical constraint" with the word "constraint" singular. [Siir KILKIS, Turkey]	Grammar, spelling have been improved in the revised section 2.2.
22532	13	14			add "," after "et al." (two cases in this line) [LUIS VALDES, Spain]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
171	13	18	13	26	It is simple and comparable to apply the single MAGICC to simulate each mitigation pathway to provide a probabilistic estimate of atmospheric concentrations, radiative forcing and global temperature outcomes but understanding of the relationship of atmospheric concentrations,radiative forcing and tempature could be constrained by the structure of MAGICC and may not reflect the common understanding of scientific society. [Mingshah Su, China]	MAGICC is used for consistency with AR5.. Another model is now used as well, FAIR for comparison with updated relationships
54606	13	19	13	19	MAGICC is not defined. It should also be defined in caption of the tables such as in table 2.3 etc [Qudsia Zafar, Pakistan]	The MAGICC model is introduced in Section 2.1
60018	13	20	13	21	Insert "global mean" before atmospheric concentrations, as a reminder that MAGICC simulations provide geophsyical characteristics in global terms. [United States of America]	taken in to account.
18034	13	23	13	23	The key MAGICC parameters can be mentioned breifly [Andrea TILCHE, Belgium]	MAGICC parameters are further described in sect 2.1 or sect2.6. Besides, an improved comparison of MAGIC parameters against another simple climate model (FAIRv1.X) is given in the technical annex
46532	13	24	13	24	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	IPCC language has been checked and updated in the revised section 2.2. We hope now that the revised section 2.2 now fit the IPCC standard

Comment No	From Page	From Line	To Page	To Line	Comment	Response
56874	13	24	13	26	Expand on this point to explain fully [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	this points has been further discussed in the revised sect 2.2 which has been deeply restructure in order to follow reviewers suggestions.
35630	13	29	15	39	A new study has recently evaluated the remaining carbon budgets to keep temperatures below both 1.5 and 2.0 °C above preindustrial levels, covered in this section. The study is "Goodwin. P., A. Katavouta, V.M. Roussenov, G.L. Foster, E.J. Rohling and R.G. Williams, (2018) Pathways to 1.5 and 2 °C warming based on observational and geological constraints, Nature Geoscience, 11, pages 102-107, doi:10.1038/s41561-017-0054-8." The evaluation of the remaining carbon budgets in Goodwin et al. (2018) is based on a probabilistic ensemble of thirty thousand simulations of an efficient Earth system model (the WASP model). Each of the thirty thousand simulations in the ensemble is consistent with nine observational constraints of surface warming, ocean heat uptake and carbon fluxes during the instrumental period. These observationally consistent simulations then extend into the future for a range of RCP scenarios (RCP2.6, RCP4.5, RCP6.0 and RCP8.5). The future projections of this observationally constrained are shown to be consistent with 13 models from CMIP5 used in AR5, but with narrower uncertainty ranges due to the tighter observational agreement. Therefore, the findings about the remaining carbon budgets in the Goodwin et al (2018) study represent 'post-AR5' science, and should be included within this IPCC Special Report. In the following comments, the results for the remaining carbon budgets for 1.5 and 2.0 °C above preindustrial of this Goodwin et al (2018) study are given, converted into units used in this report (GtCO2 from January 1st 2016). Note all subsequent comments refer to the reference given in full in this comment. The values given in the comments below (comments 2 to 5) can be found in Goodwin et al (2018) from the supplementary data, and converting from PgC from January 1st 2017 and converting into GtCO2 from January 1st 2016. [Philip Goodwin, United Kingdom (of Great Britain and Northern Ireland)]	This work has been acknowledged in the revised section 2.2.
28020	13	29	21	17	Section 2.2.2: We commend the intention of the authors to comprehensively explain the important concept of the Carbon budget and its constraints and uncertainties. We have a few comments that may improve the accessibility of this information, and suggest, given the complexity of the problem and the absence of a technical summary as a first, more technical synthesis-step that section 2.2.2 drafts a chapeau text that summarizes the key aspects of the following 8 pages. In particular, 1) please elaborate earlier on and more clearly why you are choosing the current (TPB and TRB) budget instead of the ones that were used in AR5 (TEB and TAB). Why are these more suitable in the context of the SR1.5? Will the AR6 return to the TEB and TAB, or does this constitute a progress in scientific understanding, so that we can expect to see the TRB and TPB from now on? In this context it may be helpful to frame a finding as preliminary if the surrounding uncertainties are large and give rise to the expectation of further change. 2) The important implications of the limited carbon budget for the requirement and role of negative emissions (NE) should be made more explicit earlier in the text. It is implicitly clear that the Carbon budgets imply NE for 1.5°C, however it is not straightforward to understand how the total budget then relates to what can still be emitted (without NE) over what period of time, and what needs to be offset, and how the budgets depend on the emission trajectory over time, given the lag time in CO2 removal and the asymmetric and complex reaction of the climate system to rising and falling CO2 levels. 3) It may be helpful to add (either to current figure 2.1, or as a separate figure) a graphical stylized representation of typical / possible emission trajectories, their associated (cumulative) carbon levels, and temperature (cf. e.g. Figure 1 in Obersteiner et al., 2018; NCC, Vol 8, p. 7-10, and Figure 2.7, 2.15 and section 2.3.4 in this report). Such an illustration may also help to clarify why the Carbon budget are not counted until 2100 but only until peak T or return T, which is currently not clear at all (e.g. what happens to the NE after that point? are they negligible?). 4) AR5 did not lift the details of the two concepts to the level of policy makers, see e.g. AR5 SYR SPM Fig.10. For communication to policy makers it will be very confusing to learn now that the AR5 had applied two different concepts in WG1 and WG3, and that those were not the same as those now applied for the SR1.5. Please consider the level of complexity of information that is needed to be communicated to policy makers in the SPM, given the overall uncertainties of the Carbon budgets, including potential revisions of the numbers in future reports. It may be helpful to report a range across budget types, if such an option would be considered scientifically robust. [Germany]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
36870	13	29	15	39	A new study has recently evaluated the carbon budgets to remain below both 1.5 and 2.0 °C above preindustrial levels, covered in this section. The study is "Goodwin. P., A. Katavouta, V.M. Roussenov, G.L. Foster, E.J. Rohling and R.G. Williams, (2018) Pathways to 1.5 and 2 °C warming based on observational and geological constraints, Nature Geoscience, doi:10.1038/s41561-017-0054-8." The evaluation of the TEBs in Goodwin et al. (2018) is based on a probabilistic ensemble of thirty thousand simulations of an efficient Earth system model (the WASP model). Each of the thirty thousand simulations in the ensemble is consistent with nine observational constraints of surface warming, ocean heat uptake and carbon fluxes during the instrumental period. These observationally consistent simulations then extend into the future for a range of RCP scenarios (RCP2.6, RCP4.5, RCP6.0 and RCP8.5). The future projections of this observationally constrained are shown to be consistent with 13 models from CMIP5 used in AR5, but with narrower uncertainty ranges due to the tighter observational agreement. Therefore, the findings about the TEB in the Goodwin et al (2018) study represent 'post-AR5' science, and should be included within this IPCC Special Report. In the following comments, the results for the TEB for 1.5 and 2.0 °C above preindustrial of this Goodwin et al (2018) study are given, converted into units used in this report (GtCO2 from January 1st 2016). Note all subsequent comments refer to the reference given in full in this comment. The values given in the comments below can be found in Goodwin et al (2018) from the supplementary data, and converting from PgC from January 1st 2017 and converting into GtCO2 from January 1st 2016. [Richard Williams, United Kingdom (of Great Britain and Northern Ireland)]	This work has been acknowledged in the revised section 2.2.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
53192	13	29	16	25	Generally this section, one of the most important of the chapter, is rather confusing in its layout and focus. First, the authors choose to focus only on TRB and TPB, a large deparature from TEB/TAB of AR5, with very little justification. Figure 2.1 is a helpful schematic (though I would add a median emissions line in addition to the temperature line), and I would replace most of paragraph at bottom of 2-13 with the caption description of the four different budgets, which are much clearer. Then, after dismissing TEB and TAB, a table is included that only includes TEB and TAB (2.3), followed by another table including only TRB and TPBs (2.4). Several more detailed problems: 1) It is not clear why TEB has gone down by 2-3X in Table 2.3 for the same time period; no text adequately explains it outside general reasons why differences may exist. The same is true for TAB though here estimates have gone up, again with no explanation. Given the popular usage of carbon budgets these differences must be xplained in detail! 2) Time periods in tables and text jump from 2011 onward to 2016 onward. Pick one and convert all values to the same time period. Suggest using 2016 onward for consistency with the rest of the report. AR5 values can be updated to this period. 3) Figure 2.1 implies that TRB should be greater than TPB due to the inclusion of more years (e.g. overshoot years). Yet Table 2.4 shows TPB>TRB for all values and it is not explained why this is true. I assume the reason for this is that the extra years are net negative CO2 such that including more years shrinks the "budget" but if so this means that the concept of TRB is not a budget at all, but rather a net accounting system... many users of carbon budgets in industry will not realize this, as the concept of 'carbon budget' has been unidirectional to date. Please explain this further!! 4) the description of how TPB and TRB are calculated in SR1.5 (Section 2.2.2.2.1, starting 2-16 line 35) is sorely lacking. I cannot identify from teh description how the approach differs rom either than described in lines 31-35 or in pg 17 lines 12-17. Another paragraph showing the effect such calculations would have on a single value (say, 66% TPB 1.5C) would be most helpful. A new schematic showing median scenarios for TRB and TPB (x axis time, y axis CO2 emissions) would be most helpful to elucidate these confusing concepts. [Christopher Weber, United States of America]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
56878	13	31	13	31	This whole section could perhaps rely more on tables and less on dense text [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 text has been simplified and the text has been shortened.
56676	13	33	18	18	Sections 2.2.2.1-2.2.2.2 need to be checked for grammer and language precision. [Kirsten ZICKFELD, Canada]	Grammar, spelling have been improved in the revised section 2.2.
36894	13	34	13	36	The approximate linear relationship between peak temperature and cumulative emission of carbon is reported in terms of the empirical results of Earth system models, but is also endorsed by theory. Goodwin et al. (2015) provide a single equation connecting surface warming with cumulative carbon emissions drawing upon theory for radiative response and carbon inventories. This work has also been generalised to consider the effects of non-CO2 radiative forcing (Williams et al., 2016) and the use of the theory confirmed by diagnostics of Earth system models (Williams et al., 2017). References: Goodwin, P., R.G. Williams and A. Ridgwell, 2015. Sensitivity of climate to cumulative carbon emissions due to compensation of ocean heat and carbon uptake. Nature Geoscience, 8, 29-34, doi:10.1038/ngeo2304. Williams, R.G., P. Goodwin, V.M. Roussenov and L. Bopp, 2016. A framework to understand the Transient Climate Response to Emissions. Environmental Research Letters, 11, Focus on Cumulative Emissions, Global Carbon Budgets and the Implications for Climate Mitigation Targets, doi:10.1088/1748-9326/11/1/015003. Williams, R.G., V. Roussenov, P. Goodwin, L. Resplandy and L. Bopp, 2017. Sensitivity of global warming to carbon emissions: effects of heat and carbon uptake in a suite of Earth system models. Journal of Climate, 30, 9343-9363, doi: 10.1175/JCLI-D-16-0468.1. [Richard Williams, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - the various lines of evidence supporting the TCRE concept are now discussed in the revised section 2.2.
28022	13	35	17	16	Please compare "the transient climate response to cumulative emission, TCRE" with the definition in the glossary "…cumulative CO2-emissions". [Germany]	this definition has been clarified with the glossary and also Chap 1
54584	13	35	13	36	abbreviation TCRCE should be used instead of TCRE throughout the text [Qudsia Zafar, Pakistan]	Rejected - TCRE has been maintained as the abbreviation, consistent with its use in IPCC AR5, and the scientific literature.
13838	13	36	13	36	Review the order of bibliographic citations [Poot-Delgado Carlos, Mexico]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
22534	13	36			add "," after "et al." (three cases in this line) [LUIS VALDES, Spain]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
47874	13	36	13	56	Please check the citations: Friedlingstein et al. 2014; Schneider et al. 2017a; Rogelj et al. 2016; Gasser et al.;……..not available in reference section [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
54586	13	36	13	36	brackets should be corrected at 'see Chapter 1' [Qudsia Zafar, Pakistan]	Noted. Editorial corrections have been implemented.
22536	13	37			add "," after "et al." (one case in this line) [LUIS VALDES, Spain]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
42214	13	39			reaches, ===> reaches [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
173	13	41	14	2	TPB and TRB is applied in this report. Please confirm that the understanding of scientific research, especially the findings on anthropogenic GHG emissions and global average temperature rise reflected from the references reviewed in AR 5 of WGI are integrated into this report to conclude the remaining carbon budgets. [Mingshah Su, China]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
18036	13	41	16	25	This section is important, but also confusing for the non-reader. It would be better to include only TPB & TRB in this section since these are used in the report. Explanation of how these relate to TEB & TAB budgets of previous reports should be placed in an annex. In particular, the differences between budget estimates from AR5 and this report presented in Table 2.1 must be explained. Suggest deleting this table (or placing it in annex) and discuss the differences between AR5 budgets and those of this report in the physical uncertainties section and/or in an annex. The combination of Tables 2.3 & 2.4 and the text in p 15 lines 26-39 is particularly confusing since since the budgets have different starting periods and it is not clear whether or not the Table 2.3 budgets are from multi-gas scenarios. [Andrea TILCHE, Belgium]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
60020	13	41	14	2	Include a more explicit comparison between TEB, TAB, TPB, and TRB. The text notes that TPB and TRB are identical for non-overshoot scenarios. It seems that TAB would also be identical to TPB and TRB in that instance, but that is not stated. [United States of America]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
60022	13	41	14	2	Address the issue of CDR in the context of CO2 budgets. It is presumed that net emissions are reported here, but that should be made explicit. [United States of America]	The various concept of carbon budgets introduced in the SOD have been revised and simplified for the sake of clarity and robustness.
172	13	47	13	48	Please check if the third and in the sentence is correct. [Mingshah Su, China]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
726	13	47	13	47	their limitations and assessed' should be 'their limitations are assessed' [Robert Shapiro, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
13096	13	47	13	47	Replace "and" with "are". [Eleni Kaditi, Austria]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
32740	13	47			The TEB and TAB budgets and their limitations and assessed ... after "and" misses something [Manfred Treber, Germany]	Grammar, spelling have been improved in the revised section 2.2.
43152	13	47	13	47	The word 'and' in 'limitations and assessed' is suggested to be changed to 'are'. [Muhammad Mohsin IQBAL, Pakistan]	Taken into account - This section has been significantly revised so that this comment does not apply anymore.
44810	13	47	13	48	Too many 'and' [Hiroaki Kondo, Japan]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
57984	13	47	13	48	The word "and" should be "are" in the phrase "their limitations and assessed below" to read "their limitations are assessed below." [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
45322	13	54	13	56	This TRB is dangerous without clearly combining with statement that we do not understand system well enough to know ecosystem responses in the overshooting situation, i.e. uncertaitinties of the TRB in terms of returning pathways and their implications should be open up more. Politician will misuse TRB, scienctists will misuse it and therefore related uncertainties should get deeper analysis in this report. Now TPB and TRB uncertainties get more or less similar treatment although it is admitted in the text that TRB has larger uncertainty. [Tuomo Kalliokoski, Finland]	Taken into account - The revised section does not make reference to the TRB anymore, but instead provides an assessment for the remaining carbon budget.
56644	13	54	13	54	Do you mean TPBs are conceptually close to TABs? I cannot see the conceptual similarity between TPBs and TEBs [Kirsten ZICKFELD, Canada]	This comment is not relevant anymore after the significant revisions of the carbon budget section.
58394	13	54	13	54	It is not clear why “TPBs are conceptually close to TEBs”, if anything TPBs are conceptually closer to TABs since both measure cumulative emissions up to the year when emissions peak [Andrew Prag, France]	This comment is not relevant anymore after the significant revisions of the carbon budget section.
22538	13	56			I think is a principle that the IPCC reports should be based and supported by published (peer reviewed) literature; however, I noted that there are many references without publication's year (e.g. Gasser et al. in this line 56). I understand that these are papers submitted or in press. I think these should be removed unless the papers were already printed [LUIS VALDES, Spain]	Final government distribution includes only accepted papers with updated citations. In press papers are included if they were accepted within IPCC deadlines, as per procedures.
13814	14		14		Figure 2.1: Panels b and c both show significant cooling after peak temperature is reached, implying either a strongly negative ZEC, implementation of net negative CO2 emissions, or aggressive reduction of SLCFs. Given that this is an illustrative figure I suggest showing near constant temperatures after the peak more consistent with the very long expected lifetime of the anthropogenic temperature anomaly (Eby et al. 2009) (and also taking a neutral position between ZEC being positive or negative). [MacDougall Andrew, Canada]	Figure 2.1 used scenarios of the SR15 database. Yet, this figure has been removed from the main text since we now focus on only one concept of carbon budgets. This concept is supported by recent literature and our explanation to calculate the remaining carbon budget are now fully developed in a technical annex.
18038	14		14		Fig 2.1 - the labelling needs to make clearer that these curves do not show the carbon budgets themselves, but show the (likely?) temperature pathways that correspond to different types of carbon budget. Also, as per previous comment, TEB & TAB are not necessary. [Andrea TILCHE, Belgium]	Figure 2.1 used scenarios of the SR15 database. Yet, this figure has been removed from the main text since we now focus on only one concept of carbon budgets. This concept is supported by recent literature and our explanation to calculate the remaining carbon budget are now fully developed in a technical annex.
2228	14	1	14	1	In Table 2.4, please add units for each column. [Akihiko Ito, Japan]	table 2.2 has been moved in the technical annex and has been revised accordingly
602	14	3	15	5	Figure 2.1 corresponds to Table 2.3. Rather than showning the individual figure and table, inserting numbers in Table 2.3 to Figure 2.1 will improve the understanding of the definition of various budgets. [Ken'ichi Matsumoto, Japan]	Figure 2.1 used scenarios of the SR15 database. Yet, this figure has been removed from the main text since we now focus on only one concept of carbon budgets. This concept is supported by recent literature and our explanation to calculate the remaining carbon budget are now fully developed in a technical annex.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
31408	14	3	16	25	It is difficult to understand the difference between Threshold Return Budgets and Threshold Peak Budgets for policy makers. For example, if cumulative CO2 emissions, including negative emissions, have linear relationship with global mean temperature rise, then TRB and TPB will be the same. Table SPM1 and Table 2.4, however, indicate that TPB has larger budget than TRB, except for the case of 50% likelihood limiting to 1.5. Please add more clear explanation sentences and explanation charts for policy makers to be able to understand where the gaps come from between TRB and TPB to avoid confusion. - [Japan]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
36950	14	3	16	25	As it is written, the carbon budget for the TRB and the TPB is difficult to explain. If the relationship between cumulated CO2 emissions (including negative emissions) and the temperature rise is perfectly linear, the carbon budget should be the same in the TRB and the TPB (leaving aside climate sensitivity and uncertainty). However in Table 4, the carbon budget for TPB is greater than for TRB. Is it due to a difference in the emission scenarios? Is there a more essential reason (like negative emissions have an effect on reducing the temperature for instance)? If there is such a reason, it should be explained. But if there is not, if this is due to a difference between emissions scenarios, then why take the trouble to introduce two budgets TRB and TPB? Showing the carbon budget numbers after separating two cases will confuse the reader. [Keigo Akimoto, Japan]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
13480	14	4	14	5	there should be more space between figure 2.1 and the x-axis label. Comment valid for other tables and figures. [Sergio Aquino, Canada]	All the figures of sect 2.2 have changed during the revision of section 2.2.
56646	14	4	14	6	Figure 2.1: First line of figure caption needs to be rephrased [Kirsten ZICKFELD, Canada]	All the figures of sect 2.2 have changed during the revision of section 2.2.
22706	14	5	14	14	It may be helpful to clarify that these budgets are based on CO2-only pathways as far as I understand? (Or if they include different non-CO2 forcings, that could be clarified in the figure caption). [Katarzyna B Tokarska, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
42216	14	5			function ===> a function [Egypt]	Grammar, spelling have been improved in the revised section 2.2.
44140	14	5	14	5	should be blank. [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
44812	14	5	14	13	Explanation of pannel (d) is missing. [Hiroaki Kondo, Japan]	Figure 2.1 used scenarios of the SR15 database. Yet, this figure has been removed from the main text since we now focus on only one concept of carbon budgets. This concept is supported by recent literature and our explanation to calculate the remaining carbon budget are now fully developed in a technical annex.
53804	14	5	14	6	Should it really read: "Definition of various carbon budgets relative to 2016 as function of the median temperature (relative to 1850–1900) as a function of threshold peak carbon budgets (TPB, relative to 2016)."? X as a function of Y as a function of Z might be correct, but to me it sounds a bit too convoluted. [Patrik Winiger, Netherlands]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
53814	14	5	14	5	I think it could be helpful if the carbon budget (Time-window for deriving TXX) would be written inside each panel. [Patrik Winiger, Netherlands]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
34548	14	6	14	7	TEB, TPB and TRB are stated completely "Threshold exceedance budget" and so on but TAB is only stated as avoidance budget. We suggest either remove "Threshold" in all or state it in all [Mexico]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
53806	14	6	14	7	Please write all TEB, TAB, TPB and TRB with capital letters, for consistency with the main text. [Patrik Winiger, Netherlands]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
60024	14	6	14	8	Shouldn't these have probability bands around the median? [United States of America]	Figure 2.1 used scenarios of the SR15 database. Yet, this figure has been removed from the main text since we now focus on only one concept of carbon budgets. This concept is supported by recent literature and our explanation to calculate the remaining carbon budget are now fully developed in a technical annex.
29516	14	7	19	29	Economic and financial implications of 1.5°C Scenarios from chapter 2 should be more extensivly reflected in the SPM, in relation to major shift in investment patterns needed for the transformations towards a 1.5°C world (e.g. concepts on page 102 line 13, page 103 line 13 and 50, page 105 line 9). [Italy]	This points is now clearly highlighted in the revised chapter 2 and is now emphasized in the ES
43154	14	8	14	8	Please see if the phrase 'outcomes exceeds, avoids, peaks or returns below' can better be changed to 'outcomes exceeding, avoiding, peaking or returning below'. [Muhammad Mohsin IQBAL, Pakistan]	grammar, spelling have been improved in the revised section 2.2.
53808	14	8	14	8	Shouldn't this be the correct version: "defined by the temperature outcomes exceeding, avoiding, peaking or returning below a warming threshold. "? [Patrik Winiger, Netherlands]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
43156	14	11	14	11	The word 'pending' is suggested to be changed to 'depending'. [Muhammad Mohsin IQBAL, Pakistan]	taken into account
51654	14	14	14	14	These figures are confusing, a box explaining what each of the figures means would be helpful. I got it, but it took a while. This part of the modeling is important for people to understand. [Jason Donev, Canada]	all the figures of sect 2.2 have changed during the revision of section 2.2.
14130	15		16		The carbon budgets under different scenarios (TEB, TAB, TPB, TRB) of 1.5 ? & 2 ? in table 2.3 & 2.4 are disordered. It would be more clear if they are organized in just "one table" with the same benchmark (e.g. for the 66th quantile of temperature). Also the number can be added in figure 2.1, which may make the comparison more understandable. [Yi-Chieh Chan, China]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
62966	15				Table 2.3. The quoted AR5 budgets from WGI for TEB are relative to predindustrial not relative to 2011 as indicated in the table. [Nathan Gillett, Canada]	Table 2.3 has been removed from the revised section. Now these numbers are acknowledged in the main text.
174	15		15	40	Please explicitly explain the relationship of 590 GtCO2 in line 27, 1300 Gt CO2 in Line 29 and the data in Table 2.3 to increase the transparance of the report. [Mingshah Su, China]	The revised section 2.2 has been clarified in order to present only one concept of carbon budget using the most relevant approach proposed in the literature. Besides, the methodology employed here is clearly presented in a technical annex.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
352	15	1	15	50	Table 2.3 WGI, AR5 RCP8.5 and TEB are very diffderent? [Zong-Ci Zhao, China]	Table 2.3 has been removed from the revised section. Now these numbers are acknowledged in the main text.
28024	15	1	15	4	Table 2.3: This table contains serious errors, for the WG1 assessment, the number for total emissions since pre-industrial is quoted as remaining emissions from 2011 onwards. The WG1 assessment is a lot closer to the WGIII assessment than stated (450-550 Gt CO2, not 2250). Please compare with AR5SYR Table 2.2 and revise. [Germany]	Table 2.3 has been removed from the revised section. Now these numbers are acknowledged in the main text.
40026	15	1	15	1	Comparsion would become easier if all the numbers are calculated back to 2011 (or preferably a more recent year). [Kornelis Blok, Netherlands]	In the revised section on carbon budgets for 1.5°C or 2°C, our best estimates are given from the 1rst January 2018.
51656	15	1	15	1	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	taken into account
51658	15	1	15	1	Label for table goes at the top. [Jason Donev, Canada]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
56648	15	1	15	4	Table 2.3: It would be helpful if budgets were given from 2016 for easier comparison with Table 2.4 and consistency with discussion in text [Kirsten ZICKFELD, Canada]	Table 2.3 has been removed from the revised section. Now these numbers are acknowledged in the main text.
56650	15	1	15	4	Table 2.3: Units for budgets from "This report" missing [Kirsten ZICKFELD, Canada]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
56652	15	1	15	4	Table 2.3: Why are the TEBs so much smaller than in AR5? [Kirsten ZICKFELD, Canada]	Table 2.3 has been removed from the revised section. Now these numbers are acknowledged in the main text.
57986	15	1	15	1	There are spacing issues within the cells of Table 2.3, including "90–310for the" and "CO?only" that may be addressed. [Siir KILKIS, Turkey]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
58396	15	1	15	1	table 2.3 is very confusing – it sets side by side budgets with very different assumptions and there is no way of comparing actual changes between the TEBs and TABs in AR5 with this report. [Andrew Prag, France]	Table 2.3 has been removed from the revised section. Now these numbers are acknowledged in the main text.
58398	15	1	15	1	table 2.3 presumably a typo in notes in second column third row when referring to remaining budgets from 2011 [Andrew Prag, France]	Table 2.3 has been removed from the revised section. Now these numbers are acknowledged in the main text.
728	15	2	15	2	should be either 'of' or 'for' but not both!! [Robert Shapiro, United States of America]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
5960	15	2			title should be above table [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
22714	15	2	15	5	The column with Notes for TABs does not indicate if non-CO2 forcings are the same as for TEBs in the row above. If the non-CO2 forcings were different, this would not be a consistent comparison. [Katarzyna B Tokarska, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
42218	15	2			of for ===> of [Egypt]	taken into account
44814	15	2	15	3	The legend of Table 2.3 should be located above the table. [Hiroaki Kondo, Japan]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
51246	15	2	15	3	In statement "Median and assessed likely range (the 5–95% MAGICC range) of for different types of TEB", "of for" needs to be replaced by "for". [Muhammad Latif, Pakistan]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
53810	15	2	15	2	remove the first instance of "of" [Patrik Winiger, Netherlands]	grammar, spelling have been improved in the revised section 2.2.
56654	15	2	15	2	Be specific about what you mean by "different types". [Kirsten ZICKFELD, Canada]	taken into account
56876	15	2	15	4	Shouldn't simply focus on TRB and TPB since this is what is referred to in this report? [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	That is correct. Now, section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
58116	15	2			Table 2.3: It is not clear to me which scenarios were used to put them into the bins of 1.5°C and 2°C scenarios. The problem is like this. Assume the bin of 2°C with 50% chance scenarios comprises all scenarios that comply with more than 1.5°C but no higher than 2°C temperature increase. Assume that n scenarios are in this bin. Assume that the n scenarios are distributed equaly in the 0.5°C range. In that case the mean and median temperature increase of all scenarios in this bin would be 1.75°C. Therefore, I would expect that this bin would be named 1.75°C scenarios rather than 2°C scenarios. From Figure 2.5(d) I see that this is a relevant issue.because 2°C scenarios are consistently below 2°C. This issue seems to be purely technical, but is crucial for the target formulation that uses a sample of scenarios and it has considerable impact on the carbon budgets derived in this report. The authors are required to check this issue, make the assumptions transparent and discuss it. The review editors are required to check whether the authors have addressed the issue sufficiently. [Nico Bauer, Germany]	The revised section 2.2 now uses a revised classification based on a larger set of scenarios. This new classification highlighted the fact that most of the scenarios compliant with 1.5°C or 2°C exhibit an overshoot in temperature. This new categorisation uses larger class which has reduced the number of pathways types and hence reduced overlap and inconsistency between scenarios. With that being said, the revised section 2.2 highlights that there are numerous geophysical uncertainties that will affect this classification and hence it is difficult to distinguish with a high confidence the differences between 1.5°C and 2°C scenarios.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
17902	15	6		10	The budgets have changed considerable since AR5, but the reason given here is quite weak. It would be important to give a better explaination, otherwise people could blame the IPCC for extending the budget to keep certain temperature targets still feasible. Is AR5 representing a specific subgroup of the new budget definition? [Brigitte Knopf, Germany]	The revised section 2.2 now clearly explain why carbon budgets for 1.5°C or 2°C differ from IPCC AR5 estimate in the light of recent literature. Besides, we would like to stress that section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
18040	15	6	16	25	CO2 vs multi-gas budgets: This section is confusing. It would be better not to include CO2-only budgets (or discuss them in an annex) since it is confusing for the reader, and their assumption of zero non-CO2 emissions is any case not relevant for policymakers. Better to simply state CO2 budgets from multi-gas scenarios and clarify that, although the budgets refer to CO2 only, the accompanying emissions of other forcers are important and lower (higher) emissions of these could imply higher (lower) CO2 budgets for a given temperature likelihood. [Andrea TILCHE, Belgium]	The role of non-CO2 climate forcers is now better highlighted in the revised section 2.2. The text relatives to this point has been improved and the role of non-CO2 CF in terms of expected warming and radiative forcings has been taken into account as a key variations for remaining carbon budgets for 1.5°C and 2°C
30902	15	6	15	39	to what extent does the report need this treatment of TEB vs TAB, if this report is moving away from TEB/TAB to use TRB/TPB? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
60026	15	6	15	30	This text likely refers to AR5 TEB and TAB values. For instance, line 27 cites 590 GtCO2 with a likely range of 450-750 GtCO2. Cite the source AR5 figure. [United States of America]	This text has been clarified in the revised section 2.2
44816	15	9	15	10	The TAB here is contradlict its definition given in Fig.2.1b. [Hiroaki Kondo, Japan]	The reference period to compute carbon budget has been homogenize throughout the report. It is now use the 1850-1900 averaged to described preindustrial and the average over 2005-2016 (2010 as central point) to derived remaining carbon budgets. Chap 1 as assessed current warming from 1859-1900 to 0.87°C with an uncertainty of ±0.12°C. Both current level of warming and uncertainty are now used in our assessment of the remaining carbon budget for 1.5°C and 2°C.
53812	15	9	15	9	1861-1880 is not the typical reference period chosen by this report or AR5. Would it be possible to include an uncertainty (in °C) that quantitatively assesses the difference between chosing these two different reference periods? [Patrik Winiger, Netherlands]	In the revised section on carbon budgets for 1.5°C or 2°C, our best estimates are given from the 1rst January 2018.
28026	15	12	16	25	In this section a comparison between AR5 TABs/TEBs and SR1.5°C TRBs/TPBs is drawn, i.e. with new calculations from the year 2016 onwards. Propose to summarize the numbers in a table, in order to prevent a challenging "picking from the text". [Germany]	This paragraph has been summarized. The remaining carbon budgets are now presented relative to the 1st january 2018 onwards.
56656	15	15	15	15	Include reference to Zickfeld et al., PNAS, 2009 [Kirsten ZICKFELD, Canada]	taken into account
40022	15	16	15	16	Is 'more positive' the same as 'greater'? The say that. [Kornelis Blok, Netherlands]	grammar, spelling have been improved in the revised section 2.2.
40024	15	16	15	17	Do you really mean 'non-CO2 climate forcing at the beginning of line 16? It seems like you mean 'CO2 + non-CO2'? [Kornelis Blok, Netherlands]	That is correct; the text has been revised accordingly.
62968	15	16		17	It isn't the case in general that non-CO2 climate forcing is projected to be more positive than CO2 forcing. This would only be true in the RCPs as CO2 forcing approaches zero. What the authors mean is just that non-CO2 forcing is projected to be positive. [Nathan Gillett, Canada]	That is correct. The text relative to the role of non-CO2 has been improved and this point has been clarified accordingly.
35770	15	18		19	Reference year to be added [India]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
47876	15	18	15	35	Please check the citations: Mengis et al.; Tokarska et al.; ……incomplete citations and not available in reference section [Sarah Connors, France]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
54602	15	18	15	19	years are missing from references Mengis et al.;and Tokarska et al. [Qudsia Zafar, Pakistan]	typos, these references are now acknowledged in the main text.
56658	15	18	15	19	Include reference to MacDougall et al. 2015 (they explore the effect of non-CO2 forcings on carbon budgets) [Kirsten ZICKFELD, Canada]	taken into account
42220	15	19			likelihood ===> likely [Egypt]	taken into account
34550	15	20	15	21	It might be clearer to say that the carbon budget compatible with 2°C is 2900 GtCO2 rather than the amount by which it diminishes. Stating that it is reduced by 800 GtCO2 might lead to understaning that the budget is 800 GtCO2 [Mexico]	This text has been clarified in the revised section 2.2
10502	15	26	15	40	It is not clear where these mitigation scenarios (678 mitigation pathways, 378, 215, etc.) come from. References are needed. [Hong Yang, Switzerland]	Our assessment uses the recent scenario SR15 database the list of accepted references are now acknowledged here
18042	15	26	15	39	This paragraph is confusing. Why not place these budgets in a table? And How do the budgets in this section related to Table 2.3? Are they the same budgets adjusted for a 2016 start date (instead of 2011)? Why have one period in the text and another in the Table? [Andrea TILCHE, Belgium]	In the revised section on carbon budgets for 1.5°C or 2°C, our best estimates are given from the 1rst January 2018.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
11720	15	26	15	39	This is a confusing section. Earlier (page 13, line 48-50) it was stated that TPB and TRB would be used in this report. Moreover what appears to be the summary table (Table 2.4) expresses TPB and TRB. However the discussion in this section concerns TEB and TAB. It's not clear why this is the case and the use of different budgetary concepts without clear rationale could lead to confusion. Additionally, when comparing to other published budget estimates (e.g. Millar et al) it would be helpful to clarify whether this is on the same basis (i.e. are these looking at TEB and TAB as well?) [United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
22720	15	26	15	39	This paragraph keeps mixing between 1.5C and 2.0C budgets, which some may find it a bit confusing to follow. Maybe it would be helpful to discuss 1.5C budgets first, and then 2.0C in the latter part of this paragraph (or clarify it for each range cited). Also, lines 32-39 refer to TEBs (as far as I understand in those cited studies), which could be clarified and perhaps moved up a few lines to follow the TEB discussion, because now it sounds like those numbers are cited for TABs, instead of TEBs. [Katarzyna B Tokarska, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
35632	15	26	15	39	The Goodwin et al (2018) Nature Geoscience, doi:10.1038/s41561-017-0054-8 value for the remaining carbon budget (after January 1st 2016) for staying below 1.5 °C at 66% likelihood is 770 GtCO2, assuming RCP8.5 radiative forcing for all non-CO2 agents. This ranges from 750 to 810 GtCO2 depending on how the non-CO2 forcing trajectories vary between RCP2.8, RCP4.5, RCP6.0 and RCP8.5 and the prior assumptions built into the model ensemble. [Philip Goodwin, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This reference is now acknowledged in the main text.
35634	15	26	15	39	The Goodwin et al (2018) Nature Geoscience, doi:10.1038/s41561-017-0054-8 the remaining carbon budget (after January 1st 2016) for staying below 2.0 °C at 66% likelihood is 1520 GtCO2. This ranges from 1480 to 1700 GtCO2 depending on how the non-CO2 forcing trajectories vary between RCP2.8, RCP4.5, RCP6.0 and RCP8.5, and depending on the prior assumptions built into the model ensemble. [Philip Goodwin, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This reference is now acknowledged in the main text.
35636	15	26	15	39	The Goodwin et al (2018) Nature Geoscience, doi:10.1038/s41561-017-0054-8 constraint for the carbon budget range (after January 1st 2016) from 33% to 66% likelihood for staying below 1.5 °C is from 770 to 930 GtCO2 . This range assumes RCP8.5 for non-CO2 radiative forcing. [Philip Goodwin, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This reference is now acknowledged in the main text.
35638	15	26	15	39	The Goodwin et al (2018) Nature Geoscience, doi:10.1038/s41561-017-0054-8 constraint for the carbon budget range (after January 1st 2016) from 33% to 66% likelihood for staying below 2.0 °C is from 1520 to 1760 GtCO2. This assumes RCP8.5 for non-CO2 radiative forcing. [Philip Goodwin, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This reference is now acknowledged in the main text.
36872	15	26	15	39	The Goodwin et al (2018) Nature Geoscience, doi:10.1038/s41561-017-0054-8 value for the carbon budget from 2016 for staying below 1.5 °C at 66% likelihood is 770 GtCO2, assuming RCP8.5 radiative forcing for all non-CO2 agents. This ranges from 750 to 810 GtCO2 depending on how the non-CO2 forcing trajectories vary between RCP2.8, RCP4.5, RCP6.0 and RCP8.5 and the prior assumptions built into the model ensemble. [Richard Williams, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This reference is now acknowledged in the main text.
36874	15	26	15	39	The Goodwin et al (2018) Nature Geoscience, doi:10.1038/s41561-017-0054-8 the carbon budget for staying below 2.0 °C at 66% likelihood is 1520 GtCO2 after January 1st 2016. This ranges from 1480 to 1700 GtCO2 depending on how the non-CO2 forcing trajectories vary between RCP2.8, RCP4.5, RCP6.0 and RCP8.5, and depending on the prior assumptions built into the model ensemble. [Richard Williams, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This reference is now acknowledged in the main text.
36876	15	26	15	39	The Goodwin et al (2018) Nature Geoscience, doi:10.1038/s41561-017-0054-8 range for the carbon budget range from 33% to 66% likelihood for staying below 1.5 °C is from 770 to 930 GtCO2 after January 1st 2016 (assuming RCP8.5 for non-CO2 radiative forcing). [Richard Williams, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This reference is now acknowledged in the main text.
36878	15	26	15	39	The Goodwin et al (2018) Nature Geoscience, doi:10.1038/s41561-017-0054-8 range for the carbon budget range from 33% to 66% likelihood for staying below 2.0 °C is from 1520 to 1760 GtCO2 (assuming RCP8.5 for non-CO2 radiative forcing). [Richard Williams, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. This reference is now acknowledged in the main text.
45722	15	26			In order to hold warming below 1.5°C between 2016 and 2100 with a 66% likelihood, median TEB for 1.5°C ….is 590GtCO2…. The statement is inconsistent with numbers in Table 2.4 (states 810 GtCO2). [Astrid Kiendler-Scharr, Germany]	The revised section 2.2 now clearly explain why carbon budgets for 1.5°C or 2°C differ from IPCC AR5 estimate in the light of recent literature. Besides, we would like to stress that section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
56660	15	26	15	39	This paragraph is very confusing. Budget numbers are given relative to 2016, whereas numbers in Table 2.3 are given relative to 2011. Also, why are the TEBs and TABs discussed, and not the TPBs and TRBs, which were identified earlier as the budgets relevant for this report? [Kirsten ZICKFELD, Canada]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
22708	15	33	15	36	It may be good to indicate units GTCO2 when quoting all these ranges. [Katarzyna B Tokarska, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
32742	15	33			that is to say., 750–920 for the 33–66% percentile range ... delete full stop after "say" [Manfred Treber, Germany]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
34522	15	33	13	33	Extra punctuation symbol. It says "...that is to say., 750–920..." when it should be "...that is to say, 750–920...". [Mexico]	taken into account
44142	15	33	15	33	reads "say., 750" remove full stop [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
47772	15	33	15	33	that is to say.,…Kindly recheck. [Sarah Connors, France]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
57988	15	33	15	33	There is a punctuation issue in the phrase "that is to say.," with an extra sentence stop. There are other similar punctuation issues elsewhere. [Siir KILKIS, Turkey]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
13816	15	34			RCP85 to RCP8.5 [MacDougall Andrew, Canada]	taken into account
53816	15	34	15	34	RCP85 should be "RCP8.5" [Patrik Winiger, Netherlands]	taken into account
13840	15	35	15	35	Missing years [Poot-Delgado Carlos, Mexico]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
22710	15	35	15	35	The 33-66% range of "660-1060" should be 477-936 GTCO2 (remaining from January 1st, 2016)(Tokarska and Gillett, 2018). Also, it may be good to keep the units of GTCO2 when quoting numbers in this paragraph (since some of the studies discussed use PgC as their units in the original papers). Also, these are TEB budgets, not TABs (maybe could be moved up a few lines before TABs are introduced). [Katarzyna B Tokarska, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
44818	15	35	15	35	RCP85-->RCP8.5 [Hiroaki Kondo, Japan]	taken into account
47774	15	35	15	35	Please check: (Tokarska et al.): Year missing in citation [Sarah Connors, France]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
54604	15	35	15	35	year is missing from (Tokarska et al.) [Qudsia Zafar, Pakistan]	Taken into account. This reference is now acknowledged in the main text.
61760	15	35	15	35	incomplete reference to Tokarska et al. (submitted?). [Valérie Masson-Delmotte, France]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
58400	16		16		It is mentioned that TPBs are generally smaller than TRBs. However this is not the case for a 50% 1.5 °C where the median TRB is 10 Gt greater than the TPB and the upper end of the range is 240 Gt greater. The 50% 1.5 °C budget is one of the most critical figures from this chapter and so it would be helpful to why the general result is not seen for this probability of 1.5 °C and, in particular, why the upper end of the range is so much higher. [Andrew Prag, France]	In the revised section 2.2 we now focus on only one concept of carbon budgets which corresponds to the peak budget as introduced in SOD. The concept of return budget although relevant has been assessed as non robust through our assessment. This is why we have decided to exclude its calculation from our assessment of carbon budgets for 1.5°C or 2°C. With that being said, the reversibility of the Earth system in relationship with the deployment of carbon dioxide removal approach are still included in our assessment because it remains one of the key reason for possible deviation in carbon budgets for 1.5°C or 2°C after a temperature overshoot.
7398	16	1	16	4	Unclear why for 1.5C there are large differences in the budgets between CO2 only and multi-gas, whereas for 2C there are no differences. This needs to be explained, as not clear for many readers. [Michel den Elzen, Netherlands]	During our revision, the difference between the various carbon budgets as introduced in SOD have been shown non robust because they related to a very small set of scenarios. This is why section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
8646	16	1	16	1	Table 2.4: Please state units (GtCO2 or GtCO2-fe??). And please in the Captions state what exactly is listed in the table, particularly in the columns "Multi-gas and aerosols"; I assume it is the CO2-budget if also other GHG & aerosols are considered as forcings. [Urs Ruth, Germany]	taken into account.
30904	16	1	16	7	table 2.4 – if the preceding page is saying it's more accurate to use multi-gas and aerosol scenarios than CO2 only scenarios, then why include the two CO2-only columns in this table? Doing so not only adds clutter, but it is potentially misleading readers who will have come to it straight from Table ES1, and might then think that the "multi-gas and aerosol" budget is a GtCO2e budget, and not GtCO2. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
34552	16	1	16	1	Thinking on a policy maker who read a the report, a figure might render a better understanding of the paragraph between lines 9 to 25, it would be interesting to see the differences between TRB and TPB and how their ranges overlap. [Mexico]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
45324	16	1	16	1	Table 2.4 How TRB CO2_only can be lower than TPB? Why almost no difference in TRB between 1.5 and 2.0 while huge difference in TPB? How TRB medium confidence have been derived? Only couple of scenarios of fulfilling this aim, huge uncertainties what happens in ecosystem level due to overshooting. [Tuomo Kalliokoski, Finland]	During our revision, the difference between the various carbon budgets as introduced in SOD have been shown non robust because they related to a very small set of scenarios. This is why section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
58402	16	1	16	1	it is unclear how the uncertainty ranges (e.g. the range 490 Gt – 640 Gt for TPB for 50% change of 1.5 °C with multi-gas and aerosols) have been derived. Is this similar to the method used in e.g. Table 2.2 of the AR5 Synthesis Report where “ranges show the impact of scenario uncertainty, with 80% of scenarios giving cumulative CO2 emissions within the stated range for the given fraction of simulations” or has some other method been used? [Andrew Prag, France]	The text relative to the uncertainties associated to the computation of remaining carbon budgets has been totally revised and now clearly states the key variations which are responsible of deviation in carbon budgets compatible with 1.5°C or 2°C. In order to support our approach and to provide a greater transparency, we have depicted our methodology in a technical annex.
5962	16	2			title should be above table [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
5964	16	2			budget unit should be reported (GtCO2) [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	taken into account.
34524	16	2	16	2	Missings space between word and parentesis. Its says "...likely range(the 5..." when it should say "...likely range (the 5...". [Mexico]	taken into account
35772	16	2			Add Table title at the top of table [India]	taken into account.
44144	16	2	16	2	needs space between "range (the 5" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
51660	16	2	16	2	Label for table goes at the top. [Jason Donev, Canada]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
57990	16	2	16	2	There is a spacing issue after the word "range" in the phrase "assessed likely range(the 5–95% MAGICC range)" in the caption of Table 2.4. [Siir KILKIS, Turkey]	taken into account
46564	16	6	16	7	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	IPCC language has been checked and updated in the revised section 2.2. We hope now that the revised section 2.2 now fit the IPCC standard
8648	16	9	16	25	The topic of CO2-budgets is of utmost importance to those who build energy scenarios compatible with a 1.5- or 2°C-world (e.g. institutions like IEA and others) or to those who assess such energy scenarios. Therefore, I recommend even more clarity in this "messy" topic of carbon budgets: 1) Please elaborate why TRBs are generally smaller than TPBs; if - as an example - a scenario reaches peak temp of 2.2°C in 2060, then returns to below 2.0°C in 2075 and finally reaches its equilibrium temp of 1,8°C in 2100, then this budget must not be compared to a TPB-scenario for 2.0°C! This is all highly confusing! Please consider including an additional figure that illustrates in principle why the different budgets are so different. 2) Different run-times (durations) of the scenarios warp the picture. Example: For a scenario that reaches the target temperature (e.g. 2°C) earlier (e.g. in 2050) and is stabilized there the CO2 budget (until 2050) should be smaller than the CO2 budget (until 2100) for a scenario that reaches the same target temperature later (e.g. in 2100); the reasons for this is include the amount of CO2 taken-up by the ocean during the run-time of the scenario: if a scenario runs longer then also the amount of CO2-uptake by the ocean is larger and therefore the allowable CO2-emissions (= budget) will be larger. Thus, as the scenarios for TRBs are usually longer than those for TPBs, the TRBs should be *larger* than TPBs; yet, they are not; TRBs even tend to be *smaler* than TPBs, which is really confusing; the reason for this must be that scenarios for TRBs have decreasing temperature trends at the point along the time line when the budget is determined and that they actually lead to a smaller equilibrium temperature than the 2 or 1.5 °C. Thus, the budgets listed in Table 2.4 are absolutely not comparable! 3) As a way out of this situation I suggest doing the following: a) Determine and report the CO2 budgets for two common time horizons: "2017 to 2050" and "2017 to 2100" for all scenarios. Thereby you can circumvent problems caused by having different run-times (durations) of the scenarios. Also, those who build energy scenarios will need to know exact time ranges for which the budgets are valid! Otherwise it will not be possible to use your information (i.e. the budget) to build or assess an energy scenario! b) You should only look at scenarios with stable temperature (no trend) in 2100 to avoid the "inertia" you mention in the text and I recommend obtaining the CO2 budgets in two groups: (i) for 1.5°C and (ii) for 2.0°C scenarios. If these selection criteria result in too few scenarios, then - instead of the two groups - I recommend to plot (y = carbon budget) vs. (x = stabilized temperature by 2100) for each scenario with no temperature trend in 2100. You should get a cloud of data points (hopefully the points fall along a line) and you should be able to (hopefully) make a linear fit to this line; at (x=1,5) and at (x=2.0) the linear fit should yield the best multi-model estimates for a carbon budget until 2100 for 1,5 and 2°C. [e.g. select from Figure 2.5-d those scenarios with temp. change rate 2081-2100 of less than e.g. +/- 0.01 °C/decade and plot the carbon budget until 2100 vs. mean temperature 2081-2100 for those scenarios. I would highly wellcome to see such a plot, even if you don't include it into the SR1.5 report! - Thanks!] [Urs Ruth, Germany]	We agree with reviewer suggestions. Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
13896	16	9	16	9	Precise comparison of TRBs and TPBs is complicated due to their different definitions. Why would you want to comapre them? They are so different? Maybe you want to say, because there is literature you want to pull and compare, and that's why? otherwise this paragraph seems a little silly, since it is obvious they are different? This paragraph does seem a little bit repetitive. Why not just integrate out the TPBs out to 2100 , since it doesn't add much, and then compare? [Natalie MAHOWALD, United States of America]	During our revision, the difference between the various carbon budgets as introduced in SOD have been shown non robust because they related to a very small set of scenarios. This is why section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
28028	16	9	16	25	Challenges to compare the concepts of TPB and TRB are described, i.e. relevant time periods for TPB and TRB. However the reason for choosing a 25y (2035-2060) period for TPB and a 65y (2035-2100) period for TRB does not come out clearly enough. [Germany]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
34690	16	9	16	25	Seccion 2.2.2. The comparison of TRBs and TPBs scenarios requires greater clarity, preferably adding a table to identify their differences and similarities. [Mexico]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
45326	16	10	16	12	Does shorter time span and larger carbon budget in TPB mean the larger net negative emissions in TRB? [Tuomo Kalliokoski, Finland]	During our revision, the difference between the various carbon budgets as introduced in SOD have been shown non robust because they related to a very small set of scenarios. This is why section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
730	16	12	16	13	Furthermore, because of their definition, their ranges are not determined by neither the same nor the same number of mitigation pathways.' Sentence makes no sense !! [Robert Shapiro, United States of America]	This paragraph has been improved and clarified.
42222	16	12	16	13	their ranges are not determined by neither the same nor the same number of mitigation pathways ===> their ranges are not determined by the same number of mitigation pathways. [Egypt]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
32744	16	13			neither the same nor the same number of mitigation pathways ... makes no sense [Manfred Treber, Germany]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
43158	16	13	16	13	Please see if 'neither the same nor the same number ---' needs to be changed to 'either the same or the same number --'. [Muhammad Mohsin IQBAL, Pakistan]	taken into account
45328	16	14	16	15	This shows how small number of scenarios we are talking about here. [Tuomo Kalliokoski, Finland]	The categorization of pathways have been modified since SOD. We now included 5 different category of pathways in Chap 2 pending on their probability of holding warming below 1.5°C or 2°C. Regarding the size of the SR15 scenario database, the numbers of scenario holding warming below a given threshold cannot be understood as robust. This is why section 2.2 now focus on the robust features of these pathways. Table 2.3 highlighting the geophysical characteristics of the mitigation pathways has been moved in the technical annex of Chap 2.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
11722	16	18	16	20	For example, TRBs are generally smaller than TPB - this isn't the case for the all important 1.5C budget, which is the focus of this report. This difference should be explained. [United Kingdom (of Great Britain and Northern Ireland)]	During our revision, the difference between the TPB and TRB carbon budgets as introduced in SOD have been shown non robust because they related to a very small set of scenarios. This is why section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
18044	16	18	16	25	Why are TRBs smaller than TPBs? One would expect TPBs to be smaller since they do not permit overshooting. Are the TRBs smaller because of large quantities of negative emissions late in the century? If so, does this mean that TRBs have higher quantities of CO2 emissions than TPBs, but then cancel out the difference with negative emissions? This needs to be explained clearly. Also - why are the median values for the TPB and TRB (the 580 & 590) so close, despite the fundamental differences between these budget types? Some explanation would be useful. [Andrea TILCHE, Belgium]	During our revision, the difference between the TPB and TRB carbon budgets as introduced in SOD have been shown non robust because they related to a very small set of scenarios. This is why section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
42224	16	18			however, ===> , however, [Egypt]	taken into account
45330	16	18	16	20	But the time span for returning is up to 2100. Please open up this inertia of Earth system a bit more specifically from carbon budget viewpoint for clarifying these carbon budget differences between TPB and TRB. [Tuomo Kalliokoski, Finland]	In the revised section 2.2, the role of Earth system feedbacks has been discussed in the light of recent literature. This has enabled to better quantified the order of magnitude of the impact of Earth system feedbacks on carbon budgets.
60028	16	18	16	20	Disagree with use of variable time-windows for budget estimation but, taking the budget definition as a given, this sentence still needs work: "TRBs are generally smaller than TPB for the same level of warming with a given likelihood because the inertia of the Earth system conducts the temperature to return below 1.5°C or 2°C when net CO2 emissions are negative." First, is "conducts" the right word? What the sentence is trying to say is that "because of the inertia of the Earth system, in order to return to a given target temperature after the peak, net CO2 emissions are generally required to be negative." Second, presumably, the TPB also eventually has net negative emissions, but those happen after the peak is reached so are excluded. Table 2.6 is a much clearer summary of carbon budgets, with gross emissions and total CDR the key pairing, and the other metrics (peak net cumulative emissions, net cumulative emissions, and the CDR breakdown) to be less central but potentially interesting supporting details. [United States of America]	During our revision, the difference between the TPB and TRB carbon budgets as introduced in SOD have been shown non robust because they related to a very small set of scenarios. This is why section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.
62970	16	18		20	The phrase 'TRBs are generally smaller than TPB for the same level of warming for a given likelihood because the inertia of the Earth system conducts the temperature to return below 1.5C or 2C' is not clear at all. To first order CO2-induced warming increases linearly with cumulative emissions, so either TRBs are smaller because of a hysteresis effect in the climate response to negative CO2 emissions, or because the level of non-CO2 forcings is higher the second time the global mean temperature reaches 1.5C than the first time. [Nathan Gillett, Canada]	In the revised section 2.2 we now focus on only one concept of carbon budgets which corresponds to the peak budget as introduced in SOD. The concept of return budget although relevant has been assessed as non robust through our assessment. This is why we have decided to exclude its calculation from our assessment of carbon budgets for 1.5°C or 2°C. With that being said, the reversibility of the Earth system in relationship with the deployment of carbon dioxide removal approach are still included in our assessment because it remains one of the key reason for possible deviation in carbon budgets for 1.5°C or 2°C after a temperature overshoot.
45724	16	19	16	20	The statement that TRB are generally smaller than TPB for the same warming needs more explanation. [Astrid Kiendler-Scharr, Germany]	During our revision, the difference between the TPB and TRB carbon budgets as introduced in SOD have been shown non robust because they related to a very small set of scenarios. This is why section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging the most important key variations as highlighted in the literature (e.g., shape of the Transient climate response to cumulative emissions, non-CO2 climate forcers, uncertainties in both historical temperature and emission records and earth system feedbacks). The text has been clarified and all the results presented in the revised are assessed in terms of robustness. Finally Figures have been improved in order to better support the main text. The methodology used in this section is supported by a technical annex which enables a greater transparency in our approach.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
13818	16	20			The last part of this sentence does not make sense. I'm not sure what word was intended where "conducts" is written but "... the inertia of the Earth system conducts the temperature to return below ..." does not make sense. [MacDougall Andrew, Canada]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
56662	16	20	16	20	Cite MacDougall et al., 2015 [Kirsten ZICKFELD, Canada]	taken into account
732	16	21	16	21	in response of various warming threshold' should be 'in response to various warming thresholds' [Robert Shapiro, United States of America]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
13820	16	21			Besides, they exhibit the same behaviour in response to various warming threshold; Is ungrammatical and ambiguous. What are you referring to with 'they'? Please rewrite for clarity. [MacDougall Andrew, Canada]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
42226	16	21			behaviour ===> behavior [Egypt]	taken into account
42228	16	21			response of ===> response to [Egypt]	taken into account
43160	16	21	16	21	in response of' is suggested to be changed to 'in response to'. [Muhammad Mohsin IQBAL, Pakistan]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
45726	16	22			TPB and TRB are about 20% smaller for 1.5°C than for 2°C is not obvious from numbers in Table 2.4 [Astrid Kiendler-Scharr, Germany]	In the revised section 2.2 we now focus on only one concept of carbon budgets which corresponds to the peak budget as introduced in SOD. The concept of return budget although relevant has been assessed as non robust through our assessment. This is why we have decided to exclude its calculation from our assessment of carbon budgets for 1.5°C or 2°C. With that being said, the reversibility of the Earth system in relationship with the deployment of carbon dioxide removal approach are still included in our assessment because it remains one of the key reason for possible deviation in carbon budgets for 1.5°C or 2°C after a temperature overshoot.
51662	16	22	16	25	This sentence is very awkward. Break it into several sentences. [Jason Donev, Canada]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
62972	16	22		25	But other studies baseds on ESMs, which are also discussed (Millar et al., Goodwin et al., Tokarsha and Gillett) find higher budgets. Why do the authors expect that their budgets based on MAGIC will need to be revised down? [Nathan Gillett, Canada]	Our assessment now take into account the available published studies focussing on low emissions scenarios and carbon budgets for 1.5°C or 2°C using conceptual model, Integrated assessment model, simple and complex Earth system models.
30906	16	23	16	25	it would be good to indicate any the likely scale of future potential revision downwards here. A short summary of section 2.6.2 would be useful here. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	This paragraph has been improved and clarified.
45332	16	23	16	24	So we know the qualitative sign to which direction the estimates will be corrected. For me this indicates 1.5 C aim is too optimistically presented in the text. [Tuomo Kalliokoski, Finland]	This statement has been revised and clarified in the improved sect 2.2. In particular, this statement is now supported by a quantitative assessment of possible deviations in carbon budgets
56664	16	23	16	23	Include references for "recent literature" [Kirsten ZICKFELD, Canada]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
5860	16	24			Add more likely between will and be [Peter Thorne, Ireland]	taken into account
46566	16	24	16	24	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	IPCC language has been checked and updated in the revised section 2.2. We hope now that the revised section 2.2 now fit the IPCC standard
175	16	31	17	6	It is stated in line 35 that the approach adopted within this report is to express carbon budgets relative to a specified year in the near past, such as 2013, 2014 or 2015. This indicates that historical carbon emission is not required for this report. But historical net cumulative emissions is review. It seems that The logic in the two paragraphies is not clear. [Mingshah Su, China]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
53820	16	31	17	4	I'm confused by this paragraph. By writing "Such approaches" do you mean all of the above or just the latter method "(Friedlingstein et al., 2014a; IPCC, 2014; Millar et al., 2017; Rogelj et al., 2016b; van Vuuren et al., 2016)" and why is Le Quéré et al. 2017 not included in that list if "This assessment employs historical net cumulative emissions reported by the Global Carbon Project (Le Que?re? et al. 2017)" [Patrik Winiger, Netherlands]	This paragraph has been improved and clarified. Besides our methodology is now depicted in a technical annex.
35774	16	32			Reference year to be added [India]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
47878	16	32	16	32	Please check the citation: Gasser et al. ……incomplete citations and not available in reference section [Sarah Connors, France]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
29298	16	34	16	34	delete "a" [Yuanyuan Huang, France]	taken into account
53818	16	34	16	34	enter a space between CO2 and from [Patrik Winiger, Netherlands]	taken into account
29300	16	35	16	35	comma needed between "CO2from" [Yuanyuan Huang, France]	taken into account
32746	16	35			emissions of CO2from this total ... insert blank space before "from" [Manfred Treber, Germany]	taken into account
34526	16	35	16	35	It says: "emissions of CO2from"; it should say: "emissions of CO2 from" [Mexico]	taken into account
34554	16	35	16	35	A space between "CO2" and "from" is needed [Mexico]	taken into account
57992	16	35	16	35	There is a spacing issue in "CO?from." There are other similar spacing issues after certain words. [Siir KILKIS, Turkey]	taken into account
47776	16	37	16	38	Kindly use references in proper sequence; e.g., (Friedlingstein et al., 2014a; IPCC, 2014; Rogelj et al., 2016b; van Vuuren et al., 2016; Millar et al., 2017) [Sarah Connors, France]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
56666	16	37	16	37	You said earlier that this report expresses budgets relative to 2016 [Kirsten ZICKFELD, Canada]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
13482	16	40	16	40	but they rely [Sergio Aquino, Canada]	grammar, spelling have been improved in the revised section 2.2.
62974	17	3		10	The previous paragraph explains that this chapter will report budgets relative to a year in the near past. This approach does not require estimates of historical emissions. Why then do the authors describe historical emissions here? The authors should explaion where this information is used in their assessment. [Nathan Gillett, Canada]	Our approach to compute remaining carbon budgets has been improved in the revised section 2.2. Our methodology is also described in a technical annex providing a better transparency in our assessment
22540	17	4			add "," after "et al." (one case in this line) [LUIS VALDES, Spain]	taken into account

Comment No	From Page	From Line	To Page	To Line	Comment	Response
13098	17	5	17	5	Delete the text "fossil fuel combustion and cement production" and make reference to energy-related emissions. [Eleni Kaditi, Austria]	taken into account
734	17	8	17	8	whereas 90% do from' should be ' whereas 90% come from' [Robert Shapiro, United States of America]	grammar, spelling have been improved in the revised section 2.2.
56668	17	8	17	18	Do you mean past *fossil fuel* emissions? [Kirsten ZICKFELD, Canada]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
13484	17	9	17	9	CO2 [Sergio Aquino, Canada]	taken into account
29302	17	9	17	9	subscript "2" in "CO2" [Yuanyuan Huang, France]	taken into account
34528	17	9	17	9	It says: Estimated CO2 emissions; It must be reduced the size of 2, as a subscript [Mexico]	taken into account
44146	17	9	17	9	CO2, 2 should be subscript [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
47778	17	9	17	9	Kindly use: CO2 [Sarah Connors, France]	taken into account
57994	17	9	17	9	CO2 should be formatted to include a subscript. This is another example among numerous others. [Siir KILKIS, Turkey]	taken into account
29494	17	11	17	11	Suggested addition here or elsewhere in the text (bold red): Since land use GHG emissions reported by countries to UNFCCC have a different approach in estimating the "anthropogenic" sink compared to the global carbon modelling community (Grassi et al. 2017), it should be noted that the land-related emission estimates included in this report are not necessarily directly comparable with countries' estimates at global level. [Giacomo GRASSI, Italy]	Rejected— a comparison between GHG emissions as reported by the countries to UNFCCC are the GHG emissions as given by IAMs is achieved in sect 2.3 and sect 2.4. Focussing on the key geophysical properties of mitigation pathways and remaining carbon budgets, Sect 2.2 does not aim at comparing emissions level. Besides, this text has been moved into the technical annex in the revised version of Sect 2.2.
5862	17	12	17	25	This is inconsistent with the assessment in Chapter 1 which assigns a value of 0.85C. Although I have left substantive comments on Chapter 1 which would, if enacted, move it towards the position articulated here. What is key, however, is that Chapter 2 is consistent with Chapter 1 (and indeed all chapters are consistent). It may be that a cross-chapter group ensuring consistency in respect to the discussion of PI throughout the report would be useful. [Peter Thorne, Ireland]	The referee is right, the revised section 2.2 and especially the Table 2.1 now ensures a better liaison with Chap 1 assessment.
11724	17	12	17	25	The sensitivity of the budget to estimates of present levels of warming could be explored/clarified further. This is particularly important in light of the Millar et al paper which has introduced a lot of confusion into the debate (which seems to have made it into chapter 4, page 15 line 25 as a definitive statement that 1.5C is now more feasible). A reduction of 200Gt on the values in Table 2.4 essentially rules out 1.5C. [United Kingdom (of Great Britain and Northern Ireland)]	The text relative to the uncertainties associated to the computation of remaining carbon budgets has been totally revised and now clearly states the key variations which are responsible of deviation in carbon budgets compatible with 1.5°C or 2°C. In order
13822	17	13			The citation "Tokarska and Gillett" is missing the year. [MacDougall Andrew, Canada]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
22542	17	13			add "year" in citation or delete the reference (one case in this line) [LUIS VALDES, Spain]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
47780	17	13	17	13	Please check: Tokarska and Gillett. Year missing in citation [Sarah Connors, France]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
47880	17	13	17	46	Please check the citations: Tokarska and Gillett; Joshi, 2016……not available in reference section [Sarah Connors, France]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
60030	17	16	17	16	TCRE should be spelled out here, rather than in line 30. [United States of America]	section 2.2 has been substantially revised; this comment is not relevant for the revised section.
55454	17	17	17	20	Note that chapter 1 seems to end up with a different warming between 2006-2015 and 1851-1900 (unless I misunderstood - in which case I suspect others may misunderstand, too). Please ensure that there is no inconsistency and if there is good reason for numbers to be different, explain why that is (in both chapters, or cross-reference a single box that explains this). Otherwise it looks like chapter 1 uses 0.87 and chapter 2 uses 0.95 and we will have a lot of fun in the SPM approval. [Andy Reisinger, New Zealand]	The referee is right, the revised section 2.2 and especially the Table 2.1 now ensures a better liaison with Chap 1 assessment.
62976	17	17			Provide a reference for the value of TCRE used here. [Nathan Gillett, Canada]	Our assessment now rely on the same range of TCRE as assessed in AR5. The various quantile of TCRE employed in our calculation are now given in the Table 2.1
7044	17	18	19	25	These all impinge upon human health [Cate Tuitt, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 do not aim at discussing impact of nonC_2 climate forcers on health. However, later sections pick this up
52812	17	20	17	25	Consider moving to or referencing this in Chapter 1 [Iulain Florin VLADU, Germany]	taken into account.
62978	17	20		23	Tokarska and Gillett (2018) examine the use of different temperature datasets for 1.5C carbon budgets (see their Figure 4), including Cowtan and Way, and find a relatively small impact. [Nathan Gillett, Canada]	this reference has been included in the revised text.
60032	17	23	17	23	First occurrence of "GMST" in this chapter. Spell it out. [United States of America]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
62980	17	23		25	This then raises the question of whether the global warming targets in the Paris agreement should be interpreted similarly to historical observations up until now as a blend of SSTs and SAT over land, or whether they should be interpreted as global surface air temperature. The answer does not seem to be immediately clear. [Nathan Gillett, Canada]	We agree with reviewer suggestion. The revised text now acknowledged the impact of biases in historical temperature records on carbon budgets based on the recent available literature
18046	17	28			A key uncertainty to be added is the incomplete/inadequate rendering in the models of land use emissions, especially those other than land-use change (in particular forest and soil C dynamics). Erb, Karl-Heinz, Thomas Kastner, Christoph Plutzar, Anna Lisa S. Bais, Nuno Carvalhais, Tamara Fetzel, Simone Gingrich, Helmut Haberl, Christian Lauk, Maria Niedertscheider, Julia Pongratz, Martin Thurner, Sebastiaan Luyssaert, 2018. Unexpectedly large impact of forest management and grazing on global vegetation biomass. Nature, 553, 73-76 doi: 10.1038 Shows that land management effects beyond deforestation are almost never taken into account when assessing the C effects of land-use practices, even more so in coarse models such as IAMs. [Andrea TILCHE, Belgium]	Rejected. The role of land use CO2 emissions is included in Sect 2.2 assessment as a potential drivers in historical CO2 emissions uncertainty. Le Quéré et al. 2018 has been used to derived this uncertainties. Other sections of Chap 2 or other chapter of this report further discussed the role of land used. This is why the revised section 2.2 aims at minimizing overlap with other sections of this report

Comment No	From Page	From Line	To Page	To Line	Comment	Response
56672	17	29	17	41	This paragraph s misleading as it suggests that carbon budgets are calculated directly from the TCRE, which is often not the case. It should be made clear that the TCRE is a model diagnostic that quantifies a model's physical and biogeochemical response to CO2 emissions, and is therefore related to the carbon budget estimated with that model, but is not necessariy used to estimate the carbon budget. [Kirsten ZICKFELD, Canada]	The uncertainty relative to the knowledge of the TCRE has been better described in the revised section 2.2. Besides, uncertainty the shape of the TCRE distribution and its range are now taken into account in our quantitative assessment of C budget.
60034	17	29	17	50	The discussion of Transient Climate Response to Emissions (TCRE) could be clarified, especially how Figure 2.2 relates to Table 2.4 and Figure 2.4. [United States of America]	The uncertainty relative to the knowledge of the TCRE has been better described in the revised section 2.2. Besides, uncertainty the shape of the TCRE distribution and its range are now taken into account in our quantitative assessment of C budget.
8642	17	30	17	32	The text doesn't give a complete definition of TCRE as the ratio between "A" and "B". The text only states "A" but not "and B". [Urs Ruth, Germany]	This paragraph has been improved and clarified.
32748	17	30	17	31	Because the TCRE equals the ratio between the expected warming due to a given amount ... which ratio ? [Manfred Treber, Germany]	This paragraph has been improved and clarified.
34556	17	30	17	30	The acronym for Transient Climate Response to Emissions is not mentioned until this point, it would help if it is stated the first time it is mentioned [Mexico]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
43162	17	30	17	33	The sentence 'Because the TCRE - - - - climate target' may be rechecked to see if the phrase 'between the expected warming due to a given amount' needs to be changed to 'between expected warming and a given amount'. [Muhammad Mohsin IQBAL, Pakistan]	This paragraph has been improved and clarified.
44148	17	30	17	33	"the ratio between"… the 'and' does not seem to be there. Is something missing from this sentence? [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
8334	17	31	17	32	With regard to the linear relationship between carbon concentration and warming as stated in the report – "Because the TCRE equals the ratio between the expected warming due to a given amount of the cumulative CO2 emissions (Matthews et al.32 2009; Frölicher and Paynter 2015, see Chapter 1)" (P17, line 31-32), it is suggested to add the non-linear relationship between the two mentioned by some researchers. References: 1. Dana, E. and Z. Kirsten (2017). "What determines the warming commitment after cessation of CO2 emissions?" Environmental Research Letters 12(1): 015002?2. Good, P., J. A. Lowe, T. Andrews, A. Wiltshire, R. Chadwick, J. K. Ridley, M. B. Menary, N. Bouttes, J. L. Dufresne and J. M. Gregory (2015). "Nonlinear regional warming with increasing CO2 concentrations." Nature Climate Change 5(2): 138-142. [China]	We agree with referee's suggestion and the impact of emissions stoppage on peak warming and associated carbon budget are now further discussed in the revised section 2.2. These references are now included in our assessment.
36896	17	34	17	35	The uncertainties in the TCRE for 9 Earth system models are assessed by Williams et al. (2017). The inter-model uncertainity in the TCRE is presently high due to the inter-model differences in replicating histroical data. Exploiting theory, the dominant source of inter-model uncertainty in the TCRE is from inter-model differences in the thermal response involving the value of the climate feedback parameter and ocean heat uptake, which is augmented by weaker sources of inter-model uncertainty in the TCRE from the non-CO2 radiative forcing occurring presently and from the carbon response involving differences in the ocean and terrestrial uptake of carbon. Williams, R.G., V. Roussenov, P. Goodwin, L. Resplandy and L. Bopp, 2017. Sensitivity of global warming to carbon emissions: effects of heat and carbon uptake in a suite of Earth system models. Journal of Climate, 30, 9343-9363, doi: 10.1175/JCLI-D-16-0468.1. [Richard Williams, United Kingdom (of Great Britain and Northern Ireland)]	this reference has been included in the revised text.
56670	17	34	17	34	Explain that uncertainty in TCRE arises from uncertainty in physical climate response (TCR) and carbon cycle response (airborne fraction). [Kirsten ZICKFELD, Canada]	The uncertainty relative to the knowledge of the TCRE has been better described in the revised section 2.2. Besides, uncertainty the shape of the TCRE distribution and its range are now taken into account in our quantitative assessment of C budget.
22544	17	35			Insert space between "2016b.AR5" [LUIS VALDES, Spain]	taken into account
34532	17	35	17	35	Missing space: "...2016b).AR5..." [Mexico]	taken into account
44150	17	35	17	35	needs space between "2016b). AR5" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
53824	17	35	17	35	Insert space before AR5 [Patrik Winiger, Netherlands]	taken into account
176	17	37	17	39	MAGICC model provide inforamtion of 1.6°C per 3660 GtCO2. It is helpful to link the 1.6oc/3660GtCO2 to 1.5oc rise explicitly. [Mingshah Su, China]	This paragraph has been improved and clarified.
736	17	39	17	39	which is closed to' should be 'which is close to' [Robert Shapiro, United States of America]	taken into account
738	17	39	17	40	In regards of the recent literature' should be ' In regards to the recent literature' [Robert Shapiro, United States of America]	grammar, spelling have been improved in the revised section 2.2.
22546	17	39			Insert space between "CO2which" [LUIS VALDES, Spain]	taken into account
34530	17	39	17	39	Missing space: "...GtCO2which..." [Mexico]	taken into account
34558	17	39	17	39	A space between "GtCO2" and "which" is needed [Mexico]	taken into account
39352	17	39	17	39	Between GtCO2which there must be a free space: GtCO2 which [Olga Alcaraz, Spain]	taken into account
44152	17	39	17	39	needs space between "GtCO2 which" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
51664	17	39	17	39	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	taken into account
53826	17	39	17	39	Insert space before which [Patrik Winiger, Netherlands]	taken into account
53828	17	39	17	39	close instead of "closed" [Patrik Winiger, Netherlands]	taken into account
57996	17	39	17	39	There is a spacing issue in "GtCO?which" that remains to be addressed. [Siir KILKIS, Turkey]	taken into account
740	17	40	17	40	we assign a medium confidence on the TCRE best estimate' should be 'we assign a medium confidence to the TCRE best estimate' [Robert Shapiro, United States of America]	grammar, spelling have been improved in the revised section 2.2.
46568	17	40	17	40	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	IPCC language has been checked and updated in the revised section 2.2. We hope now that the revised section 2.2 now fit the IPCC standard
60036	17	41	17	41	Put 'high confidence' after "… could be revised downwards or upward in the future." [United States of America]	agree, take into account
34534	17	43	17	43	Missing space: "...non-CO2forcers…" [Mexico]	taken into account
34560	17	43	17	43	A space between "non-CO2" and "forcers" is needed [Mexico]	taken into account

Comment No	From Page	From Line	To Page	To Line	Comment	Response
36880	17	43	17	49	Williams et al. (2017) J. Climate doi. 10.1175/JCLI-D-16-0468.1 provide an alternative way of including the surface warming dependence on fossil-fuel carbon emissions, DT=(DT/DR)(DR/DR_CO2)(DR_CO2/DI) in equation (2) where DT/DR is given in terms of heat uptake and radiative forcing in equation (5) and DR_CO2/DI is given in terms of carbon ocean undersaturation, terrestrial carbon changes and carbon emissions in equation (9) in their paper. This approach includes the effect of non-CO2 radiative forcing. This approach is also set out in Williams, R.G., P. Goodwin, V.M. Roussenov and L. Bopp, 2016. A framework to understand the Transient Climate Response to Emissions. Environmental Research Letters, 11, Focus on Cumulative Emissions, Global Carbon Budgets and the Implications for Climate Mitigation Targets, doi:10.1088/1748-9326/11/1/015003 [Richard Williams, United Kingdom (of Great Britain and Northern Ireland)]	this reference has been included in the revised text.
39354	17	43	17	43	Between non-CO2forcers there must be a free space: non-CO2 forcers [Olga Alcaraz, Spain]	taken into account
44154	17	43	17	43	needs space between "CO2 forcers" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
51666	17	43	17	43	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	taken into account
56674	17	43	17	44	This sentence is misleading. The TCRE is defined only for CO2. Te uncertainty arises from how non-CO2forcers are handled in the *carbon budget* computation. [Kirsten ZICKFELD, Canada]	The paragraph relative to the TCRE assessment has been expanded and improved in the revised section 2.2. In particular, our assessment clearly distinguish the uncertainty relative to the CO2-only C budget as predicted by the TCRE calculation and those associated to the non-CO2 climate forcers.
22548	17	44			Insert space between "process(Collins et al." [LUIS VALDES, Spain]	taken into account
32750	17	44			computation process(Collins et al., 2013; Gillett et al., 2013) ... insert blank space before bracket [Manfred Treber, Germany]	taken into account
34536	17	44	17	44	Missing space: "process(Collins" [Mexico]	taken into account
44156	17	44	17	44	states "process(Collins et al., 2013; Gillett et al., 2013)." take one out [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
51668	17	44	17	44	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	taken into account
53830	17	44	17	44	Insert space after process [Patrik Winiger, Netherlands]	taken into account
62982	17	46		49	These references do not rely on the assumption of a proportionality between total warming and non-CO2 warming. They use scenarios including non-CO2 forcing agents to directly infer carbon emissions budgets, based on when individual simulations cross particular temperature thesholds. [Nathan Gillett, Canada]	This paragraph has been improved and clarified.
36898	17	48	17	50	For realistic radiative forcing including non-CO2 contributions, the proportionality of surface warming to cumulative carbon emissions can vary in time due to the contrasting effects of thermal, carbon and non-CO2 effects. This response can be model dependent. For an examination of the temporal response of 9 Earth system models compared with theory, see Williams, R.G., V. Roussenov, P. Goodwin, L. Resplandy and L. Bopp, 2017. Sensitivity of global warming to carbon emissions: effects of heat and carbon uptake in a suite of Earth system models. Journal of Climate, 30, 9343-9363, doi: 10.1175/JCLI-D-16-0468.1. [Richard Williams, United Kingdom (of Great Britain and Northern Ireland)]	this reference has been included in the revised text.
62984	17	55			Replace 'is used' with 'may be used'. In some scenarios which exceed the TPB consistent with 1.5C, no CDR is used, and the climate continues to warm. [Nathan Gillett, Canada]	This paragraph has been improved and clarified.
34538	17	56	17	56	Extra punctuation symbol: "...is to say., TRB…" [Mexico]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
44158	17	56	17	56	reads "say., TRB" remove full stop [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
51670	17	56	17	56	Comma and a period [Jason Donev, Canada]	taken into account
53832	17	56	17	56	Remove dot after "say" [Patrik Winiger, Netherlands]	taken into account
5966	18				poor quality figure [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	all the figures of sect 2.2 have changed during the revision of section 2.2.
42230	18	3			behaviour, ===> behavior [Egypt]	grammar, spelling have been improved in the revised section 2.2.
39122	18	4	18	18	This is a good example of language that leaves a policy maker completely unclear about what policy actions could be taken. Does this mean best not to act stop burning fossil fuels? Dangerously confusing. [Lindsey Cook, Germany]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
13824	18	5			Zickfeld and MacDougall, 2016 should be "Zickfeld et al. 2016" [MacDougall Andrew, Canada]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
742	18	9	18	9	Table 2.4' should be 'Figure 2.4' [Robert Shapiro, United States of America]	all the figures of sect 2.2 have changed during the revision of section 2.2.
5866	18	9	18	9	This is a totally counter-intuitive result, presumably driven by sample size effects and yet goes completely unremarked. As this is an assessment this result should be assessed and discussed rather than simply presented without comment here. How can the lower bound for 1.5C exceed the lower-bound for 2C? All logic says that the lower and upper bounds for 1.5C must both be lower than for 2C. [Peter Thorne, Ireland]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging
11726	18	9	18	9	Value for 1.5 differs from the table [United Kingdom (of Great Britain and Northern Ireland)]	This paragraph has been improved and clarified. Besides, we would like to stress that since our methodology to compute carbon budget has been updated during the revision of our chapter, the numbers as given in SOD have changed.
18048	18	9	18	9	The range should be 420 - 880 and 590 - 880 [Andrea TILCHE, Belgium]	This paragraph has been improved and clarified. Besides, we would like to stress that since our methodology to compute carbon budget has been updated during the revision of our chapter, the numbers as given in SOD have changed.
30908	18	9	18	9	shouldn't it be 420-880 for 1.5 degrees, rather than 590-880? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
32752	18	9			for TRBs is estimated to590–880 GtCO2 for 1.5°C and ... insert blank space after "to" [Manfred Treber, Germany]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
34540	18	9	18	9	Missing space: "...to590…" It says: is estimated to590-880; it should say: is estimated to 590-880 [Mexico]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
44160	18	9	18	9	needs space between "to 590" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
51672	18	9	18	9	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	taken into account
53834	18	9	18	9	Insert space between "to" and "590-880" [Patrik Winiger, Netherlands]	taken into account
53836	18	9	18	9	590-880 GtCO2 should be 420-880 GtCO2 [Patrik Winiger, Netherlands]	This paragraph has been improved and clarified. Besides, we would like to stress that since our methodology to compute carbon budget has been updated during the revision of our chapter, the numbers as given in SOD have changed.
58404	18	9	18	9	“TRBs is estimated to 590–880 GtCO2 for 1.5°C”should be 420 Gt? [Andrew Prag, France]	In the revised section 2.2 we now focus on only one concept of carbon budgets which corresponds to the peak budget as introduced in SOD. The concept of return budget although relevant has been assessed as non robust through our assessment. This is why we
60038	18	9	81	9	Change "for TRBs is estimated to 590-880 GtCO2 for 1.5°C" to "for TRBs is estimated to 420-880 GtCO2 for 1.5°C." [United States of America]	The concept of TRB has been removed.
62986	18	9		11	The meaning here is not clear. [Nathan Gillett, Canada]	This paragraph has been improved and clarified.
45334	18	12	18	14	The extensive role of MAGICC model in the results and uncertainties due to that should be given better in the summary. [Tuomo Kalliokoski, Finland]	We agree this point has been better discussed in the revised text and highlights in the ES
60040	18	12	18	12	Every result in this document has to be "viewed with caution." [United States of America]	taken into account
34542	18	14	18	14	For clarity, "negative emissions" could be used in quotation marks to avoid any possible confusion, otherwise specify that it refers to carbon removal. Suggestions: 1) "...cycle response to 'negative emissions'…" and 2) "cycle response to carbon removal (negative emissions)...". [Mexico]	This point is now clarified in the revised text
42232	18	14			behaviour ===> behavior [Egypt]	taken into account
42972	18	14	18	16	Furthermore, some feedbacks are not readily included in the calculations, particularly those relating to carbon released from thawing permafrost and from wetlands. See Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1618481114. [Durwood Zaelke, United States of America]	this reference has been included in the revised text.
62988	18	14		18	The text indicates that Earth system feedbacks beyond the carbon cycle influence 1.5C and 2C carbon budgets, but notes that they are difficult to assess based on current literature. Clearly climate feedbacks influence the carbon budgets. These are uncertain, but have been extensively discussed in the literature, so it doesn't seem to be these that this text is referring to. Make more clear what types of feedbacks are meant. [Nathan Gillett, Canada]	We agree with the referee. The role of Earth system feedbacks has been now quantified in our assessment using the recent literature. Because of its importance, the uncertainty relative of Earth system feedbacks on carbon budget is now acknowledged in the ES.
11728	18	16	18	18	their impacts would be limited - this needs to be justified. Indeed this is contradicted by the text on page 110, lines 21-24. [United Kingdom (of Great Britain and Northern Ireland)]	The role of permafrost feedback has been now clarified and quantified in the revised text. It also better liaises with Chapter 3 (impacts)
55960	18	16	18	16	Add, "especially carbon release from greater permafrost thaw." [Pamela Pearson, United States of America]	taken into account
42234	18	17			regards of ===> regards to [Egypt]	taken into account
5368	18	18	18	19	The picture seems not clear between the colour. Suggest to increase the resolution. [Sulistyawati Sulistyawati, Indonesia]	all the figures of sect 2.2 have changed during the revision of section 2.2.
22722	18	18	19	6	I found it unclear what the multiple colour dots mean in Figure 2.2 (spread of the budgets calculated from TCRE estimates or from different models models or different pathways?), and why one purple dot seems to be much further up than all the other dots? It may be good to clarify it, maybe in the figure caption. [Katarzyna B Tokarska, United Kingdom (of Great Britain and Northern Ireland)]	all the figures of sect 2.2 have changed during the revision of section 2.2.
34692	18	18	18	19	Seccion 2.2.2.2.2 Physical uncertainties. A location of the Figures closer to the paragraph where they refer will be very helpful to achieve a faster understanding. [Mexico]	all the figures of sect 2.2 have changed during the revision of section 2.2.
54608	18	18	18	19	High quality fig of fig 2.2 ,2.3,2.5,2.6 etc should be added [Qudsia Zafar, Pakistan]	Section 2.2 has been deeply revised and now a new structure has been proposed following reviewers suggestions. In brief, the revised section now focussed on carbon budgets that could be understood as peak budget using published methodology and acknowledging
10498	18	19	18	19	Figure 2.2 needs to be redrawn for clarity. Texts in the legend are not clear. [Hong Yang, Switzerland]	all the figures of sect 2.2 have changed during the revision of section 2.2.
8644	18	19	18	19	I find Figure 2.2 rather confusing: The pink dots of "Below 2°C" (per definition in the logend) are located in the range of y = 1.5°C. I am sure there is a reason for this, but it should get explained more prominently, e.g. in the Figure Captions. Also: Reading from AR5_WG1 (2013) TFE8 - Figure 1: For a 2°C warming the Cumulative total CO2 emissions budget is ~ 790 PgC (for 50% percentile); with cumulative anthropogenic emissions until 2016 of ~ 580 PgC there is a remaining budget of 210 PgC from 2016 onwards, which is equal to 770 GtCO2; this is a Threshold Exceedence Budget, if I understand right. This fits moderately well to the range stated in the text (line 9) and Table 2.4 of 570 - 1460 GtCO2 for 2°C. However, in SR1.5 Figure 2.2 the grey dots intersect y = 2°C at about x = 2800 GtCO2 since 2016, which is Threshold Peak Budget, if I understand right. But this difference between ~770 GtCO2 and ~2800 GtCO2 is huge (factor ~3.5) and surely cannot be explained by the different types of Budgets! Also, in Figure 2.2 the pink dots for 2°C-scenarios are located at x ~ 1700 GtCO2, which is much higher than the range mentioned in the text. This difference should be explained more clearly to avoid confusion. [Urs Ruth, Germany]	Figure 2.2 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure.
34544	18	19	18	19	The image is not very clear. [Mexico]	all the figures of sect 2.2 have changed during the revision of section 2.2.
39356	18	19	18	19	Figure 2.2 doesn't have a good definition, it's not clear [Olga Alcaraz, Spain]	all the figures of sect 2.2 have changed during the revision of section 2.2.
51674	18	19	18	19	This picture looks fuzzy, please use a higher resolution image. [Jason Donev, Canada]	all the figures of sect 2.2 have changed during the revision of section 2.2.
35780	19		19		The balance between sources and sinks of methane is not yet fully understood. Also, its reaction with the hydroxyl radical, which is produced photochemically in the atmosphere. Production of this radical is not fully understood and has a large effect on atmospheric concentrations. The uncertainties emanating from these highly variable sinks should also to be included. [India]	rejected— this section does not aim at focussing on balancing sink and source of methane but rather describing the impact of non-CO2 climate forcers; Following sections of this chapter further investigated the impacts of mitigation options to reduce methane emissions and atmospheric methane concentrations

Comment No	From Page	From Line	To Page	To Line	Comment	Response
56852	19				Figure 2.2 : Why do points not lie on a strait line if they are all cpmputed with MAGICC? Is it because of uncertainty in CO2-induced warming? [Kirsten ZICKFELD, Canada]	Figure 2.2 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure.
30414	19	2	19	5	Figure 2.2 : This figure is a bit hard to read. The budget beyond 3°C is not so interesting for our conversation. Would it be possible to rescale the y-axis between 0-3°C in order to see more clearly the interesting part of the graph? (at the bottom left) [France]	all the figures of sect 2.2 have changed during the revision of section 2.2.
53844	19	5	19	5	Insert space before climate [Patrik Winiger, Netherlands]	taken into account
11730	19	8	20	29	The discussion of non-CO2 forcers should make the point that non-radiative effects of CO2 such as ocean acidification, CO2 fertilization and increased plant water use efficiency complicate the comparison with non-CO2 forcers, so that comparison in terms of radiative forcing alone does not always present a full picture if the focus is on ecosystem impacts. [United Kingdom (of Great Britain and Northern Ireland)]	This point is now acknowledged in the revised; however we would like to stress that impacts such as ocean acidification are extensively detailed in chapter 3 in this report
35776	19	8	19	56	Aerosols and methane should not be clubbed together. The lifetime of methane is more than 10 years while that of aerosols is one week. Furthermore, the technologies that are needed to abate the emission of methane and Black Carbon are also very different. [India]	We have taken in to account this remarks in order to better describe the impact of aerosols and methane with respect to other non-CO2 climate forcers
62994	19	8	20	29	Tokarska et al. (2018) quantify the contribution of non-CO2 forcings to 1.5C and 2C carbon emissions budgets in CMIP5 models under the RCP scenarios, and may be relevant here. Reference: K. B. Tokarska, N. P. Gillett, V. K. Arora, W. G. Lee, and K. Zickfeld, The influence of non-CO2 forcings on cumulative carbon emissions budgets, Environ. Res. Lett., accepted, 2018. [Nathan Gillett, Canada]	This reference is now included in the assessment
1570	19	9	19	10	Non-CO2 climate forcers… Please cite Jacobson, M. Z., Strong radiative heating due to the mixing state of black carbon in atmospheric aerosols, Nature, 409, 695-697, 2001 as this identified black carbon as the second leading cause of global warming in terms of radiative forcing. [Mark Jacobson, United States of America]	This reference is now included in the text
30910	19	9	19	56	this is quite a tricky page – some terms are not clear eg line 31 what is a “scattering-aerosol precursor emission” [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
42236	19	9			add this paragraph: One of the most recent researches regarding the possible causes of the Climate Change is done in the National Research Centre in Egypt, the main focus of this research is the possible effect of the solar radiation change on the climate of the Earth at the low level latitudes area (specially Africa and the Arabian Peninsula) according to two scenarios of change one with an increase of about 1% of the current solar radiation amount and the other is with an increase of about 10% of the current solar radiation amount, the output of these scenarios is calculated using the Regional Climate Model 4.5.7., this research concluded that even with either small or large increase/change in the solar radiation the whole climate over the area of Africa and the Arabian Peninsula is not affected, and the researchers concluded that the possible change in the climate over this area will be due to the Anthropogenic effects which agrees to the results of various researches around the world. (Mostafa El Nazer, Ali Wheida, A. S. Soliman, M. M. Abdel Wahab, A. Hady, 4th IAGA International Symposium, Hurghada, Egypt, 2016, DOI: 10.13140/RG.2.2.23732.76169) [Egypt]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
22550	19	10			Insert space between "outcomes(Harmsen et al." [LUIS VALDES, Spain]	taken into account
34546	19	10	19	10	Missing space: "outcomes(Harmsen" [Mexico]	taken into account
51676	19	10	19	10	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	taken into account
53838	19	10	19	10	Insert space after outcomes [Patrik Winiger, Netherlands]	taken into account
42238	19	12			and ===> , and [Egypt]	taken into account
11732	19	19	19	21	Why is the global methane budget paper not used? Choice of data needs justifying. https://www.earth-syst-sci-data.net/8/697/2016/ [United Kingdom (of Great Britain and Northern Ireland)]	Saunois et al. 2016 is acknowledged in the reference list. Besides, most of the mitigation pathways used a level of methane emission in 2010 in agreement with the global methane budget (Saunois et al., 2016)
35778	19	20	19	22	Methane reduction is mainly from Paddy fields and animal enteric fermentation. In the recent days, technologies have been identified to reduce the methane emission from rice paddies through SRI cultivation. Similarly, animal feed management for reducing the methane emission is also under consideration. These technology advancements need to be kept in mind when calculating the future methane emission. [India]	rejected— this section does not aim at assessing mitigation options but rather assessing the geophysical characteristics of non-CO2 radiative forcings. Other sections of chapter 2 further discuss these points
60042	19	21	19	22	Granier et al. [Evolution of anthropogenic and biomass burning emissions of air pollutants at global and regional scales during the 1980-2010 period, Climatic Change (2011)] and Hoesly et al. [Historical (1750--2014) anthropogenic emissions of reactive gases and aerosols from the Community Emissions Data System (CEDS), 2018] better qualify this statement on uncertainties on emissions of non-CO2 GHG and aerosols. [United States of America]	This reference has been included in the revised text; we have now clarified that mitigation pathways rely on most up-to-date emissions data as starting point.
31700	19	24	19	38	A paper under revision in ERL that could be discussed in this section: Aamaas et al. Regional temperature reductions due to ambitious mitigation of short lived climate forcers. The study finds that if SLCFs are cut optimized to climate, technical measures on SLCFs can contribute to up to 0.3 C cooling in 2050, while a small warming may occur if SLCFs are cut extensively without regarding the temperature response. [Borgar Aamaas, Norway]	This reference is now acknowledged in the text
60044	19	24	19	38	Some key points here about non-CO2 forcers that should be amplified in the summary and the SPM. [United States of America]	This points is now clearly highlighted in the revised chapter 2 and is now emphasized in the ES
177	19	26	19	26	There are no space between non-CO2 and climate. [Mingshah Su, China]	taken into account
1572	19	26	19	27	Because most of the non-CO2 climate forcers have radiative efficiencies must stronger than CO2. This was shown quantitatively in Paragraph 63 of Jacobson, M. Z., Control of fossil-fuel particulate black carbon plus organic matter, possibly the most effective method of slowing global warming, J. Geophys. Res., 107 (D19), 4410, doi:10.1029/ 2001JD001376, 2002 [Mark Jacobson, United States of America]	We thanks the reviewer for this suggestion. However, the current statement has been deleted in the revised sect 2.2. We would like to stress that this study has been taken into account in our assessment.
29304	19	26	19	29	comma for "non-CO2climate" [Yuanyuan Huang, France]	taken into account
39358	19	26	19	26	Between non-CO2climate forcers there must be a free space: non-CO2 climate forcers [Olga Alcaraz, Spain]	taken into account
42240	19	26			CO2climate ===> CO2 climate [Egypt]	taken into account
44162	19	26	16	26	needs space between "Co2 climate forcers" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
51678	19	26	19	26	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	taken into account
57998	19	26	19	29	There are two instances in lines 26 and 29 in which "non-CO? climate forcers" is written as "non-CO?climate forcers" with a spacing issue. [Siir KILKIS, Turkey]	taken into account

Comment No	From Page	From Line	To Page	To Line	Comment	Response
47882	19	27	19	27	Please check the citation: Myhre et al. 2013b…….not available in reference section [Sarah Connors, France]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
30416	19	28	19	30	« Several studies suggest that non-CO2climate forcers could cause the global mean temperature to exceed 1.5°C by mid-century (Gambhir et al., 2017; Rogelj et al., 2014b; Stohl et al., 2015). » Would it be possible to look further into this statements, as it seems curious that non-CO2 forcers alone would cause GMST to exceed 1.5°C without a contribution from CO2 ? [France]	This point is now clarified in the revised text
42754	19	28	19	38	Additional citation for the unmasked warming from removing cooling aerosols. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1618481114. Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1002293107. [Kristin Campbell, United States of America]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
42974	19	28	19	38	Reduction of SLCPs can avoid 0.6ºC of warming by 2050 and 1.2ºC by 2100; unmasked warming from removing aerosols will add 0.3ºC of warming by 2050 and 0.6ºC of warming by 2100. See Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1618481114; and Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1002293107; and UNEP (2017) The Emissions Gap Report; and Shindell et al (2012) Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security. [Durwood Zaelke, United States of America]	This reference is now acknowledged in the text
62990	19	28			Make clear that non-CO2 forcer emissions changes could affect the rate of warming in either direction - as written the text could be read as indicating that non-CO2 emissions will increase the warming rate at mid-century. [Nathan Gillett, Canada]	the text has been revised accordingly
178	19	29	19	29	There are no space between non-CO2 and climate. [Mingshah Su, China]	taken into account
3308	19	29	19	30	This sentence seems to indicate that the would do so even without any CO2 impact. I strongly believe this is an overstatement and that a contribution from CO2 is necessary to reach 1.5°C [Francois-Marie Breon, France]	This point is now clarified in the revised text
34562	19	29	19	29	A space between "non-CO2" and "climate" is needed [Mexico]	taken into account
39360	19	29	19	29	Between non-CO2climate forcers there must be a free space: non-CO2 climate forcers [Olga Alcaraz, Spain]	taken into account
42242	19	29			CO2climate ===> CO2 climate [Egypt]	taken into account
44164	19	29	16	29	needs space between "Co2 climate forcers" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
53840	19	29	19	29	Insert space before climate [Patrik Winiger, Netherlands]	taken into account
744	19	33	19	35	Even if non-CO2 long-lived greenhouse gas emissions stay at the same level their concentrations and warming effect will increase. Stohl et al. (2015) estimated that a warming of 0.25°C in 2050 could be attributed to methane emissions alone in absence of mitigation' But methane has been referred to as a short-lived greenhouse gas, not a long-lived!!! We assign methane as a SLCF for the purpose of climate assessment, because its lifetime is comparable to or shorter than the thermal adjustment time of the climate system.This from chapter one. [Robert Shapiro, United States of America]	This section has been revised and this point has been clarified.
37826	19	35	19	38	As shown in Figure 2.3a, a mean warming of about 0.5°C in 2050 can be attributed to non-CO2 forcers... This is in fact not shown in Figure 2.3a. What is shown in this figure is a bunch of lines and it is not evidence for this number, nor is it clear which class of scenarios this statement applies to, as "most stringent mitigation pathways" is undefined. Is that only below 1.5°C 50%? Maybe is the bad graphical resolution of the figure, but I can only infer a 0.5°C contribution of 0.5°C around 2035, and substantially less by 2050. This seems a factual mistake [Michiel Schaeffer, Netherlands]	Figure 2.3 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure.
62992	19	35			I suggested 'could be caused by' instead of 'could be attributed to'. Usually 'attributed to' refers to an observed change. [Nathan Gillett, Canada]	the text has been revised accordingly
13842	19	42	19	42	Duplicate parentheses [Poot-Delgado Carlos, Mexico]	taken into account
46570	19	43	19	44	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	IPCC language has been checked and updated in the revised section 2.2. We hope now that the revised section 2.2 now fit the IPCC standard
42976	19	44	19	56	Add citation for the unmasking and quantity of warming to Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1002293107.; also, Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1618481114 [Durwood Zaelke, United States of America]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
13846	19	47	19	47	Space [Poot-Delgado Carlos, Mexico]	taken into account
13916	19	48	19	50	However, reduction in SO2 (and NOx) emissions largely associated with fossil-fuel burning are expected to reduce the cooling effects of both aerosol radiative interactions and aerosol cloud interactions (medium confidence), leading to warming (Myhre et al., 2013; Samset and Myhre, 2017). In addition, aerosols have been enhancing the natural carbon uptake by the land and ocean (both by cooling and by fertilizing), and so when the aerosols are cut, we expect to see more carbon remaining in the atmosphere (Mahowald et al., 2017). [Natalie MAHOWALD, United States of America]	taken in to account.
60046	19	48	19	50	Reductions in NOx may also feedback on methane via increases in the primary sink of methane (hydroxyl) radical. This needs to be acknowledged. [United States of America]	our assessment has focussed on major contributions and this is seen as too technical
46572	19	50	19	50	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	IPCC language has been checked and updated in the revised section 2.2. We hope now that the revised section 2.2 now fit the IPCC standard
179	19	51	19	51	There are no space between non-CO2 and climate. [Mingshah Su, China]	taken into account
34564	19	51	19	51	A space between "non-CO2" and "climate" is needed [Mexico]	taken into account
39362	19	51	19	51	Between non-CO2climate forcers there must be a free space: non-CO2 climate forcers [Olga Alcaraz, Spain]	taken into account
42244	19	51			CO2climate ===> CO2 climate [Egypt]	taken into account
44166	19	51	16	51	needs space between "Co2 climate forcers" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account

Comment No	From Page	From Line	To Page	To Line	Comment	Response
53842	19	51	19	51	Insert space before climate [Patrik Winiger, Netherlands]	taken into account
4534	19	52	19	52	Please consider adding the following reference. Acosta Navarro, et al. (2017). Future response of temperature and precipitation to reduced aerosol emissions as compared with increased greenhouse gas concentrations. Journal of Climate, 30(3), 939-954. [Juan Camilo Acosta Navarro, Spain]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
13844	19	52	19	52	Review the order of bibliographic citations [Poot-Delgado Carlos, Mexico]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
60048	19	54	19	56	This is a key point that is not widely understood. Suggest amplifying it in the summary. [United States of America]	to be acknowledged
4536	19	56	19	56	Please consider adding the following reference. Acosta Navarro & Varma, et al. (2016). Amplification of Arctic warming by past air pollution reductions in Europe. Nature Geoscience, 9(4), 277-281. [Juan Camilo Acosta Navarro, Spain]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
55962	19	56	19	56	Add, "Complicating the picture, impacts of non-CO2 forcers, particularly black carbon-rich sources may differ in regional impacts, especially when emissions take place near snow and ice. On the other hand, the World Bank has posited that such responses also raise the possibility of region-specific emissions pathways aimed at slowing snow, ice and permafrost loss (World Bank, 2013). Cite: The World Bank and International Cryosphere Climate Initiative (2013). On Thin Ice: How Cutting Pollution Can Slow Warming and Save Lives. Washington,DC. [Pamela Pearson, United States of America]	rejected— By pointing toward Myhre et al. 2013 (AR5) we aim at acknowledging the variety of uncertainty that relates to the regional response and impacts of non-CO2 climate forcers
462	20	1	20	1	temperature outcomes [David Reay, United Kingdom (of Great Britain and Northern Ireland)]	grammar, spelling have been improved in the revised section 2.2.
30912	20	1	20	10	talks about some reduction levels by some dates for some non-CO2 GHGs – eg CH4 by 40% by 2100 relative to 2030. Could figures be presented for 2016, 2030, 2050 and 2100 for all GHGs, in a table, and why does this page at the moment present % reductions against a 2030 baseline? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken in to account. The revised Figure 2.1 now depicted the change in global mean temperature across three key decades 2030, 2050 and 2100.
37828	20	1	20	5	Does this correctly reflect why certain measures are implemented in the models? It seems a more accurate description that while CH4 reductions are resulting both from CO2 measures and from targeted CH4 measures, in most, of not all, literature on 1.5°C the reductions in BC come from CO2 measures. This paragraph should make clear what the cause is of reductions of these agents, otherwise it remains unclear why this is relevant [Michiel Schaeffer, Netherlands]	This point is further discussed in sect 2.3 and/or 2.4. The revised text of sect 2.2 aims to minimize overlaps with other sections of this chapter
3204	20	3	20	7	Here the required reduction in non-CO2 climate forcers are stated "relative to 2030". This isnt very informative. Why not relative to 2010/2015/2017? [Vassilis Daioglou, Netherlands]	We agree with the reviewer. This paragraph has been revised accordingly
37830	20	3	20	5	Does this correctly reflect why certain measures are implemented in the models? It seems a more accurate description that while CH4 reductions are both resulting from CO2 measures and from targeted CH4 measures, in most, of not all, literature on 1.5°C the reductions in BC come from CO2 measures. [Michiel Schaeffer, Netherlands]	This point is further discussed in sect 2.3 and/or 2.4. The revised text of sect 2.2 aims to minimize overlaps with other sections of this chapter
42246	20	3			likelihood ===> likely [Egypt]	grammar, spelling have been improved in the revised section 2.2.
39364	20	5	20	5	Between non-CO2climate forcers there must be a free space: non-CO2 climate forcers [Olga Alcaraz, Spain]	taken into account
42248	20	5			CO2climate ===> CO2 climate [Egypt]	taken into account
44168	20	5	20	5	needs space between "Co2 climate forcers" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
58000	20	5	20	5	This is another instance of "non-CO? climate forcers" written as "non-CO?climate forcers" with a spacing issue. [Siir KILKIS, Turkey]	taken into account
42250	20	6			and ===> , and [Egypt]	taken into account
60050	20	8	20	9	How does the reader assess a "high risk" with 'medium confidence'? This is needlessly confusing. [United States of America]	Confidence statement has been revised considering available lines of evidence
46574	20	9	20	10	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	IPCC language has been checked and updated in the revised section 2.2. We hope now that the revised section 2.2 now fit the IPCC standard
39124	20	12	20	29	It would help policy makers if you could highlight most harmful human activities related to non-CO2 emissions, so they can find this complex information relevant to the policy work they must define. [Lindsey Cook, Germany]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
62996	20	12		29	It might be worth noting here that cumulative carbon emissions budgets for 1.5C are not significantly different based on the different RCP scenarios (Tokarska and Gillett, 2018). (Final version of Tokarska and Gillett (2018) compares budgets calculated from models with multiple ensemble members of different RCP scenarios, and finds no statistically significant differences). This may tell us that the non-CO2 forcing evolution as a function of cumulative CO2 emissions is very similar in the RCPs, but may not be a result that is general to all possible scenarios, but is still worthwhile reporting here, since many other studies use the RCPs to calculate emissions budgets. [Nathan Gillett, Canada]	That is correct. The revised text now discussed this point. Besides, this reference is now taken into account in the revised text
30914	20	18	20	18	if the median non-CO2 warming is 0.36 degrees, this implies (line 16) that 0.16 and 0.56 warming would have respectively 300GtCO2 lower/higher CO2 budgets. However in Figure 2.4, it looks like the non-CO2 variation (the black bars on yellow background) is quite a bit higher than 300 – more like 450 each way. I don't understand this apparent difference. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2
39366	20	19	20	19	Between "860 GtCO2at" there must be a free space: "860 GtCO2 at" [Olga Alcaraz, Spain]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
53846	20	19	20	19	Insert space before at [Patrik Winiger, Netherlands]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
37832	20	20	20	21	While this seems correct, it is also tendentious. The problem seems to be that (unintentionally) this statement suggests that non-CO2 societal choices are all-determining for warming. This is correct if one assumes a fixed CO2 budget, but of course societal choices on CO2 are much more important for determining whether that fixed carbon budget is actually achieved, and therefore whether the scenario is ultimately 1.5 or 2°C compatible. For a balanced reflection of the literature, an additional sentence is recommended: "Note that this does not imply that non-CO2 mitigation options are the largest factor determining whether a scenario is, or is not, compatible with 1.5°C or 2°C, which critically depends on the CO2 reductions achieved." [Michiel Schaeffer, Netherlands]	We thanks the reviewer for this suggestion. It is now taken into account in the revised text.
46534	20	20	20	20	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	IPCC language has been checked and updated in the revised section 2.2. We hope now that the revised section 2.2 now fit the IPCC standard

Comment No	From Page	From Line	To Page	To Line	Comment	Response
55456	20	20	20	22	This sentence strikes me as rather important that deserves to end up in some form in the executive summary and SPM where carbon budgets are referred to. [Andy Reisinger, New Zealand]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
56880	20	20	20	20	Explain what a "societal variation" is for the poor policymaker? [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2
42978	20	24	20	29	Sentence fragment in L29, and generally awkward. [Durwood Zaelke, United States of America]	grammar, spelling have been improved in the revised section 2.2.
53852	20	24	20	29	In my opinion these sentences are written in a very confusing way. I suggest the "strongest non-CO2 warming" is replaced with "the least mitigation of non-CO2 warming agents" and likewise should "the weakest non-CO2 warming" be replaced with "the strongest mitihation of non-CO2 warming agents ". [Patrik Winiger, Netherlands]	This paragraph has been totally revised since our methodology to compute remaining carbon budget now rely on TCRE calculation. The importance of non-CO2 climate forcers on the remaining carbon budget is estimated using several approaches as depicted in the technical annex.
5868	20	25	20	29	This passage as written made no sense to me. It feels like text that was intended either was redacted or never added at various points in this passage. A substantial redraft for clarity would greatly aid the reader. [Peter Thorne, Ireland]	grammar, spelling have been improved in the revised section 2.2.
46576	20	25	20	29	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	IPCC language has been checked and updated in the revised section 2.2. We hope now that the revised section 2.2 now fit the IPCC standard
55458	20	25	20	25	Is this a likelihood referring to the real world, or to the ensemble of opportunity? If the latter, please don't call it likelihood but refer to a percentage of scenarios. [Andy Reisinger, New Zealand]	This paragraph has been totally revised since our methodology to compute remaining carbon budget now rely on TCRE calculation. The importance of non-CO2 climate forcers on the remaining carbon budget is estimated using several approaches as depicted in the technical annex.
43164	20	26	20	29	Both the sentences 'In contrast, - - - - aerosol cooling.' and 'So (medium confidence.' are incomplete. May please be checked. [Muhammad Mohsin IQBAL, Pakistan]	This paragraph has been totally revised since our methodology to compute remaining carbon budget now rely on TCRE calculation. The importance of non-CO2 climate forcers on the remaining carbon budget is estimated using several approaches as depicted in the technical annex.
53848	20	26	20	28	The sentence is not finished and I can't tell what you were trying to say. [Patrik Winiger, Netherlands]	grammar, spelling have been improved in the revised section 2.2.
55460	20	27	20	27	weakest -> least [Andy Reisinger, New Zealand]	taken into account
42252	20	28			dominate ===> dominates [Egypt]	grammar, spelling have been improved in the revised section 2.2.
180	20	29	20	29	The sentence "So" is not a completed sentence. [Mingshah Su, China]	grammar, spelling have been improved in the revised section 2.2.
746	20	29	20	29	So (medium confidence).' What is this ??? [Robert Shapiro, United States of America]	grammar, spelling have been improved in the revised section 2.2.
1704	20	29	20	29	Delete 'So'. [Greece]	grammar, spelling have been improved in the revised section 2.2.
3206	20	29	20	29	Last sentence of paragraph has a mistake. [Vassilis Daioglou, Netherlands]	grammar, spelling have been improved in the revised section 2.2.
11734	20	29	20	29	So……..? [United Kingdom (of Great Britain and Northern Ireland)]	grammar, spelling have been improved in the revised section 2.2.
13100	20	29	20	29	Delete the text "So (medium confidence).". [Eleni Kaditi, Austria]	grammar, spelling have been improved in the revised section 2.2.
13486	20	29	20	29	not clear: So (medium confidence). [Sergio Aquino, Canada]	grammar, spelling have been improved in the revised section 2.2.
29306	20	29	20	29	I don't understand " So (medium confidence)." at the end of the sentence [Yuanyuan Huang, France]	grammar, spelling have been improved in the revised section 2.2.
44820	20	29	20	29	So (mediumconfidence)-->Probably some sentences may be missing here. [Hiroaki Kondo, Japan]	grammar, spelling have been improved in the revised section 2.2.
45336	20	29	20	29	Typo "So (medium confidence). [Tuomo Kalliokoski, Finland]	grammar, spelling have been improved in the revised section 2.2.
53850	20	29	20	29	So (medium confidence). Does this belong to the previous sentence? [Patrik Winiger, Netherlands]	grammar, spelling have been improved in the revised section 2.2.
55462	20	29	20	29	incomplete sentence and reasoning? But a good attempt at wrapping up an important discussion with a statement that uses uncertainty language! [Andy Reisinger, New Zealand]	grammar, spelling have been improved in the revised section 2.2.
58002	20	29	20	29	The word "So" may be deleted prior to "medium confidence" in the phrase "reduced aerosol cooling. So (medium confidence)." [Siir KILKIS, Turkey]	grammar, spelling have been improved in the revised section 2.2.
60052	20	29	20	29	Incomplete sentence. [United States of America]	grammar, spelling have been improved in the revised section 2.2.
61762	20	29	20	29	Missing sentence? "So (medium confidence)". [Valérie Masson-Delmotte, France]	grammar, spelling have been improved in the revised section 2.2.
5370	20	30	20	31	The picture seems not clear between the colour. Suggest to increase the resolution. [Sulistyawati Sulistyawati, Indonesia]	all the figures of sect 2.2 have changed during the revision of section 2.2.
10500	20	30	20	30	Figure 2.3 needs to be redrawn for clarity. Texts in the legend are not clear. [Hong Yang, Switzerland]	all the figures of sect 2.2 have changed during the revision of section 2.2.
22552	20	30			The sentence "So (medium confidence)" should be part of a longer sentence. As "medium confidence" is already in the previous line, my recommendation is to remove it from here [LUIS VALDES, Spain]	taken in to account.
39368	20	30	20	30	Figure 2.3 doesn't have a good definition, it's not clear [Olga Alcaraz, Spain]	all the figures of sect 2.2 have changed during the revision of section 2.2.
5968	20	31			poor quality figure [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	all the figures of sect 2.2 have changed during the revision of section 2.2.
51680	20	31	20	31	This picture looks fuzzy, please use a higher resolution image. [Jason Donev, Canada]	all the figures of sect 2.2 have changed during the revision of section 2.2.
42254	20	35			function ===> a function [Egypt]	grammar, spelling have been improved in the revised section 2.2.
18050	21				Fig 2.4: in the second panel (societal choices) it is not clear what the discrete blocks for non-CO2 mean. Why is this not merely a range (as in the panel below). Also see previous comment re: median value for TPB & TRB. It seems curious that they are so close, given the magnitude of the other identified uncertainties. [Andrea TILCHE, Belgium]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2
353	21	1	21	45	Fugure 2.4 is hard to understand. Please add an appendix to give meaning and methods. [Zong-Ci Zhao, China]	add an appendix = preferable to better explain the figure in the text
5870	21	1			Why in Figure 2.4 is the threshold peak budget not left shifted in the lower panel relative to the return budget? This is naively counter-intuitive yet in neither the figure or the text is the reader guided as to why this result stands (if indeed it isn't an error in the figure itself). [Peter Thorne, Ireland]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2

Comment No	From Page	From Line	To Page	To Line	Comment	Response
14028	21	1	21	10	Fig 2.4 A picture is worth 100 words but an IPCC picture takes 1000 words to explain it! I support the use of figures but cannot make any sense of this one after much contemplation. For example, what is the "Umbrella" trying to show? Does it link with scale above it?No y axis scale? Some boxes not labelled. It remains a mystery! [Ralph Sims, New Zealand]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2
14098	21	1	21	3	The meaning of the blue scale used in the bars of the Societal Choices for Non Co2 Pathways panel is not clear. Please insert a legend if it is the case [Meimalin Moreno, Venezuela]	Not applicable anymore. This figure was not included in the FGD.
21444	21	1	21	17	In the design of Figure 2.4, the societal choices part (pink) is somewhat unclear to me and would benefit from improved clarity. While the outer two pathways that include a written description are clear, for the semi-transparent pathways in the middle this is less the case. An option could be to add text tot the current four semi-transparent pathways in the middle that states that these are example pathways illustrating societal choices/conditions linked ot non-CO2 emissions [Volker Krey, Austria]	all the figures of sect 2.2 have changed during the revision of section 2.2.
28030	21	1	21	17	Figure 2.4: clarification needed for second top picture on "societal choices for non-CO2 pathways". What do the blue boxes at the end of the different lines mean? The term "choices" is rather unclear too, maybe better "options". See also our comments in the SPM regarding this figure. [Germany]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2
30916	21	1	21	17	I like Figure 2.4. Calling the black bar on yellow background “societal variations” seems wrong though – shouldn’t it be “non-CO2 variations”? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	all the figures of sect 2.2 have changed during the revision of section 2.2.
31410	21	1	21	1	Fig.2.4 It is not clear what the black bars and green/blue bars show: the legend explains the budgets but does not explain explicitly the color code. [Japan]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2
39370	21	1	21	1	Figure 2.4 doesn't have a good definition [Olga Alcaraz, Spain]	all the figures of sect 2.2 have changed during the revision of section 2.2.
44822	21	1	21	1	It is not easy to understand the relationship between top, second, third and bottom pannel in this figure. Why are there so many lines in second figures? How was the range of societal variation determined in the third pannel? [Hiroaki Kondo, Japan]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2
45338	21	1	21	1	Figure 2.4 Climate sentivity -> Climate sensitivity. [Tuomo Kalliokoski, Finland]	all the figures of sect 2.2 have changed during the revision of section 2.2.
49584	21	1	21	2	Figure: The shadings and levels of societal choices blocks should be explained, if there is a meaning behind. Why are they layouted so differntly? If there is no significance, please revise. [Karlheinz ERB, Austria]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2
51682	21	1	21	1	The white text reading 'societal variations' looks like its just the left half of that bar, which I don't think is what was meant. The white bars also look a bit odd overall. [Jason Donev, Canada]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
53854	21	1	21	1	Figure 2.4: In the top green colored field "Climate sentivity" must be replaced by "Climate sensitivity" [Patrik Winiger, Netherlands]	all the figures of sect 2.2 have changed during the revision of section 2.2.
58406	21	1	21	1	table 2.4 - Are the lengths of bars here supposed to represent the actual levels of variation seen or is this figure purely schematic? [Andrew Prag, France]	Table 2.4 has been removed from the main text and has been replaced by another table which clearly indicate key variations in remaining C budget.
58408	21	1	21	1	table 2.4 - Further, it is unclear if this is an assessment for a specific probability of keeping the temperature rise below 1.5 °C (e.g. 50%) or is supposed to span the full range of probabilities. If the latter, then it is surprising that the variation in the budget coming from climate sensitivity (in the first green-shaded area) is so narrow given the TCRE is between 0.8 and 2.5 °C per 3,670 Gt CO2. If the former, then it is not really climate sensitivity that gives rise to the spread in budgets. It would be helpful for the reader to clarify and discuss what actual factors give rise to this range of uncertainty in CO2-only budgets (e.g. is the small range appearing because of uncertainty over historical CO2 emissions as explained in section 2.2.2.2.2?). [Andrew Prag, France]	need to better include TCRE uncertainties in Figure 2.4= do not use a single prob outcomes to compute climate response uncertainty
58410	21	1	21	1	how do the total carbon budget ranges then relate to the figures in Table 2.4? [Andrew Prag, France]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2
13898	21	3	21	3	Figure 2.4: this looks to be a potenttially valuable figure, but I had to reread it several times to figure it out. I thik you might want to make it clearer that you are usign the same scale across the figure (if you are), by having the scale of carbon emissions extend across the whole vertical extent of the figure. Right now it looks liek 4 different figures, but I think it should be interprted as 4 different elements of the same figure, so maybe keep the carbon amounts on the bottom and top, and extend vertical grid lines, perhaps, to make it more visually connnected? but I don't quite understand how the threshold return budget uncertainty is assessed? The very top description (climate response uncertainties), maybe should come under the total carbon budget uncertainty: maybe that would make it clearer. So show your final answer first, and then show the parts. [Natalie MAHOWALD, United States of America]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2
22716	21	3	21	18	I found Figure 2.4 confusing. Maybe a different way of merging panels 1,3,4 would be easier to read. Also, it looks like uncertainty due to societal variations is in black on the bottom panels, but in blue in the second panel. Climate sensitivity is misspelled in the top panel. It is unclear what do negative TRB (in bottom panel) imply. [Katarzyna B Tokarska, United Kingdom (of Great Britain and Northern Ireland)]	all the figures of sect 2.2 have changed during the revision of section 2.2.
55464	21	3	21	3	Figure 2-4: the carbon budgets are for 50% probabilities - this needs to be made prominently clear within the figure itself (and in the caption). [Andy Reisinger, New Zealand]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2
56882	21	3	21	3	I like this figure [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	thanks. However this figure has been removed from the main text and has been replaced by a table (supported by a technical annex).

Comment No	From Page	From Line	To Page	To Line	Comment	Response
60054	21	3	21	17	Are the non-CO2 radiative forcings derived from IAM simulations using the pathways from the SR1.5 scenarios? If so, the caption should mention the model used to derive these estimates. Also, the blue boxes in the purple panel (societal choices for non-CO2 pathways) could indicate the values of the non-CO2 forcings, so that there are numbers associated with each box in the figure. [United States of America]	Figure 2.4 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure. For sake of clarity, we have preferred to present remaining carbon budget in a table including the key variations as assessed in sect 2.2
42256	21	4			preindustrial ===> pre-industrial [Egypt]	taken into account
748	21	5	21	5	Table 2.4' should be' Figure 2.4' [Robert Shapiro, United States of America]	Both table 2.4 and Figure 2.4 have been removed from the main text. We would like to stress that Sect 2.2 has been deeply revised in order to take into account reviewer suggestions.
1574	21	6	21	6	Jacobson (2017) should be Jacobson et al. (2017) [Mark Jacobson, United States of America]	taken into account
42258	21	6			variation ===> the variation [Egypt]	taken into account
42260	21	8			includes ===> include [Egypt]	taken into account
42262	21	8			associated to ===> associated with [Egypt]	taken into account
35782	21	12	21	14	Superscript for Wm-2 at three places. [India]	taken into account
39372	21	12	21	12	small non- CO2: it must be small non-CO2 in order to use always the same structure [Olga Alcaraz, Spain]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
40818	21	12	21	14	superscript for Wm-2 at three places [NARESH KUMAR SOORA, India]	taken into account
44824	21	12	21	14	Wm-2-->Wm-2 [Hiroaki Kondo, Japan]	taken into account
47782	21	12	21	14	Kindly use: Wm-2 [Sarah Connors, France]	taken into account
51684	21	12	21	12	Extra space [Jason Donev, Canada]	taken into account
53856	21	12	21	14	Fix the forcing units by writing "-2" as supersrcript [Patrik Winiger, Netherlands]	taken into account
58004	21	12	21	14	The unit "W m-2" may be written as "W/m²" with the numerical value "2" as superscript in the caption of Figure 2.4. [Siir KILKIS, Turkey]	taken into account
39374	21	13	21	13	median non- CO2: it must be median non-CO2 in order to use always the same structure [Olga Alcaraz, Spain]	Section 2.2 has been substantially revised; this comment is not relevant for the revised section.
750	21	17	21	17	Table 2.4' should be' Figure 2.4' [Robert Shapiro, United States of America]	Both table 2.4 and Figure 2.4 have been removed from the main text. We would like to stress that Sect 2.2 has been deeply revised in order to take into account reviewer suggestions.
28032	21	20	25	42	Aspects of the section "geophysical characteristics …" are shown in this Ch 2. However the relevant information on the surveyed scenarios (i.e. precise timing of reaching net zero-emissions; 1.5°Cpathways 2040-2065/2Cpathways after 2065) is missing in the Chapter-2-ExSummary and even subsequently not picked up in the overall SPM adequately. [Germany]	This points is now clearly highlighted in the revised chapter 2 and is now emphasized in the ES
42264	21	20			path ways ===> pathways [Egypt]	taken into account
42980	21	22	24	7	This section does not cover rate of warming, though it is briefly mentioned in the "to 2100" section that follows. Rate of warming is important in the near-term because of the proximity to hitting 1.5C and as a means to track the reductions of emissions that are necessary to achieve the well below 2C goal. Rate of warming is also relevant to Article 2 of UNFCCC: "ARTICLE 2 OBJECTIVE The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner." [Durwood Zaelke, United States of America]	We agree with the reviewer. Section 2.2 now assessed this point in the light of most up-to-date version of the scenario database.
752	22	1	22	1	Table 2.1' should be' Figure 2.1' [Robert Shapiro, United States of America]	rejected— Table 2.1 display the scenario category
52814	22	1	22	3	Consistency between the order of the key geophysical characteristic in this para and the figure 2.5 (temperature overshoot and time of reaching net zero versus time of reaching net zero and temperature overshoot) [Iulain Florin VLADU, Germany]	changes the other of figures
13848	22	4	22	6	Review the order of bibliographic citations and missing years [Poot-Delgado Carlos, Mexico]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
55532	22	4	22	4	The following reference focuses on stringent mitigation pathways and illustrates these two dimensions (overshoot / timing of reaching net-zero CO2 emi), amongst others, at global, national and local levels (23 case studies - focus on the energy system). It could be added here. Giannakidis G., K. Karlsson, M. Labriet, B. Ó Gallachóir (eds.), 2018. Limiting Global Warming to Well Below 2°C: Energy System Modelling and Policy Development. Springer, Lecture Notes in Energy, in press. [Maryse Labriet, Spain]	this reference has been included in the revised text.
22554	22	5		6	add "," after "et al." (nine cases in these two lines) [LUIS VALDES, Spain]	taken into account
11736	22	6	22	8	The tiny number of pathways that stick below 1.5 for the whole century is a significant point and should be made clearer/more transparent. Deserves prominence in the executive summary. [United Kingdom (of Great Britain and Northern Ireland)]	This points is now clearly highlighted in the revised section 2.2. However, since our assessment mainly rely on an ensemble of opportunity, this finding has been assessed as not robust. This is why we chose to avoid mentioning non robust statement in the ES.
22556	22	6			add "year" in citation or delete the reference (one case in this line) [LUIS VALDES, Spain]	taken into account
35784	22	6			Year of the reference to be added. [India]	the year of the reference has been included
47784	22	6	22	6	Please check: "Holz et al." Year missing in citation [Sarah Connors, France]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
47884	22	6	22	6	Please check the citation: Holz et al……incomplete; no year; not available in reference section [Sarah Connors, France]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
53484	22	6	22	8	It would be useful to list references to the studies where those 10 non-overshoot scenarios come from. Since this is such a limited number of studies and since these scenarios are likely of particular interest to many users of the SR1.5, it seems reasonable to provide these references, rather than expecting users to be able to extract the information from the scenario DB. [Christian Holz, Canada]	the references of these scenarios is included in the main text
54610	22	6	22	6	year is missing from Holz et al. [Qudsia Zafar, Pakistan]	the year of the reference has been included
56884	22	7	22	7	Makr it cleat that this is because teh modelligh commnity chose not to model strict 1,5 pathways? [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Too technical here

Comment No	From Page	From Line	To Page	To Line	Comment	Response
754	22	11	22	11	Table 2.5' should be' Figure 2.5' [Robert Shapiro, United States of America]	This error in table reference has been corrected
11738	22	11	22	13	That net zero needs to be reached before 2050 in most scenarios needs to be communicated more clearly - in particular in the executive summary and SPM (which states "around or shortly after 2050"). [United Kingdom (of Great Britain and Northern Ireland)]	The importance of the timing of net-zero CO2 emissions is now highlighted in the ES and hence in the SPM.
18052	22	11	22	23	It would be useful to summarise this information in a table. Table 2.5 captures much of. However, metrics such as the timing of peak emissions and CO2 neutrality are amongst the most policy relevant. This paragraph (&/or a table) should also distinguish between 2°C pathways with >66% probability and those with a lower probability. Particularly because >66% pathways are more in keeping with the Paris goal (well below 2°C) and presumably require carbon neutrality earlier. [Andrea TILCHE, Belgium]	improve Table 2.5 keep policy relevant ES; need to simplify this table
50190	22	11	22	13	This statement ("Both pathways …..reach carbon neutrality (or net zero anthropogenic CO2 emssions) BEFORE 2050 in most of these scenarios.") is avery important one, that needs to be in the Exec Summary and the SPM. Unfortunately, weaker variants of this statement are now in the Exec Summary and the SPM. I see no reason why at the summary level this statement needs to be weakened. [Bert Metz, Netherlands]	This points is now clearly highlighted in the revised chapter 2 and is now emphasized in the ES.
18054	22	12	22	12	Is "carbon neutrality" the same as "net zero", or are these mentioned as different (alternative) target indicators? If the same, it would be good to use only one of them throughout, and it should not be "carbon neutrality", as it is a poorly defined and loaded term (overused in loose language with very different meanings). In any event, the term(s) used should be clarified when they first appear, not on p 22 of Chapter 2, after having been used many times. [Andrea TILCHE, Belgium]	The wording of this paragraph has been improved accordingly
756	22	17	22	17	Table 2.1' should be' Figure 2.1' [Robert Shapiro, United States of America]	rejected— Table 2.1 display the scenario category
42266	22	19			overshoots ===> overshot [Egypt]	taken into account
56678	22	20	22	21	The same goes.. Unclear. [Kirsten ZICKFELD, Canada]	the reference list in section 2.2 has been updated and corrected. It now includes accepted references.
5970	23				poor quality figure [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	all the figures of sect 2.2 have changed during the revision of section 2.2.
39376	23		23		Figure 2.5 doesn't have a good definition [Olga Alcaraz, Spain]	all the figures of sect 2.2 have changed during the revision of section 2.2.
181	23		23	3	Please check "60%-60%" in the first line of figure 2-5(c) is correct. [Mingshah Su, China]	all the figures of sect 2.2 have changed during the revision of section 2.2.
5372	23		23		The picture seems not clear between the colour. Suggest to increase the resolution. [Sulistyawati Sulistyawati, Indonesia]	all the figures of sect 2.2 have changed during the revision of section 2.2.
51686	23	1	23	1	This picture looks fuzzy, please use a higher resolution image. [Jason Donev, Canada]	all the figures of sect 2.2 have changed during the revision of section 2.2.
3700	24				Suggestion: I believe that if you rotate 180 degrees the headings of the table 2.5 they would be much easier to read. [Castor Muñoz Sobrino, Spain]	all the figures of sect 2.2 have changed during the revision of section 2.2.
19544	24				Table 2.5 There seems to be an error there in the table, as the numbers for below 2°C with 50% and 66 % likelihoods are identical. [Jennifer Morgan, Netherlands]	table 2.5 has been moved into the technical annex and included referees suggestions and corrections
19546	24				Table 2.5 Please add, into the caption, a sentence that gives an example on how to read the table, if one wants to understand how the 1.5°C scenarios relate to likelihoods of staying below 2°C. Something like this: So-called 1.5°C scenarios, that include the first three categories, include scenarios that imply at least a 85 % probability of staying below 2°C in 2100. [Jennifer Morgan, Netherlands]	Table 2.5 has been removed from the main text. And move in the technical annex. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figures and table.
3208	24	1	24	1	Second row (column names), 4th column should be "peak year" (or something like that), right? [Vassilis Daioglou, Netherlands]	table 2.5 has been moved into the technical annex and included referees suggestions and corrections
28034	24	1	24	7	In order to enhance readability turn Table 2.5 to 90° to capture hole size of page [Germany]	table 2.5 has been moved into the technical annex and included referees suggestions and corrections
44826	24	1	24	1	Legend should be put above the Table 2.5. [Hiroaki Kondo, Japan]	table 2.5 has been moved into the technical annex and included referees suggestions and corrections
44828	24	1	24	1	Unit for Subm. and Harm Cummulative CO2 emissions should be added probably in legend of Table 2.5. [Hiroaki Kondo, Japan]	table 2.5 has been moved into the technical annex and included referees suggestions and corrections
45340	24	1	24	1	Table 2.5 Give the unit of cumulative CO2 emissions in the titles of the table columns. [Tuomo Kalliokoski, Finland]	table 2.5 has been moved into the technical annex and included referees suggestions and corrections
46390	24	1	24	6	In Table 2.5, columns of Subm.and Harm. Cummulative CO2 emissions do not have physical units. As the report data shows the unit looks Gt of CO2. [Ijaz Ahmad, Pakistan]	Table 2.5 has been removed from the main text. And move in the technical annex. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figures and table.
46392	24	1	24	6	In Table 2.5, if we compare Subm.and Harm. Cummulative CO2 emissions for Below 1.5 oC and Return 1.5 oC scenario categories, CO2 emissions of Return 1.5 oC are higher for the period 2016-2100 and so the higher CO2 concentration in atmosphere. However, if we see Table 2.4, Page 2-16, CO2 budgets are lower for TRB as compared with TPB in case of 1.5 oC. So, there looks inconsistency in term of CO2 budgets and CO2 emissions when Table 2.4 and Table 2.5 are compared. There is need to recheck these cummulative quantities. [Ijaz Ahmad, Pakistan]	Table 2.5 has been removed from the main text. And move in the technical annex. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figures and table.
51688	24	1	24	1	Label for table goes at the top. [Jason Donev, Canada]	table 2.5 has been moved into the technical annex and included referees suggestions and corrections
13900	24	2	24	2	Table 2.5. Do we really know these to 4 significant digits? Or wouldn't it be more accurate to just show 2 significant digits here? [Natalie MAHOWALD, United States of America]	Table 2.5 has been removed from the main text. And move in the technical annex. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figures and table.
34694	24	2	24	6	Seccion 2.2.3 Table 2.5 requires to clearly indicate the abbreviations and the texts of the headings for example "Prob Exceed 1.5 ° C" [Mexico]	table 2.5 has been moved into the technical annex and included referees suggestions and corrections
56886	24	2	24	2	break up/simplify this table? [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Table 2.5 has been removed from the main text. And move in the technical annex. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figures and table.
182	24	3	24	3	It may be better to replace columns by row in "in the last two columns". [Mingshah Su, China]	table 2.5 has been moved into the technical annex and included referees suggestions and corrections

Comment No	From Page	From Line	To Page	To Line	Comment	Response
51690	24	3	24	3	The term 'NA' has different meanings, I don't believe that the definition given here is actually how it's used in this table. [Jason Donev, Canada]	table 2.5 has been moved into the technical annex and included referees suggestions and corrections
42268	24	4			exhibits ===> exhibit [Egypt]	taken into account
44170	24	5	24	5	CO2, 2 should be subscript [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
44830	24	5	24	5	CO2-->CO2 [Hiroaki Kondo, Japan]	taken into account
47786	24	5	24	5	Kindly use: CO2 [Sarah Connors, France]	taken into account
5748	24	27	24	27	“net negative CO2 emissions” has not been defined. A sentence defining the meaning of “negative” emission is needed. [Govindasamy Bala, India]	The wording of this paragraph has been improved accordingly
35786	24	27			“net negative CO2 emissions” needs to be defined. [India]	The wording of this paragraph has been improved accordingly
62078	25		27		Remark: The section between tables is labelled "First order draft", although this content has been substantially improved from FOD. [Antoine Bonduelle, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
37	25		95		The page header says 'first order draft' instead of second order draft [Risto Herrala, United States of America]	Noted and corrected.
183	25		95		The"First Order Draft"in line 0 of the pages should be "Second Order Draft". [Mingshah Su, China]	Noted and corrected.
28036	25		95		Template says: First Order Draft, which we assume is just an editing mistake, but should nevertheless be corrected. [Germany]	Noted and corrected.
51692	25	1	95	1	My copy says 'first order draft' on these pages?? [Jason Donev, Canada]	Noted and corrected.
758	25	2	25	2	Table 2.5' should be' Figure 2.5' [Robert Shapiro, United States of America]	rejected— this point refers to Table 2.5
5972	25	2			poor quality figure. This comment applies to many figures withing chapter two. Please increase the figures quality [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	taken into account
760	25	3	25	3	Table 2.1' should be' Figure 2.1' [Robert Shapiro, United States of America]	rejected— Table 2.1 display the scenario category
21446	25	6	25	21	The description of the pathways in this paragraph suggest a probablistic interpretation of the pathway features (e.g., probability of reaching 1.5 vs. 2 degrees) which should be avoided. Actually, the introduction to Section 2.3 (page 26, line 33 to page 27, line 10) describes why avoiding such presentation of pathways should be avoided, so applying these guidelines also in Section 2.2.3.2 would be appreciated. [Volker Krey, Austria]	We thanks the reviewer for this suggestion. It is now taken into account in the revised text. Besides, we would like to stress that our assessment now rely key geophysical features of mitigation pathways. The use of probability remains limited to the achievement of the long-term climate goal of the paris agreement.
31856	25	6	25	7	It is not clear whether the 167 2C pathways are in addition to the 118 1.5C pathways, or inclusive of, in the text: "With a 50% likelihood, 118 mitigation pathways out of 578 limit median temperature below 1.5°C and 167 to below 2°C by 2100" [Stuart Capstick, United Kingdom (of Great Britain and Northern Ireland)]	section 2.2 has been substantially revised; this comment is not relevant for the revised section.
42270	25	6			limit ===> limits [Egypt]	taken into account
762	25	10	25	10	Table 2.5' should be' Figure 2.5' [Robert Shapiro, United States of America]	rejected— this point refers to Table 2.5
11740	25	12	25	14	This is an important point that deserves greater prominence and communication to policy makers in exec summary and SPM [United Kingdom (of Great Britain and Northern Ireland)]	to be put upfront
45342	25	12	25	14	Low confidence here in the temperature outcomes. Is that consistent with previous text? See earlier comments. [Tuomo Kalliokoski, Finland]	This section has been revised and this point has been clarified.
46578	25	12	25	12	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	IPCC language has been checked and updated in the revised section 2.2. We hope now that the revised section 2.2 now fit the IPCC standard
30918	25	15	25	16	“Pathways limiting warming below 1.5°C over the 21st century or by 2100 all reach net-zero CO2 emissions in the period 2040–2065” – this seems to be a critical conclusion, and should be in the ES. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	to be put upfront
55466	25	16	25	16	Delete "Due to the inertia in the carbon cycle" - the factors involved are not only carbon cycle inertia but equally climate system time scales and lifetimes of other forces. The remaining statement is more robust with this phrase deleted. [Andy Reisinger, New Zealand]	correct to take into account
56680	25	16	25	16	I doubt that the earlier temperature peak is related to carbon cycle inertia. I think it is largely driven by a decline in emission of short-lived forcers. [Kirsten ZICKFELD, Canada]	Both are playing here, to clarify this point
56888	25	16	25	21	This non-simulataneity point is worth drawing out becasie its touches on the somewhat tendentious intepretationns of balancing sources/sinks in chapter 1 [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	agree need to be discussed with ch1
11742	25	19	25	21	The observation r.e. ppm is quite stark and would warrant greater prominence, through inclusion in the SPM [United Kingdom (of Great Britain and Northern Ireland)]	to put upfront
50192	25	19	25	21	This is a key message that needs to be in the Exec Summary and the SPM. [Bert Metz, Netherlands]	to put upfront
5750	25	25	25	25	because most anthropogenic climate forcers cannot be reduced below zero” does not sound right. Should it be changed to “because forcing from most anthropogenic climate forcers cannot be reduced below zero” [Govindasamy Bala, India]	section 2.2 has been substantially revised; this comment is not relevant for the revised section.
35788	25	25			“because most anthropogenic climate forcers cannot be reduced below zero” may be reframed as “because forcing from most anthropogenic climate forcers cannot be reduced below zero” [India]	take into account
42756	25	30	25	36	The warming from aerosol reductions comes from unmasking the warming from the forcing already in the atmosphere. Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1002293107 (“CO2 (1.65 Wm?2) and the non-CO2 GHGs (1.35 Wm?2) have added 3?(range: 2.6–3.5) Wm?2 of radiant energy since preindustrial times. The non-CO2 GHGs are methane (CH4); nitrous oxide (N2O); and halocarbons (HCs), which in- clude CFCs, HCFCs, HFCs; and ozone in the troposphere. The 3-Wm?2 energy should have led to a warming of 2.4 °C (14). The observed warming trend (as of 2005) is only about 0.75 °C (15), or 30% of the expected warming. Observations of trends in ocean heat capacity (16) as well as coupled ocean–atmosphere models suggest that about 20% (0.5 °C warming) is still stored in the oceans (17). The rest of the 50% involves aerosols or particles added by air pollution. BC aerosols in soot absorb solar radiation and add 0.5 (inner white circle) to 0.9 Wm?2. SON_Mix of particles from fossil fuel and biomass combustion act like mirrors and reflect solar radiation back to space (?2.1 Wm?2; the transparent blue-shaded circle). The resulting dimming effect at the surface has been observed in land stations around the world (18, 19). The net aerosol masking effect (?2.1 + 0.9 = ?1.2 Wm?2), along with the 0.2-Wm?2 cooling by land surface changes, accounts for the missing 50% of the warming by GHGs. There is at least a 3-fold uncertainty in current estimates of the aerosol masking effect (the inner and outer circle of the net forcing in the figure), which has significant implications for 21st century warming as explained later.”). [Kristin Campbell, United States of America]	The revised section 2.2 now provides a quantitative assessment of the role of non-CO2 climate forcers (including aerosols) on the geophysical characteristics or mitigation pathways and remaining carbon budgets. Besides, our assessment now includes an update list of reference

Comment No	From Page	From Line	To Page	To Line	Comment	Response
42982	25	30	25	39	The warming from aerosol reductions comes from unmasking the warming from the forcing already in the atmosphere. See Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1002293107 ("CO2 (1.65 Wm?2) and the non-CO2 GHGs (1.35 Wm?2) have added 3?(range: 2.6–3.5) Wm?2 of radiant energy since preindustrial times. The non-CO2 GHGs are methane (CH4); nitrous oxide (N2O); and halocarbons (HCs), which include CFCs, HCFCs, HFCs; and ozone in the troposphere. The 3-Wm?2 energy should have led to a warming of 2.4 °C (14). The observed warming trend (as of 2005) is only about 0.75 °C (15), or 30% of the expected warming. Observations of trends in ocean heat capacity (16) as well as coupled ocean–atmosphere models suggest that about 20% (0.5 °C warming) is still stored in the oceans (17). The rest of the 50% involves aerosols or particles added by air pollution. BC aerosols in soot absorb solar radiation and add 0.5 (inner white circle) to 0.9 Wm?2. SON_Mix of particles from fossil fuel and biomass combustion act like mirrors and reflect solar radiation back to space (?2.1 Wm?2; the transparent blue-shaded circle). The resulting dimming effect at the surface has been observed in land stations around the world (18, 19). The net aerosol masking effect (?2.1 + 0.9 = ?1.2 Wm?2), along with the 0.2-Wm?2 cooling by land surface changes, accounts for the missing 50% of the warming by GHGs. There is at least a 3-fold uncertainty in current estimates of the aerosol masking effect (the inner and outer circle of the net forcing in the figure), which has significant implications for 21st century warming as explained later."). [Durwood Zaelke, United States of America]	The revised section 2.2 now provides a quantitative assessment of the role of non-CO2 climate forcers (including aerosols) on the geophysical characteristics or mitigation pathways and remaining carbon budgets. Besides, our assessment now includes an update list of reference
42272	25	31			reached at the year ===> reached the year [Egypt]	taken into account
13488	25	38	25	38	Temperature changes between 2081 and 2100 offer a complementary approach [Sergio Aquino, Canada]	section 2.2 has been substantially revised; this comment is not relevant for the revised section.
39126	25	38	25	42	This is a profoundly important statement that needs highlighting, emphasising the importance of a 1.5C target for future generations too. [Lindsey Cook, Germany]	this statement has been put upfront in the revised section 2.2
50194	25	38	25	42	This paragraph raises questions about the definition of the 2 degree limit. Does this indeed mean that there are pathways in the literature that go beyond 2 degrees C, while they are at or below 2C by the year 2100? If that is the case then it would be much clearer if these pathways are placed in a separate class, and not merged with pathways that do not go beyond 2C. [Bert Metz, Netherlands]	This paragraph has been improved and clarified.
45344	25	42	25	42	This is only partly true. In Fig. 2.5 only small number of pathways limiting warming to 2 C show still increasing temperatures at the end of century. Clear majority shows declining temperatures. [Tuomo Kalliokoski, Finland]	This paragraph has been improved and clarified.
60056	25	42	25	42	You could put high confidence after this finding. [United States of America]	Confidence statement has been assigned to this findings
5374	26		26		The picture seems not clear between the colour. Suggest to increase the resolution. [Sulistyawati Sulistyawati, Indonesia]	all the figures of sect 2.2 have changed during the revision of section 2.2.
13902	26	2	26	2	Figure 2.6: For the value on the vertical coordinate (year of median peaek temperature), it looks like you averaged to 10 year intervals, but not for the x-axis value. I think this figure would look much cooler if you didn't average to decades, but instead used the eral value. It sholudnt' be that hard to redo, so I would recommend you try. [Natalie MAHOWALD, United States of America]	improve this figure but this is related to the temporal resolution of IAM/MAGICC outcomes (5 years)
39378	26	2	26	2	Figure 2.6 doesn't have a good definition [Olga Alcaraz, Spain]	all the figures of sect 2.2 have changed during the revision of section 2.2.
42274	26	2			Timing ===> the timing [Egypt]	grammar, spelling have been improved in the revised section 2.2.
56890	26	2	26	2	Only mildly intersted in this figure [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Figure 2.6 has been removed from the main text. We would like to stress that section 2.2 has been deeply revised and now includes a smaller set of Figure.
42276	26	3			function ===> a function [Egypt]	grammar, spelling have been improved in the revised section 2.2.
42278	26	3	26	4	end-of- centur ===> end-of-century [Egypt]	all the figures of sect 2.2 have changed during the revision of section 2.2.
42280	26	4			budget ===> the budget [Egypt]	grammar, spelling have been improved in the revised section 2.2.
42282	26	4			year ===> the year [Egypt]	grammar, spelling have been improved in the revised section 2.2.
4568	26	9	60	44	As is stated in several parts of the report, economic activity is an important driver for GHG emissions (see for example page 9 line 35-27, page 39 line 27-28). Thus, a reduction in economic activity should prove a viable strategy to reduce greenhouse gas emissions apart from more technical solutions such as renewable energies and energy efficiency (See Victor 2012 "Growth, degrowth and climate change: A scenario analysis", Ecological Economics 84). This option is not openly discussed throughout the report. One reason probably being that it is not considered a desirable pathway. The Working Group III Contribution to the IPCC Fifth Assessment Report however stated that „Studies of emotional well-being do identify clear satiation points beyond which further increases in income no longer enhance emotional well-being (medium evidence, medium agreement)." (continued in next comment) [Kai Kuhnhenn, Germany]	See response to Comment ID 4570 (=second part of the comment)
4570	26	9	60	44	(continued from last comment) It is disappointing that this line of thought has not been expanded on in this report since a stopping of economic growth or even a reduction of economic activity might very well be compatible with an increase in welfare as long as it is designed (degrowth by design, not by disaster). Understanding that the IPCC relies on the research of others and considering that most models use equilibrium or cost minimization model-based frameworks, it might be impossible for the IPCC to present a comprehensive analysis of post-growth or degrowth strategies. However, these options should at least be discussed and the lack of research especially in the modeling community pointed out. As long as this is not done, the report fails to present possible mitigation pathways that would be especially interesting with regards to ambitious mitigation targets. Instead it reproduces economic assumptions that unlimited economic growth is not only possible but desirable. [Kai Kuhnhenn, Germany]	Rejected. The available mitigation scenarios and 1.5°C pathways span a wide range of economic growth assumptions. This is now shown in a new figure in Section 2.3.1. The impact of GDP on emissions is mostly mediated via energy demand and to a much lesser extent industrial process emissions. We cover the case of very low energy demand scenarios in the assessment (Grübler et al., 2018, study), even though this case was motivated by energy efficiency increases rather than de-growth.
10504	26	9	26	9	The title of section 2.3 is Overview of 1.5C mitigation pathways, while in the section 2.2 these pathways have been used in the text. It is better to introduce them before section 2.2 to make the text consistent. [Hong Yang, Switzerland]	Noted. However, we stick with the Section title because it provides an overview of the emissions and systems transformation in 1.5°C pathways, while Section 2.4. discusses sector transformations and Section 2.2 discusses geophysical characteristics.
22718	26	10	30	6	It may be helpful to include somewhere within this or next section a figure similar to Figure 1 and Figure 2 from Obersteiner et al., (2018). How to spend a dwindling greenhouse gas budget. Nature Climate Change 8, 2-12, which could clearly illustrate different CDR methods. [Katarzyna B Tokarska, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. CDR is discussed in Section 2.3.4, overlap with discussion in 2.3.2.2 was reduced, Table 2.6 was removed.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
13102	26	11	26	16	Delete the text "Stabilizing global mean temperature increase at any level requires global CO2 emissions to become net zero at some point in the future (Collins et al., 2013). At the same time, limiting the residual warming of shorter-lived non-CO2 emissions, can be achieved by reducing their annual emissions as far as possible (Section 2.2). This will require large-scale transformations of the global energy-economy-land system, affecting the way in which energy is produced, agricultural systems are organised, and the extent to which energy and materials are consumed (Clarke et al., 2014).". [Eleni Kaditi, Austria]	Rejected. The sentence is factually correct and at the same time a good introduction to the Section. No reason is given why it should be deleted.
21448	26	11	27	17	The introcution of the emissions pathways used in Chapter 2 lacks a systematic introduciton to the five example scenarios shown in Figure 2.7 and on several other occasions in Section 2.3. Having such an introduction upfront would be useful and beyond this I would also suggest to consider applying the concept of these example scenarios beyond Section 2.3, for example in 2.4. [Volker Krey, Austria]	Accepted. Illustrative Scenarios are now introduced in Section 2.3.1.
51694	26	11	26	11	The statement is 'net zero', but it could also be 'net negative' as well. [Jason Donev, Canada]	No, net zero is meant here.
42284	26	12	26	13	shorter- lived ===> shorter-lived [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
46394	26	12	26	13	Shorter-lived need to be changed to short-lived as defined in the report. [Ijaz Ahmad, Pakistan]	Accepted. Changed as requested.
51248	26	12	26	13	In statement "At the same time, limiting the residual warming of shorter-lived non-CO2 emissions", "shorter-lived" needs to be changed to "short-lived" [Muhammad Latif, Pakistan]	Accepted. Changed as requested.
32754	26	13			lived non-CO2 emissions, can be achieved by reducing their annual emissions ... delete comma after "emissions" [Manfred Treber, Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42286	26	13			emissions, ===> emissions [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
56892	26	14	26	14	Include food (not just land) in this list [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The list describes the coupled systems, agriculture has been added. Food is added to the ways of consumption in the next line.
36882	26	20	26	31	A new study has recently evaluated the carbon budgets to remain below both 1.5 and 2.0 °C above preindustrial levels, covered in this section. The study is “Goodwin. P., A. Katavouta, V.M. Roussenov, G.L. Foster, E.J. Rohling and R.G. Williams, (2018) Pathways to 1.5 and 2 °C warming based on observational and geological constraints, Nature Geoscience, doi:10.1038/s41561-017-0054-8.” This study includes exploring the effects of different RCPs. [Richard Williams, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The study is cited in the chapter.
45674	26	20	26	23	A reference to Robiou du Pont et al. 2016 would be relevant here. This reference selects from the IPCC AR5 database, and from Rogelj et al. 2015a the pathways specificatlly consistent with the Paris Agreement mitigation thresholds of well below 2°C and 1.5°C, combined with net-zero emissions by the end of the century. See Figure 1a of Robiou du Pont et al. Nature Climate change 2016 (DOI: 10.1038/nclimate3186). [Yann Robiou du Pont, France]	Rejected. The reference list refers to original publications of pathways.
51696	26	20	36	22	This statement is unclear, could it be rephrased? [Jason Donev, Canada]	Statement was removed assuming the comment refers to pg. 36.
55534	26	20	26	23	The following reference presents 23 analyses of well below 2D scenarios (focus on the energy system) at global, national and local levels. It could be added here. Giannakidis G., K. Karlsson, M. Labriet, B. Ó Gallachóir (eds.), 2018. Limiting Global Warming to Well Below 2°C: Energy System Modelling and Policy Development. Springer, Lecture Notes in Energy, in press. This book shows that a well below 2°C world is feasible but extremely challenging. [Maryse Labriet, Spain]	Accepted. Reference added
49382	26	21	26	23	I have done a work related to mitigation pathways consistent with the 1.5°C target. Please consider including the following paper to this collection of literature. Tanaka K, O'Neill BC (2018) Paris Agreement zero emissions goal is not always consistent with 2°C and 1.5°C temperature targets. Nature Climate Change (in press). [Katsumasa Tanaka, Japan]	Noted. We have restricted the list of references to pathways describing also the underlying systems transformation together with the emissions.
56894	26	24	26	24	pathways derived from integrated assessment models rather than integrated pathways? [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. Integrated pathways may also be generated with other models, e.g. system dynamics models (Holz et al., 2018), if the defining feature of IAMs is not assumed to only be the ability to produce integrated pathways. Of course, such a definition would be possible, but many interpret IAM more narrowly as including an economic / general or partial equilibrium core.
58424	26	26	26	30	we find the sentence describing IEA models as " sectoral….lacking the integrated picture" to be a bit misleading . Suggest instead: "IEA models that cover all energy-related CO2 emissions (about 90% of CO2) but use external estimates for land-use-related emissions and non-CO2 forcers (IEA 2017x [World Energy Outlook 2017], IEA 2017y [Energy Technology Perspectives]" [Andrew Prag, France]	Taken into account. We edited the sentence: which provide detail in their domain of application, and make exogenous assumptions about cross-sectoral or global factors
3326	26	28	26	28	The IEA (2017) reference should be 2 references to IEA/WEO 2017 and IEA/ETP 2017 [Kamel Bennaceur, United Arab Emirates]	Associated text was removed.
57198	26	28	26	28	IEA and IRENA mentioned, but Greenpeace with E[R] scenario is missing, despite of excellent methodolgy, being at least as good as IEA and IRENA. This gap needs to be closed. [Christian Breyer, Finland]	Taken into account. We included a reference to Jacobson to add a representative of the 100% RE literature.
45924	26	30	26	30	Please clarify what integrated picture means. [Deger Saygin, Turkey]	Text was removed.
58288	26	33	26	34	Perhaps "Such scenarios allow answers to specific questions, for example,…"? [Peter Marcotullio, United States of America]	Text was removed.
764	26	34	26	34	scenarios allow to answer' should be 'scenarios allow us to answer' [Robert Shapiro, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42288	26	34			to answer ===> answering [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
52816	26	36	26	37	Replace several with two [Iulain Florin VLADU, Germany]	Accepted. Implemented.
53860	26	36	26	37	Suggetion. Change "This literature can be assessed in several ways, both of which are used in this section." to "This literature can be assessed in several ways, two of which are used in this section. [Patrik Winiger, Netherlands]	Taken into account. Changed to "two ways"
58426	27	1	27	2	Suggest to delete or change the sentence as it is repeted in page 11, line 38 [Andrew Prag, France]	Taken into account. Discussion only occurs in Section 2.3.1 now.
56896	27	2	27	2	ensemble of opportunity is so concise it may convey no meaning to the uninitiated - explain what this means [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. We now clarify: "In other words, it is a collection of scenarios from a diverse set of studies and was not developed with a common set of questions and a statistical analysis of outcomes in mind"

Comment No	From Page	From Line	To Page	To Line	Comment	Response
3210	27	4	27	4	This sentence should either start with "Hence this means…" or "This means…" [Vassilis Daioglou, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42290	27	5			modelling ===> modeling [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
56898	27	8	27	10	This is a good characterisation [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	In principle yes, but sentence was removed due to the fact that the single variation of illustrative scenarios in the Chapter is the addition of IEA ETP in Section 2.4.
47886	28	2	28	2	Please check the citation: Yanguas-Parra et al…..incomplete; no year; not available in reference section [Sarah Connors, France]	Accepted. Reference replaced.
58290	28	3	28	4	Here is where the definitions of pathways and scenarios are important. This first sentence, under the sub-title with pathways is confusing. Perhaps it's two sentences. The first focuses on the soltion oriented "i.e., mitigation" aspects. The second states that it has been show to be possible through scenarios? [Peter Marcotullio, United States of America]	Taken into account. The referenced text was removed, but care was taken concerning the consistent use of pathways vs. scenarios.
39380	28	4	28	4	Between non-CO2GHGs there must be a free space: non-CO2 GHGs [Olga Alcaraz, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
53862	28	4	28	4	Insert space before GHGs [Patrik Winiger, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
766	28	15	28	15	Table 2.1' should be 'Figure 2.1' [Robert Shapiro, United States of America]	Rejected. It is a table.
2080	28	17	28	29	Ignores natural C-cycle feedbacks. A temporary temperature overshoot risks destabilising reservoirs eg permafrost. http://iopscience.iop.org/article/10.1088/1748-9326/9/8/085003/meta [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	This is discussed in Section 2.2.2
22558	28	18			Insert space between "(TBO)of" [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
36648	28	18	28	18	Add space between (TPB) and of. [Anna Harper, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
39382	28	18	28	18	Between (TPB)of there must be a free space: (TPB) of [Olga Alcaraz, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51698	28	18	28	18	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
56076	28	18	28	18	Insert space before of [Patrik Winiger, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
45346	28	21	28	21	Clarify why two different ranges here for TRB? [Tuomo Kalliokoski, Finland]	The concept of TRB has been removed. The two different numbers for the remaining carbon budget are due to two different likelihoods of staying below 1.5°C. Has been clarified.
51700	28	22	28	25	This sentence is very awkward. Break it into several sentences. [Jason Donev, Canada]	Sentence was removed.
768	28	24	28	25	Beside on the likelihood' clumsey!! [Robert Shapiro, United States of America]	Text was removed.
42292	28	24			Beside ===> Besides [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
56078	28	25	28	25	remove the first instance of "on" [Patrik Winiger, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
30920	28	27	28	29	this is a good explanation of the net/gross CO2 point, and needs to be made earlier as well, particularly in regard to Table ES1 [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The ES speaks of net CO2 emissions where relevant.
50196	28	27	28	29	This is a clarifying statement that would be useful for the SPM [Bert Metz, Netherlands]	Noted. The SPM speaks of net CO2 emissions where relevant.
42294	28	28			therefore ===> , therefore, [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
184	28	31	28	34	It is recommended to use "(fossil fuel and cement industrial processes)" instead of "(fossil fuel and industrial processes)". [Mingshah Su, China]	Rejected. We think that industrial process emissions is sufficient.
4310	28	31	28	35	The data on global emission from landuse listed here are significantly different from IPCC AR5 WGI report. You may want expore more literature and provide level of confidence. [Gensuo JIA, China]	Taken into account. Data for land use and fossil fuel emissions were aggregated.
11744	28	31	28	47	It would be clearer to separate out the NDC trajectory and the fact that this essentially exhausts the 1.5 budget from the data on potentially committed fossil fuel reserves. You are not necessarily comparing like with like here and while it is important to recognise that we are committed to a lot of high carbon infrastructure, it would improve clarity to make these into separate points. [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Discussion separated
36650	28	31	28	47	The inclusion of committed emissions from existing infrastructure confuses this paragraph and I think there is more information needed. How much of the committed emissions are embedded in the NDCs? Therefore following the NDC trajectory will exhaust the TPB of 1.5C by 2030, plus there is an additional XX GtCO2 emissions commited due to existing infrastructure. This would help set the stage for the level of negative emissions needed following both the NDC trajectory and assuming all committed emisisons are emitted. [Anna Harper, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. We have separated the discussion of actual carbon commitment and what will be emitted under the NDCs
38394	28	31	28	47	On coals plants and carbon busget pay please attention to the paper from Gonzalez-Eguino, M. Ribera Teresa (2017) that actually shows under which condictions for lifetime of coal plants and CCS availability will 1.5 targe be overshooted. Current operating and projected coal plants can alone make the 1.5 target infesiable if projects are not canceled and current plants are not phase out. González-Eguino, M., Olabe, A. and Ribera, T. (2017), New Coal-Fired Plants Jeopardise Paris Agreement, Sustainability, 9 (2) [Mikel González-Eguino, Spain]	Accepted. Reference was included in assessment.
56900	28	31	28	47	Could this paragraph about non-overshoot be a separate section [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. We think it fits nicely here, the section is all about what it takes to not overshoot.
13104	28	32	28	34	Delete the text "Recent global CO2 emissions over the 2011–2015period were 180 ±10 GtCO2 (fossil fuel and industrial processes) and 25 ± 15 GtCO2 (land use change) (Le Quéré et al., 2017).". [Eleni Kaditi, Austria]	Rejected. This is a factual statement and relevant for the discussion.
36646	28	33	28	33	Add space between 2015 and period. [Anna Harper, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

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39384	28	33	28	33	Between 2011–2015period there must be a free space: 2011–2015 period [Olga Alcaraz, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44172	28	33	28	33	needs space between "2011–2015 period" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51702	28	33	28	33	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
56080	28	33	28	33	Insert space before "period" [Patrik Winiger, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58006	28	33	28	33	There is a spacing issue in the phrase "2011–2015period." [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42758	28	35	28	47	Emissions of non-CO2 forcers can further reduce the available budget. Rogelj et al 2015, Impact of short-lived non-CO2 mitigation on carbon budgets for stabilizing global warming, Envtl. Research Letters, doi: 10.1088/1748-9326/10/7/075001. [Kristin Campbell, United States of America]	This is true and discussed in Section 2.2.2.
42984	28	35	28	47	Emissions of non-CO2 forcers can further reduce the available budget. See Rogelj et al 2015, Impact of short-lived non-CO2 mitigation on carbon budgets for stabilizing global warming, Envtl. Research Letters, doi: 10.1088/1748-9326/10/7/075001. [Durwood Zaelke, United States of America]	This is true and discussed in Section 2.2.2.
51704	28	38	28	38	Does 'power sector' mean 'electrical power sector' here? It's ambiguous. [Jason Donev, Canada]	Yes, power sector and electricity sector are synonymous.
60058	28	39	28	43	Old reference here. What about new IEA data from 2017? [United States of America]	Noted, but committed emissions from fossil fuel infrastructure would need to be estimated in a report. It is unclear which IEA report the reviewer comment refers to. We include newer references on committed CO2 emissions from coal power plants.
2082	28	40			reference outdated, new coal is not necessarily growing as fast now [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Reference deleted.
19550	28	41	28	43	Committed emissions from existing coal fired power plants built until the end of 2016 are estimated to add up to roughly 200 GtCO2 and a further 100–150 GtCO2 from coal fired power plants are under construction or planned (Edenhofer et al., 2017; Yanguas-Parra et al.) There was a very significant reduction in coal fire power project pipeliness in 2016/17, which is not clearly included here. See for example: Christine Shearer, Nicole Ghio, Lauri Myllyvirta, Aiqun Yu, dan Ted Nace: Boom and Bust, 2017 http://m.greenpeace.org/india/Global/india/docs/BoomAndBust_2017_EMBARGO.pdf , quotes: “After a decade of unprecedented expansion, the amount of coal power capacity under development worldwide saw a dramatic drop in 2016, mainly due to shifting policies and economic conditions in China and India,… Key developments include: A 48% drop in pre-construction activity, a 62% drop in construction starts, and a 19% drop in ongoing construction. As of January 2017 the amount of coal power capacity in pre-construction planning was 570 gigawatts (GW), compared to 1,090 GW in January 2016.” [Jennifer Morgan, Netherlands]	Accepted. Reference was included in assessment.
42296	28	41			coal fired ===> coal-fired [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42298	28	42			coal fired ===> coal-fired [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
22560	28	43			add "year" in citation or delete the reference (one case in this line) [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
35790	28	43			Year of the reference to be added. [India]	Noted. Reference removed and replaced with another reference from the peer-reviewed literature.
44174	28	43	28	43	needs space between "al.). The expected" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47788	28	43	28	43	Please check: "Yanguas-Parra et al." year missing in citation [Sarah Connors, France]	Reference was removed.
54612	28	43	28	43	Yanguas-Parra et al. reference correction [Qudsia Zafar, Pakistan]	Noted. Reference removed and replaced with another reference from the peer-reviewed literature.
39128	28	44	28	48	This is where you need to highlight for policy makers, the message of your findings. For example, what actions have the most effective GHG mitigation in the power sector? Highlight. Make it clear. These people have limited time and near clear messages in order to make the appropriate decisions [Lindsey Cook, Germany]	Taken into account. The message was highlighted prominently in the ES and SPM, and same goes for the associated systems transformation discussed in other (sub) sections.
50198	28	46	28	47	This is an important statement for the Exec Summary and the SPM. Add "and the TRB" after "TPB", as it also applies there and policy makers are most likely going to use the TRB, rather tahn the TPB. [Bert Metz, Netherlands]	Noted. The TRB estimate was dropped from the chapter due to large uncertainties in the Earth system response to overshoot.
60060	28	46	28	47	Would a comment on CCUS here be valuable? These all assume all CO2 is emitted, correct? [United States of America]	Rejected. The amount of CO2 in the NDCs depends on policies and targets.
60062	28	47	28	47	An important point to amplify. [United States of America]	Taken into account. The message was highlighted prominently in the ES and SPM.
51706	28	49	29	6	One needs to be careful in the framing of this paragraph. Are the upper limits or lower limits what's important? Are you trying to say how much we can safely emit, or how good the models are. The point of this is not cleare. [Jason Donev, Canada]	Accepted. We have reworded the discussion to make the focus on the lower limit clearer.
11746	28	50	28	52	This sentence states that 1.5C consistent pathways incorporate currently committed emissions. On line 37, this is estimated at 500 +/-200. Is there no assumption/scope in the scenarios for these committed emissions from existing infrastructure to be lost (e.g. as the divestment movement would hope to do)? [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Yes, plants can be retired prematurely although the amount of premature retirement is limited. We have removed the link to emissions commitment in the sentence.
51708	28	51	28	51	Does 'power sector' mean 'electrical power sector' here? It's ambiguous. [Jason Donev, Canada]	Yes, power sector and electricity sector are synonymous.
44176	28	55	28	55	needs space between "(5-95 percentile" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51710	28	55	28	55	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
58008	28	55	28	55	There is a spacing issue in the phrase "(5–95percentile range." [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42300	29	4			end use ===> end-use [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42302	29	4	29	5	a lowest ===> the lowest [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
4312	29	8	29	18	Need more literature and evidence to support the statement: "Land use turns from a source into a sink of atmospheric CO2 in 1.5°C pathways." [Gensuo JIA, China]	Taken into account. Sentence was confusing and has been replaced.
18056	29	8	29	8	Delete "Land use turns from a source into a sink" to "Land use turns from a sink into a source". "Land use" is currently a strong sink of atmospheric CO2, even if LUC emissions are deducted. See most recently: "Le Quéré et al. 2017: Global Carbon Budget 2017" AR5 (WGI report) assumed that land would remain a sink until at least teh end of the 21st century under most scenarios. The high levels of bioenergy assumed in this report may turn land use into a source, but then this should also be properly acknowledged and attributed in the discussion of bioenergy and BECCS. If the statement refers to AFOLU (instead of "land use"), then that is what it should say. Even then, it cannot turn into a sink of CO2 (as it is one), but the sink could plausibly become bigger than (and thus fully compensate) the non-CO2 emissions of the sector. [Andrea TILCHE, Belgium]	Taken into account. Sentence was confusing and has been replaced. We meant to say that LUC CO2 emissions turn from positive to negative.
37368	29	8	29	10	Please explicitly discuss to what extent the land-based sink projected in these scenarios has been explicitly shown to be consistent with the contributions expected from increased use of biomass for bioenergy or even BECCS and other mitigation options, e.g. biochar, etc. Was this considered in some of these scenarios, in all of them? If it was considered, how was this implemented? Were all land-use related emissions/sinks been considered, including C-cycle effect beyond afforestation, re-afforestation and deforestation (see Erb et al. 2018 Nature, 553, 73ff, who show that deforestation is only about half of the story and other management activities may play a similarly large role). [Helmut Haberl, Austria]	Taken into account - many of the models of which pathways are assessed in this chapter internalise land use change and thus also the implied emissions. This has now been clarified in an explanatory text in the technical annex. A detailed assessment of the land and carbon cycle implications of this are outside the scope of this Special Report on 1.5°C which has not received a mandate to asses land-use related aspects in much depth. The Special Report on Climate Change and Land will here be able to provide more information.
39130	29	8	29	18	Do these figures include the Nove 2017 study, Natural Climate Solutions. If not, why not? http://www.pnas.org/content/114/44/11645 [Lindsey Cook, Germany]	Noted. The numbers are based on the pathway literature, which does not cover the full breadth of NCS, but individual options, in particular afforestation. This is highlighted in Section 2.3.4 and Griscom et al. is cited. For the assessment of overshoot in this Section, what matters is the amount of AFOLU emissions until they reach zero. Here the pathways show already very strong reductions, mostly due to afforestation.
49588	29	8	29	8	Should a correct formulation be: In (all) 1.5° pathways, land use has to turn from a net source into a net sink. [Karlheinz ERB, Austria]	Noted. Sentence was confusing and has been replaced. We meant to say that LUC CO2 emissions turn from positive to negative.
50200	29	8	29	30	Also provide the numbers for the TRB, as those are more policy relevant, given the enormous challenges of non-overshoot pathways. [Bert Metz, Netherlands]	Noted. Due to large knowledge gaps about the return budget, the attempt to asses it in the Special Report was dropped. This is left for AR6.
51712	29	8	29	8	In this case, care must be taken when framing the discussion. Rather than 'land use turns from a source to a sink ...' it would be stronger to say 'land use must turn from a source to a sink in order to follow the 1.5C pathways' [Jason Donev, Canada]	Noted. Sentence was confusing and has been replaced. We meant to say that LUC CO2 emissions turn from positive to negative.
56456	29	8	29	8	Getting Russia deploying activities to create CO2 uptake in thawed areas may be a diplomatic opportunity for many countries [Henk Daalder, Netherlands]	Noted
29496	29	10	29	10	Suggested addition here or elsewhere in the text (bold red): Given the difference in estimating the "anthropogenic" sink between countries and the global carbon modelling community (Grassi et al. 2017), the land-related emission estimates included here are not necessarily directly comparable with countries' estimates at global level . [Giacomo GRASSI, Italy]	Accepted. Sentence added.
770	29	11	29	11	Table 2.6' should be 'Figure 2.6' [Robert Shapiro, United States of America]	Table has been removed.
60064	29	11	29	14	Would it be useful to add Ghectare of land, reforestation, etc vs just GtCO2 in this to give a sense of scale? [United States of America]	Noted. Underlying land demand is not the topic of this subsection, but it is a topic of Section 2.3.4 where Mha numbers are provided.
44832	29	14	29	15	Kriegler et al., 2017a, -->Kriegler et al. (2017a), [Hiroaki Kondo, Japan]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58010	29	14	29	15	The reference "Kriegler et al., 2017a" should be written as "Kriegler et al. (2017a)" since it is used within a sentence. [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42304	29	15			reaches ===> reache [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42306	29	16			therefore ===> , therefore, [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
46580	29	18	29	18	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
60066	29	18	29	18	Given all that has been presented and the wording of this sentence, the assessment of 'medium confidence' is confusing. What stops the assessment from being 'high confidence'? [United States of America]	The medium confidence reflected the uncertainty about the CO2 peak budget.
42760	29	20	29	30	In framing this, need to be careful to avoid the moral hazard of CDR – belief that existence of technologies means we can delay mitigation actions. [Kristin Campbell, United States of America]	Noted. The moral hazard argument is discussed in Section 2.3.4.1.
42986	29	20	29	30	In framing this, it is important to emphasize that CDR is needed in addition to mitigation of CO2 and non-CO2 forcers, and not as a substitute. [Durwood Zaelke, United States of America]	Accepted. We have reworded the text and highlighted that CDR would complement mitigation.
60068	29	20	29	21	Clarify that CDR is "anthropogenic" (i.e., not land/afforestation). [United States of America]	Accepted. This has been clarified.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
51126	29	21	29	23	On the treatment of CDR requirements in scenarios, quoting from Cross-Chapter Box 3.1: "Indeed, scenarios that limit end-of-century warming to below 1.5°C are available that use no (Grubler et al.; van Vuuren et al.) or annual amounts of less than 1.5 GtCO2 yr-1 (Bertram et al.; van Vuuren et al.) – the lower end of the assessed potential range, see Table 1 – in 2050. (...) Because scenario design (which is determined by the research question that is explored) determines to a large degree the deployment of BECCS in scenarios, averaging over an arbitrary selection of scenarios does not contain much valuable information." (p. 3-175) [Linda Schneider, Germany]	Noted. This section talks about CDR, while the quote from Box 3.1 focused on BECCS. We have included a reference to Section 2.3.4 where CDR is discussed in greater depth.
56902	29	23	29	23	This is a real modellers perspective. This mau=y be true in pathways, in the "real world" CDR would have only iin function - to remove CO2 from the atmosphere. [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. This also makes a difference in the real world - e.g for public perception and for generating investments for deployment.
42308	29	24			year ===> years [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
49590	29	24	29	24	I wonder if the "Carbon neutrality" term should not be avoided here, not to create confusion with carbon-neutral technolgies, maybe by stating "before net emissions are zero" [Karlheinz ERB, Austria]	Noted. We use carbon neutrality and net zero CO2 emissions interchangeably.
42310	29	25			function ===> function, [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44178	29	29	29	29	reads "Threshold Return Budget (TRB, see Section 2.2)" does it need TRB? And does it need to be capitals [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Discussion of TRB was removed from Third Order Draft.
13906	29	32	29	33	CDR fulfils both functions in 1.5°C pathways: it compensates residual CO2 emissions and produces net negative emissions to return warming after a temporary overshoot. this sentence repeats the previous paragraph and does not seem necessary. [Natalie MAHOWALD, United States of America]	Accepted. Discussion was streamlined.
18058	29	32	30	3	The difference between gross and net CO2 emissions requires clarification. For example, lines 34-36 apears to draw a logical connection between up 320 GtCO2 of CDR and up to 1050 GtCO2 gross emissions at peak. Yet it is not obvious how these figures relate to each other. Similarly, in Table 2.6 one would expect that (total CDR + net cumulative emissions = gross emissions). The table should include a note to explain why this is not the case (presumably because the ranges come from scenarios with different characteristics). [Andrea TILCHE, Belgium]	Taken into account. Numbers and table have been removed, paragraph now discusses role of CDR qualitatively.
30922	29	32	29	36	is a pretty clear explanation of why you need CDR to meet a TPB – include in ES? The figure of 30-320 is quite crucial – that's a factor of 10 difference there. What's more likely? Where do 320 and 30 come from? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The range came from the scenario database, reasons for the range are manifold (scenario design, model assumptions). Hard to make a likelihood. statement. 100 GtCO2 by mid century would mean ca. 5 GtCO2/yr in 2050. So anything above 100 GtCO2 by 2050 is quite massive.
42312	29	32			fulfils ===> fulfills [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51714	29	32	29	32	This statement is also a framing problem about CDR. This implies that the technology is far more available than it actually is. Nature can't be fooled by smooth talking. We have *not* proven this technology at scale yet, and this sentence would be better served as a call to seriously invest in CDR advancement. [Jason Donev, Canada]	Accepted. We added a qualifying sentence pointing to the concerns about feasibility and sustainability.
63194	29	32	29	33	Sentence not clear. [Greg Rau, United States of America]	Text has been reworded to clarify the meaning.
36652	29	33	29	33	Should 'return' be 'reduce'? [Anna Harper, United Kingdom (of Great Britain and Northern Ireland)]	No, should be return. Text was reworded to clarify the meaning.
772	29	36	29	36	Table 2.6' should be 'Figure 2.6' [Robert Shapiro, United States of America]	Table has been removed.
13490	29	37	29	37	start new paragraph at line 37: The assessment … [Sergio Aquino, Canada]	Text was reshuffled and these sentences now precede the discussion of overshoot.
49592	29	38	29	41	Please state explicitly, which type of CDR is assumed in this scenario, and check if it indeed fulfills the criteria of net carbon absorption (additionality of bioenergy plant growth, use of biomass that would otherwise decay). Please also state the area demand for various land-use types assumed in these scenarios, and explicitly assure that managment effects on biomass stocks, that are about the size of all deforestation effects (Erb et al., 2018, nature 553, 73-76, doi10.1038/nature25138) are also taken into account. If not all carbon fluxes and dynamics are considered, the result might be biased. [Karlheinz ERB, Austria]	Noted. This scenario was removed from the set of illustrative scenarios due to uncertainty about timely publication of the underlying paper and its availability for the assessment.
51716	29	38	29	38	This is curiously different from how the first order draft talked about this. [Jason Donev, Canada]	Noted. Drafts are revised based on reviewer comments and progress of the assessment in the author team.
45348	29	43	29	44	How so? Please clarify why lower end of gross emissions would be more probable than upper end? [Tuomo Kalliokoski, Finland]	Taken into account. Paragraph was reworded.
13106	29	46	29	46	Delete the text "a". [Eleni Kaditi, Austria]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
28038	29	46	30	3	Table 2.6 seems to indicate that there are no scenarios available that apply less than 380 Gt CO2 negative Emissions / CDR in total. This seems to conflict with earlier statements, e.g. on p29 ln 46 the MESSAGE-GLOBIOM-LED-pathway is singled out for its 190 Gt CO2 removal from afforestation only. Maybe this scenario got dropped due to the 5-95 percentile condition in the table? Else please revisit and ensure consistency. [Germany]	Table has been removed due to overlaps with Section 2.3.4. Yes, scenarios outside the 5-95th percentile range were dropped.
28040	29	46	29	46	Delete "a" before the bracket, otherwise misleading [Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
36654	29	46	29	46	Remove the 'a' after measure. [Anna Harper, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58012	29	46	29	46	There is an extra article "a" in the phrase "CDR measure a (for a total... " that should read "CDR measure (for a total..." [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
39386	29	55	29	55	Between 5–95percentile there must be a free space: 5–95 percentile [Olga Alcaraz, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
51128	30		30		On the treatment of CDR requirements in scenarios, quoting from Cross-Chapter Box 3.1: "Indeed, scenarios that limit end-of-century warming to below 1.5°C are available that use no (Grubler et al.; van Vuuren et al.) or annual amounts of less than 1.5 GtCO2 yr-1 (Bertram et al.; van Vuuren et al.) – the lower end of the assessed potential range, see Table 1 – in 2050. (...) Because scenario design (which is determined by the research question that is explored) determines to a large degree the deployment of BECCS in scenarios, averaging over an arbitrary selection of scenarios does not contain much valuable information." (p. 3-175) [Linda Schneider, Germany]	Noted. Due to the many different scenario designs underlying 1.5°C pathways, resulting ranges become informative.
4476	30	1	30	3	Is it possible to add non-CO2 emissions in Table 2.6 cauculated in equivalent CO2. [Mitsutsune Yamaguchi, Japan]	Table has been removed.
30924	30	1	30	1	Table 2.6 – the numbers here are very confusing, and don't appear to add up [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Numbers are provided in Section 2.3.4, so have been removed from the table.
31412	30	1	30	3	There is no non-CO2 emissions data. Is it possible to add them into this table? [Japan]	Table has been removed.
45350	30	1	30	1	Table 2.6 Is the columns same here, i.e. Mitigation and CRD use, or what? If they are the same as above then change the color of row of column topics and move it above the first "Function…" [Tuomo Kalliokoski, Finland]	Table was removed.
44180	30	1	30	1	It states " hard to decarbonise" Given that according to McAlister (The Solar Hydrogen Economy, ISBN0-9728375-0-7), hydrogen burns at approximately 585 degrees C, which is higher than gasoline (Table 3.5 page 39) and given that McAlister has tested ordinary ICE cars and has shown that the emission particulates on exhaust are less than that on the ordinary air intake. Hydrogen should be looked at as being a means to decarbonise all transport including aviation, shipping and road vehicles. See also The Philosopher Mechanic ISBN-13: 978-1603220446 about using hydrogen in ordinary cars to clean the air and reduce emissions. See page 2-76 lines 14 and 15 [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Noted. Hydrogen is mentioned in Section 2.3.1.2 of the revised chapter
49344	30	1	30	1	the yellow color fill of the first line of the table is perhaps too bright. [Spyros Schismenos, China]	Table was removed.
51718	30	2	30	2	Label for table goes at the top. [Jason Donev, Canada]	Table was removed.
51720	30	2	30	2	This table again implies that CDR is far more ready for deployment than it actually is. [Jason Donev, Canada]	Noted. The table reports on the various uses of CDR in 1.5°C pathways in the literature. Variations in CDR use in these pathways are discussed extensively in Section 2.3.4.
5974	30	3			caption should be above table. This comment applies to all the tables from now on [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
11748	30	3	30	3	Probably a stupid question but will ask it anyway - why is the lower end of the total CDR range so much higher than the combined low end of the ranges of the next three lines? [United Kingdom (of Great Britain and Northern Ireland)]	This is because the sum is performed for each scenario, and there is no scenario that is at the low end of the range for all quantities.
13904	30	3	30	3	Table 2.6: I think the table caption needs more ifnormaion for this figure, since it should be standalone. Please describe what scenarios are included (50% chance of <1.5?), and some citations? Also this figure separates mitigation from CDR, whereas in Chapter 1, we define CDR as a type of mitigation. This table does seem redundant with the more detailed Table 2.9. Do you really need? [Natalie MAHOWALD, United States of America]	Table was removed.
18060	30	6			Since this section focusses on SLCF the section could be renamed as Emission of SLCF [Andrea TILCHE, Belgium]	Rejected - this section is on Kyoto-GHG not SLCF
50208	30	6	37	18	What is missing in this section on Emission evolution is a discussion on the evolution of total GHG emissions. It is in figure 2.8 (which is good and should be in the SPM), but there is no text with clear numbers. That is the reason that the current SPM does not mention the total GHG emission numbers and in particular does not clearly state the date at which net zero GHG should be reached for the various 1.5 C scenario classes. This is politcally very relevant and should be added here and summarised in the SPM. [Bert Metz, Netherlands]	Taken into account - the 2030 emissions benchmarks are now appropriately discussed, with strengths and limitations indicated.
50212	30	6	37	18	I miss a discussion on the concept of CO2 equivalent emissions. This section makes clear that 1.5C strategies have very different implications for the various GHGs. To me this says that continuing the use of CO2 equivalent emissions in policy targets may not be the best approach. I very much would like to see a discussion of this issue in this section. [Bert Metz, Netherlands]	Rejected - Emissions metrics indeed impact temperatures in difference ways. However, they are not exclusively related to 1.5°C pathways and hence are more appropriately dealt with in the AR6. A dedicated box on this topic is included in Chapter 1.
42762	30	7	30	12	SLCF's contribute to the rate of warming, which is important for particularly vulnerable areas like the Arctic and the speed with which we approach tipping points and self-reinforcing feedbacks. Molina M., et al. (2009) Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO2 emissions, PROC. NAT'L. ACAD. SCI. 106(49):20616–20621, 20616 ("We define ''fast-action'' to include regulatory measures that can begin within 2–3 years, be substantially implemented in 5–10 years, and produce a climate response within decades. We discuss strategies for short-lived non-CO2 GHGs and particles, where existing agreements can be used to accomplish mitigation objectives. Policy makers can amend the Montreal Protocol to phase down the production and consumption of hydrofluorocarbons (HFCs) with high global warming potential. Other fast-action strategies can reduce emissions of black carbon particles and precursor gases that lead to ozone formation in the lower atmosphere, and increase biosequestration, including through biochar. These and other fast-action strategies may reduce the risk of abrupt climate change in the next few decades by complementing cuts in CO2 emissions."); Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1618481114; Arctic Monitoring and Assessment Programme (AMAP) (2017) SNOW, WATER, ICE, AND PERMAFROST IN THE ARCTIC: SUMMARY FOR POLICYMAKERS, 8 ("The Arctic is still a cold place, but it is warming faster than any other region on Earth. Over the past 50 years, the Arctic's temperature has risen by more than twice the global average. Increasing concentrations of greenhouse gases in the atmosphere are the primary underlying cause: the heat trapped by greenhouse gases triggers a cascade of feedbacks that collectively amplify Arctic warming."); Overland J. E., Hanna E., Hanssen-Bauer I., Kim S.-J., Walsh J. E., Wang M., Bhatt U. S., & Thoman R. L. (2017) Surface air temperature, in ARCTIC REPORT CARD 2017 ("The greater rate of Arctic temperature increase, compared to the global mean increase, is referred to as Arctic Amplification. Mechanisms for Arctic Amplification include: reduced summer albedo, due to sea ice and snow cover loss; the increase of total water vapor content in the Arctic atmosphere; a summer decrease and winter increase in total cloudiness (Makshtas et al., 2011; Lenaerts et al., 2017); the additional heat generated by newly sea-ice free ocean areas that are maintained later into the autumn (Serreze and Barry, 2011); and the lower rate of heat loss to space in the Arctic relative to the subtropics, due to lower mean surface temperatures in the Arctic (Pithan and Mauritsen, 2014). Arctic warming has also been influenced by past air pollution reductions in Europe (Acosta Navarro et al., 2016)."). [Kristin Campbell, United States of America]	Taken into account - This section, and this chapter more in general, clearly indicates that both short and long-lived climate forcers have to be reduced for limiting warming to 1.5°C. Commenting on the regional impacts of SLCF mitigation goes beyond the scope of this chapter, which focusses on pathways limiting global mean temperature increase to 1.5°C. However, the regional impact of some SLCF reductions is highlighted

Comment No	From Page	From Line	To Page	To Line	Comment	Response
42988	30	7	30	12	Both CO2 and SLCP mitigation are essential for keeping warming to 1.5C. Mitigating SLCPs can cut the rate of warming faster than mitigating CO2, and have a unique role in slowing positive feedbacks. Molina M., et al. (2009) Reducing abrupt climate change risk using the Montreal Protocol and other regulatory actions to complement cuts in CO2 emissions, PROC. NAT'L. ACAD. SCI. 106(49):20616–20621, 20616 ("We define ''fast-action'' to include regulatory measures that can begin within 2–3 years, be substantially implemented in 5–10 years, and produce a climate response within decades. We discuss strategies for short-lived non-CO2 GHGs and particles, where existing agreements can be used to accomplish mitigation objectives. Policy makers can amend the Montreal Protocol to phase down the production and consumption of hydrofluorocarbons (HFCs) with high global warming potential. Other fast-action strategies can reduce emissions of black carbon particles and precursor gases that lead to ozone formation in the lower atmosphere, and increase biosequestration, including through biochar. These and other fast-action strategies may reduce the risk of abrupt climate change in the next few decades by complementing cuts in CO2 emissions."); Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1618481114; Report of the Committee to Prevent Extreme Climate Change (Chairs: V. Ramanathan, M. L. Molina, and D. Zaelke) (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change; Arctic Monitoring and Assessment Programme (AMAP) (2017) SNOW, WATER, ICE, AND PERMAFROST IN THE ARCTIC: SUMMARY FOR POLICYMAKERS, 8 ("The Arctic is still a cold place, but it is warming faster than any other region on Earth. Over the past 50 years, the Arctic's temperature has risen by more than twice the global average. Increasing concentrations of greenhouse gases in the atmosphere are the primary underlying cause: the heat trapped by greenhouse gases triggers a cascade of feedbacks that collectively amplify Arctic warming."); Overland J. E., Hanna E., Hanssen-Bauer I., Kim S.-J., Walsh J. E., Wang M., Bhatt U. S., & Thoman R. L. (2017) Surface air temperature, in ARCTIC REPORT CARD 2017 ("The greater rate of Arctic temperature increase, compared to the global mean increase, is referred to as Arctic Amplification. Mechanisms for Arctic Amplification include: reduced summer albedo, due to sea ice and snow cover loss; the increase of total water vapor content in the Arctic atmosphere; a summer decrease and winter increase in total cloudiness (Makshtas et al., 2011; Lenaerts et al., 2017); the additional heat generated by newly sea-ice free ocean areas that are maintained later into the autumn (Serreze and Barry, 2011); and the lower rate of heat loss to space in the Arctic relative to the subtropics, due to lower mean surface temperatures in the Arctic (Pithan and Mauritsen, 2014). Arctic warming has also been influenced by past air pollution reductions in Europe (Acosta Navarro et al., 2016)."). [Durwood Zaelke, United States of America]	Taken into account - This section, and this chapter more in general, clearly indicates that both short and long-lived climate forcers have to be reduced for limiting warming to 1.5°C. Commenting on the regional impacts of SLCF mitigation goes beyond the scope of this chapter, which focusses on pathways limiting global mean temperature increase to 1.5°C. However, the regional impact of some SLCF reductions is highlighted
56904	30	7	30	12	repetition here [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Agreed - and shortened in order to remove the repetition.
47064	30	12	30	12	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted. All instances of the particular use of these words have been remediated
28042	30	18	30	20	Upon the explicit request of the UNFCCC (UNFCCC Secretariat, 2015), this section provides aggregated emissions levels as a guide, and consistent with their earlier use in the UNFCCC. Although the IPCC generally supports the UN Framework Convention on Climate Change process, it does not carry out specific tasks upon request by the UNFCCC, unless the IPCC plenary decides to do so in response to an invitation by the UNFCCC. Please rephrase this statement in order to avoid misinterpretations, e.g. by deleting the first half of the sentence, or by saying: "honouring a request by the UNFCCC, this section.....". [Germany]	Agreed - this has been edited/removed to ensure that this is not misinterpreted. We removed the sentence.
52752	30	18	30	20	The reference to an explicit request of the UNFCCC to provide aggregated emissions levels consistent with their earlier use in the UNFCCC is absolutely unclear and vague. First, it is unclear if earlier use is referred to use of GWP (100-year time horizon) as a metric for expressing GHGs in terms of CO2 equivalent emissions and if this corresponsds to the GWP values from the IPCC SAR or AR4. But most importantly, the reference to "UNFCCC Secretariat, 2015" (Adoption of the Paris Agreement - Proposal by the President. Bonn, Germany) as explict request from the UNFCCC may not be correct, in particular with the understanding that this is not coming from a COP decision, but likely from a proposal during negotiations. This should be carefully checked and revised as necessary, as it has implications on the contents of this relevant section and the chapter itself. This issue is also related to the comments on the contents in Box 1.2 of Chapter 1. [Iulain Florin VLADU, Germany]	Taken into account - we have removed this specific reference and instead just state the approach taken in the chapter.
49346	30	24	30	24	FIVE ALTERNATIVE EXAMPLE SCENARIOS: only the first image is visible, the other 4 (right side) are too small to read or see their content. Make same size. [Spyros Schismenos, China]	Accepted - All archetype pathways are now the same size, yet still small. The authors trust that high-quality print might help here.
50202	31	1	31	9	This paragraph makes the theoretical case that comparing 2030 global emissions with absolute benchmark values from IAM studies is wrong. But for 1.5C limits thsi is misleading for practical application by policy makers. First, section 2.3.5 on page 60, lines 39-44 notes that most models are unable to meet the 1.5C limit, starting from expected 2030 NDC emission levels, because the necessary transformation rates are too steep. Second, the few scenarios that are available making it to 1.5C from the expected NDC levels, use rather extreme assumptions of emission reduction rates, behavioural change or CDR use. Third, the pathways from the IAM least cost studies that form the basis of the benchmarks are already using very ambitious assumptions on all fronts, and do not cover institutional and societal inertia. Do we really want to point policy makers to high risk "escape routes" by de-emphasising the value of the IAM derived 2030 benchmark emissions levels? [Bert Metz, Netherlands]	Taken into account - the 2030 emissions benchmarks are now appropriately discussed, with strengths and limitations indicated.
42314	31	7	31	8	the more adequate ===> the adequate [Egypt]	Accepted
35792	31	13	31	14	Use 1.5 degree C rather than 1.5C [India]	Taken into account - Scenario category names have been updated, and are introduced in Section 2.1. They typically include a "°" sign.
40820	31	13	31	14	use 1.5oC rather than 1.5C and else where in the text….as this is explicit thjan 1.5C….may mean 1.5 times C.. Which is not the intention….. [NARESH KUMAR SOORA, India]	Taken into account - Scenario category names have been updated, and are introduced in Section 2.1. They typically include a "°" sign.
774	31	14	31	14	Table 2.7' should be 'Figure 2.7' [Robert Shapiro, United States of America]	Accepted - cross-references to tables and figures have been checked
776	31	16	31	16	so as stay within' should be 'to stay within' [Robert Shapiro, United States of America]	Accepted
13108	31	16	31	16	Add the text "to". [Eleni Kaditi, Austria]	Accepted
778	31	18	31	18	Table 2.4' should be' Figure 2.4' [Robert Shapiro, United States of America]	Accepted - cross-references to tables and figures have been checked
3212	31	18	31	18	It is unclear what the "50" means in the "return 1.5C 50" (this is also repeated later on line 57 and beyond) [Vassilis Daioglou, Netherlands]	Taken into account - pathway class labels have been revised for the FGD

Comment No	From Page	From Line	To Page	To Line	Comment	Response
60070	31	24	31	27	Does this say "we don't need to work hard at mitigating methane and N2O"? That is a possible interpretation.... [United States of America]	Noted - it does not say this. The paragraph is on incremental mitigation of CO2 and non-CO2 emissions between 1.5°C and 2°C scenarios. We moved the sentence in order to try to avoid this interpretation.
42316	31	28			supply side ===> supply-side [Egypt]	Accepted
3214	31	30	31	33	This sentence higlights an important caveat of current IAMs, which ultimately also affects their mitigation strategies (or at least that is implied by the rest of the text). Is there an indication of what mitigation measures could help in further reducing these non-CO2 emissions? It isnt clear if this is a oversight of the IAMs, or indeed it is "impossible" to reduce these emissions further. A discussion on this would (or a reference to the relevant section in the report) be helpful both to the general reader, and the IAM developers. [Vassilis Daioglou, Netherlands]	Taken into account - while this chapter cannot cover this topic in too much depth, this issue is briefly discussed in Section 2.4 and illustrated in an overview table of mitigation measures included in IAMs that is available in the Technical Annex. As we do not assess this topic in depth, we do not want to speculate on whether it is "impossible" or not to reduce these emissions. We do highlight though that "If higher-cost non-CO2 mitigation measures are identified and integrated in integrated models, they are expected to also contribute in moving from a 2°C to a 1.5°C pathway, but the magnitude of this contribution is unclear."
60072	31	30	31	33	The limitation of the models is important to recognize. What "technical or behavior" options have been considered that are not captured in the IAMs beyond livestock production and fertilizer use? Are the models then too conservative on the estimates of mitigation potential? What does this imply about the scenarios? [United States of America]	Taken into account - The technical annex now contains an overview of measures that are or are not included in the IAMs that provided scenarios to this assessment. If options are not included, the resulting most stringent scenario will be more conservative than what would be possible when the mitigation option is included. We now highlight "If higher-cost non-CO2 mitigation measures are identified and integrated in integrated models, they are expected to also contribute in moving from a 2°C to a 1.5°C pathway, but the magnitude of this contribution is unclear."
18062	31	31	31	32	sentence talks of the "absence of mitigation options in the current generation of integrated models" for CH4 & N2O. Is this because the models are not sufficiently developed or because the technology does not exist? The sentence implies the former, but this is not clear. (related to p35 lines 36-37). Also, check consistency of this part with p51 lines 1-2 (CH4 & N2O mitigation in AFOLU). [Andrea TILCHE, Belgium]	Taken into account - It is the former, which have tried to clarify by providing a reference to the overview table of mitigation measures in the technical annex, which shows which measures models include to which degree. We also have cross-checked and -referenced Section 2.4
10506	31	38	33	8	In section 2.3.1.2.1, Figure 2.8, the uncertainty band for the annual global emission characteristics of 2050 is smaller than those of 2030 and 2100. The authors need to explain the causes of these differences in uncertainty bands in more details. [Hong Yang, Switzerland]	Taken into account - The uncertainty bands are the results of the individual evolutions of single scenarios. We have clarified this in the revised draft by including icons for specific archetype markers, and where appropriate highlight the different evolutions in each marker.
40974	31	38	31	53	CCS is described as a critical option. But where captured CO2 are stored has not been described well although there are several options, for instance aquifer, oil and gas reservoir, and coal seam. This chapter seems that CO2 captured is assume to be stored in only aquifer but, from economic points of views, CCS/CO2 EOR and CCS/ECBM is more practical and it is expected to be a fast track for reducing capture cost. IEA had a workshop for “decarbonization of hydrocarbon” by using EOR (see attached). https://www.iea.org/newsroom/news/2018/january/iea-and-kapsarc-co-host-workshop-on-decarbonisation-potential-of-advanced-co2-eor.html Hydrocarbon energy, particularly liquid fuel, is not easy to be replaced even though global society is looking for net zero emission. Low carbonization of hydro carbon energy, like “low carbon fuel by EOR”, is thought to be important option. Also, ISO TC265 is dealing CCS and a part of CCS standard is CO2 EOR and it is going to be issued by the end of 2018. This is recent progress and should not be dropped from this report. Potential of CO2 EOR is analyzed below https://www.iea.org/newsroom/news/2018/january/iea-and-kapsarc-co-host-workshop-on-decarbonisation-potential-of-advanced-co2-eor.html [Takashi Hongo, Japan]	Noted - However, the indicated section does not address the storage location of CO2 from CCS. It is a general paragraph that clarifies the different contributions to net CO2 emissions.
3216	31	39	31	47	This text alludes to a figure, but the figure reference is not given. [Vassilis Daioglou, Netherlands]	Taken into account - the text made reference to the figure in the second sentence of the paragraph
47790	31	40	31	40	Kindly use proper formatting for citations. [Sarah Connors, France]	Noted.
35482	31	41	31	47	The list does not seem to include reducing activities leading to CO2 production (demand reduction) in regions/countries with high per-capita emissions/demand - suggest it should be added [Ashok Sreenivas, India]	Taken into account - the text inadvertently suggested that this list described the various measures by which net CO2 emissions can be reduced. However, this is not the case. The list merely lists the contributions to overall net CO2 emissions. Demand reduction is an important mitigation measure, but would not fit in this list
13110	31	42	31	42	Delete the text "fossil fuel combustion and industrial processes" and make reference to energy use. [Eleni Kaditi, Austria]	Rejected - In this list we list the direct activities that contribute to CO2 production, sequestration, and emission. Energy use is on a secondary level here, as it can be produced in a variety of ways. Moreover, not all CO2 produced in industry is energy-related. Some industries also produce important amounts of process-related CO2, like the cement industry.
22562	31	42			Insert space between "CO2produced" [LUIS VALDES, Spain]	Accepted
39388	31	42	31	42	Between CO2produced there must be a free space: CO2 produced [Olga Alcaraz, Spain]	Accepted
44182	31	42	31	42	needs space between "Co2 produced" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
51722	31	42	31	42	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Accepted
56082	31	42	31	42	Insert space before produced [Patrik Winiger, Netherlands]	Accepted
58014	31	42	31	43	There are two spacing issues in these lines for "CO?produced" that should be "CO? produced" [Siir KILKIS, Turkey]	Accepted
22564	31	43			Insert space between "CO2capture" [LUIS VALDES, Spain]	Accepted
37220	31	43	31	44	Change …"CO2capture and sequestration" to ..capture and storage or CCS for consistency. [John Scowcroft, Belgium]	Accepted
39390	31	43	31	43	Between CO2capture there must be a free space: CO2 capture [Olga Alcaraz, Spain]	Accepted

Comment No	From Page	From Line	To Page	To Line	Comment	Response
44184	31	43	31	43	does "Agriculture, Forestry and Other Land Use" need to have capitals? [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Yes, because it highlights the characters that form the AFOLU acronym.
56084	31	43	31	43	Insert space before capture [Patrik Winiger, Netherlands]	Accepted
13112	31	44	31	44	Delete the text "fossil fuels or industrial activities" and make reference to energy-related emissions. [Eleni Kaditi, Austria]	Rejected - In this list we list the direct activities that contribute to CO2 production, sequestration, and emission. Energy use is on a secondary level here, as it can be produced in a variety of ways. Moreover, not all CO2 produced in industry is energy-related. Some industries also produce important amounts of process-related CO2, like the cement industry.
60074	31	45	31	47	BECCS is comprised of two components: bioenergy production and use, and carbon capture, utilization, and storage (CCUS). Bioenergy production and use might be done without CCUS, and CCUS may be applied to a number of different energy production facilities, including those using biomass. Each of these components is discussed separately in this report, and is included under b) and c) respectively in this paragraph. Suggest focusing on these two component parts here and throughout the report, rather than treating BECCS as a unique technology. [United States of America]	Noted - However, this list focusses on the CO2 emissions for which CO2 production, sequestration and emissions are playing a role. BECCS is only mentioned here as an example. Discussing its components is not the topic of this section.
11750	31	55	31	56	Seems to contradict the statement that net zero needs to be reached before 2050 in most scenarios - page 22, line 11. [United Kingdom (of Great Britain and Northern Ireland)]	Accepted - these two instances have been made consistent by only discussing this issue in this section.
28044	31	55	32	8	This paragraph contains valuable information regarding the difference between more stringent scenarios that lead to lower requirements of CO2 removal to stabilize temperatures at 1.5°C. This is exactly the type of information that would be useful for policymakers. It would be helpful to focus the interpretation and representation of analysis result more in such a fashion, without compromising the comprehensiveness of the assessment. [Germany]	Taken into account - throughout Chapter 2 we highlight ranges of pathways as well as illustrative pathway archetypes that illustrate the choices decisionmakers can make.
50204	31	55	31	56	The statement "all 1.5 oC sceanrio classes …..reaching (near) net ero by 2050 or shortly thereafter." is inconsistent with the statement on page 22, lines 11-13, which is the most precise in terms of reflecting the literature. So make the text here consistent with the earlier one. [Bert Metz, Netherlands]	Accepted - these two instances have been made consistent by only discussing this issue in this section.
56096	32	1	34	11	NOT REVIEWED [Patrik Winiger, Netherlands]	Noted. Yet it is unclear which action is expected here from the authors.
780	32	6	32	6	Table 2.7' should be 'Figure 2.7' [Robert Shapiro, United States of America]	Accepted - Tables and numbers have been cross-checked for consistency.
19554	32	7	32	7	Please add here and important finding that can be concluded from the Figures 2.7 and Figure 2.15, which is that pathways that assume limited or no contribution of BECCS imply at least halving global fossil fuel and industrial CO2 emissions by 2030. [Jennifer Morgan, Netherlands]	Taken into account - throughout Chapter 2 we highlight ranges of pathways as well as illustrative pathway archetypes that illustrate the choices available to decisionmakers, including the amount of BECCS their strategy wants to rely on.
185	32	9	77	3	There are no space between CO2 and emisssion. [Mingshah Su, China]	Accepted
13492	32	9	32	9	separate CO2emissions [Sergio Aquino, Canada]	Accepted
11752	32	9	32	20	I think this section is potentially confusing and there needs to be greater clarity on the use of CDR. In essence, as described earlier, CDR serves two purposes in the scenarios 1) to compensate for residual emissions in hard to decarbonise sectors 2) to produce net negative emissions at some point in order to compensate for excess emissions earlier in the century. As stated on page 29 (line 33), usage 2 is in overshoot scenarios ("to return warming after a temporary overshoot"). Presumably there is therefore no need for net negative in a non-overshoot scenario (although are budget overshoots and temperature overshoots necessarily the same thing)? So it is confusing, based on the above definitions and discussion provided earlier in the report, that this section states that "consequently, 1.5°C overshoot scenarios display larger values of net negative emissions by the end of the century than non-overshoot scenarios". Why exactly are net negative emissions being used in a non-overshoot scenario? They do not need to compensate for earlier build up of CO2 if the budget has not been exceeded - so what purpose, if any, do they serve. Or is this statement incorrect? Additionally, if it is indeed the case that net negative emissions are not required in a non-overshoot scenario, it would be helpful if figure 2.8 (which is excellent by the way) included a scenario with no net negative emissions. Perhaps rather than displaying the raw model output (which is what I assume is the case), you could turn these more (or even more) into stylised cartoons displaying broader features of particular scenario classes, such that a no net negative scenario is included. I think as well that these excellent summary images could be included more prominently in the report, perhaps in the exec summary. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - When only considering CO2 warming, net zero CO2 emissions would indeed lead to approximate temperature stabilisation on timescales of about a decade. However, because in the real world also non-CO2 forcers play a role, this is not the case. First of all, forcing from short-lived climate forcers would, even when stabilized through emissions at low constant levels, slowly evolve from its instantaneous response to a higher, equilibrium response. This takes multiple decades to centuries. Moreover, some non-CO2 GHGs are long-lived climate forcers (e.g. N2O) and their emissions thus accumulate in the atmosphere. Unless their emissions are reduced to zero, their forcing and warming needs to be offset by CDR. A simple explanation with stylized pathways of these effects is provided in Chapter 1 and thus not repeated here. However, by making use of illustrative pathway archetypes we also here illustrate some of these aspects. We have also clarified this better in the text.
39392	32	9	32	9	Between CO2emissions there must be a free space: CO2 emissions [Olga Alcaraz, Spain]	Accepted
44186	32	9	32	9	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
56086	32	9	32	9	Insert space before emissions [Patrik Winiger, Netherlands]	Accepted
58016	32	9	32	9	The spacing issue in phrases such as "CO?emissions" re-occurs in the chapter. [Siir KILKIS, Turkey]	Accepted
13494	32	10	32	10	Figure 2.8 [Sergio Aquino, Canada]	Accepted
32756	32	10			budget (Section 2.2, Section 2.3.1.1).Figure 2.8 shows ... insert blank space before "Figure" [Manfred Treber, Germany]	Accepted
44188	32	10	32	10	needs space between "2.3.1.1). Figure 2.8" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
56088	32	10	32	10	Insert space before "Figure" [Patrik Winiger, Netherlands]	Accepted
42764	32	12	32	20	Important to consider the costs of overshooting: up to a staggering $89 to $535 trillion just for carbon removal this century. See Hansen, et al., Young people's burden: requirement of negative CO2 emissions, Earth Systems Dynamics. [Kristin Campbell, United States of America]	Rejected - This section focusses on emissions. Costs of single technologies and mitigation measures are assessed in Chapter 4.
42990	32	12	32	20	Important to consider the costs of overshooting: up to a staggering $89 to $535 trillion just for carbon removal this century. See Hansen, et al., Young people's burden: requirement of negative CO2 emissions, Earth Systems Dynamics. [Durwood Zaelke, United States of America]	Rejected - This section focusses on emissions. Costs of single technologies and mitigation measures are assessed in Chapter 4.
56090	32	12	32	12	Insert space before Virtually [Patrik Winiger, Netherlands]	Accepted
782	32	15	32	15	Table 2.6' should be 'Figure 2.6' [Robert Shapiro, United States of America]	Accepted - Tables and numbers have been cross-checked for consistency.
18064	32	19	32	20	end of century CO2 levels for 1.5°C non-overshoot scenarios are similar to 2°C pathways. Is this really so? It does not appear to be the case from Table 2.7. What is the point of this sentence? Is it attempting to argue that the main characteristic of 1.5°C TPB scenarios compared to others is aggressive short-term mitigation? If so this should be stated more clearly. [Andrea TILCHE, Belgium]	Accepted - This sentence was confusing and has been edited beyond recognition as it now refers to 2030 levels.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
4484	32	24	32	25	Are there any reason to choose those 5 models? In other words, is ther no other model doing the same kind of research? [Mitsutsune Yamaguchi, Japan]	These pathways were selected because they reflect a wide range of different mitigation portfolios and strategies. Models were not the prime concern in selecting the scenarios. There are more models that have submitted scenarios to the SR1.5 scenario database. Both the illustrative pathways archetypes as all modelling frameworks that submitted scenarios to the database are listed in Section 2.1
30926	32	24	32	31	I think this figure needs to make clear that these scenarios have different end goals. Three are return 1.5 66%, one is return 1.5 50%, one is below 1.5% 50%. In particular, one of them has a large overshoot to 1.8 degrees. This figure is one of the best in the report for explaining budgets – if it included or made reference to the issue of non-CO2 [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - the pathway archetypes are now used consistently throughout the chapter and introduced in Section 2.1, where also their differences in climate outcome are highlighted.
31414	32	24	32	25	There are many models working in the world. IPCC report should be written based on wide and well-balanced data from available models. To avoid concerns that limited data were taken for the 1.5 Special Report, information should be added on how many models have tried to solve 1.5°C pathway, how many models could solve it, and why such models could have solutions. [Japan]	Taken into account - This is very important indeed. In order to be able to provide a balanced assessment of available modelled pathways, a scenario database dedicated to the report has been compiled on which is drawn to carry out the assessment for this chapter. Many modelling groups have submitted pathways to this database, which is reported in Section 2.1. At the same time, Section 2.5 discusses the fact that pathways could not be achieved under certain conditions. Except for cases where pathways were attempted as part of a structured model exploration exercise, there is no possibility to know how many modelling teams have tried to model 1.5°C pathways and were either successful or failed. The number of available scenarios also here does not provide a robust indicator. The last point of the reviewer can thus not be addressed in a structured way within the time limits of this report.
34182	32	24	32	31	Figure 2.7: Please specify in the caption if these example scenarios all have the same temperature goal (1.5C) [Norway]	Taken into account - the pathway archetypes are now used consistently throughout the chapter and introduced in Section 2.1, where also their differences in climate outcome are highlighted.
40036	32	24	32	31	All these scenarios suggests that AFOLU emissions are zero by 2030, and not yet negative. Nevertheless, other sources, like Chapter 4 of the 2017 Emissions Gap Report and Griscom 2017 (already quoted) suggest that total AFOLU emissions can already be negative in 2030, at modest costs. This should at least be added as a disclaimer. This is important as to often carbon dioxide removal is considered as something for the 2nd half of this century. [Kornelis Blok, Netherlands]	Rejected - these scenarios were selected to illustrate variations across scenarios. Griscom et al (2017) identifies mitigation potential, but that study does not provide evidence for the how quickly a simultaneous achievement of all measures could be implemented. At the same time, the next figure, showing global long-lived GHG emissions, clearly shows that in some cases AFOLU emissions can already be negative in 2030. So this aspect is not neglected.
50206	32	24	32	31	Figure 2.7 is in principle very helpful in clarifying the various components of the effort to stay with a 1.5 C budget and would (after improvement) be very good for the SPM. The left hand panel is best turned into a qualitative one, without numbers, in order to avoid this implicitly being seen as the most realistic scenario. It then helps to explain the various components and their relationship. Then having four variants with numbers can help explain the alternatives and their consequences in terms of how fast emissions form fossil fuel use have to come down for the various alternatives (to be discussed in the main text). The current graph for alternative 3 shows declining fossil fuel emissions even before 2020, which is totally unrealistic. So replace that one with a scenrio that assumes increasing emissions before 2020, as all the other scenarios do. Make clear that BECCS stands for a group of technological options, inclusing DACCS and enhanced weathering and AFOLU is not just afforestation , but also includes soil carbon enhancement , biochar, etc. [Bert Metz, Netherlands]	Accepted - the figure has been amended with a panel showing global CO2 emissions evolutions, a qualitative panel from which all quantitative information was removed, and then a set of detailed panels for archetype pathways, which have been checked for their near-term emission evolution.
54598	32	24	32	25	Text in Fig 2.7 is not very clear. High quality fig with a larger text font should be used here. [Qudsia Zafar, Pakistan]	Accepted - figures will be copy edited and improved for clarity for the final print version.
8650	32	25	32	25	I am puzzled why CO2-uptake by the ocean does not seem to play a role here. In IPCC_AR5_WG1 (2013) in Figure 6.1 there is a depiction of the Carbon cycle, indicating a net atmosphere-to-ocean flux of CO2 of 2.3 PgC/yr. My understanding (and that of many people I spoke to) had always been that: "This flux will continue in the future because the ocean is such a large reservoir; the rate of atmosphere-to-ocean flux will decrease somewhat because the ocean surface layer will increasingly get saturated with the surface-to-midocean flux becomming the limiting factor and because the warming ocean will increasingly degas CO2; but the ocean will always continue to be a sink for CO2 if atmospheric concentrations continue to increase or stay constant.". Now, in Figure 2.7 and its discussion the ocean is not mentioned at all. Thus, I assume that my understanding (as outlined above) is indeed incorrect! But I suggest you comment on the role of oceans (and maybe land biomass) as CO2-sinks and why these sinks are not considered here. Alternatively, please consider the ocean (and maybe other sinks) as natural sinks for CO2. [Urs Ruth, Germany]	Noted - the ocean sink is a natural sink, which absorbs part of the anthropogenic CO2 that is emitted into the atmosphere. It is correct that this sink will continue to persist in the future for at least as long as the partial pressures between CO2 in the near-surface atmosphere and top-layers of the ocean are not in equilibrium. However, this is not a human/anthropogenic sink of CO2. This figure only show anthropogenic CO2 fluxes, not the full global redistribution of carbon over the various pools. We have clarified this by explicitly indicating that these are anthropogenic emissions that are shown here.
55630	32	25	32	31	Fig 2.7. To improve understanding and consistency of presentation can we use a common and simpler/shorter name for each of the five scenarios, and consistency in the order of presentation with other figures, including figures 2.15 and 2.17 and the "scenario class" used in eg figure 2.8 and table 2.7 [David Cooper, Canada]	Accepted - the pathway archetypes are now used consistently throughout the chapter and introduced in Section 2.1. Each scenario has received a short label, which is used consistently throughout the chapter text and figures.
55632	32	25	32	31	would be useful to have larger figures, all the same size, to aid readability and comparison [David Cooper, Canada]	Accepted. Figures were harmonized better in this next iteration.
28046	32	26	32	26	Figure 2.7 shows evolution and break down of global CO2 emissions until 2100, not "mid-century" as been stated in the caption. Please substitute "mid-century" by "2100". [Germany]	Accepted
56906	32	26	32	26	very useful figure [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
29498	32	31	32	31	Suggested addition here or elsewhere in the text (bold red): Given the difference in estimating the "anthropogenic" sink between countries and the global carbon modelling community (Grassi et al. 2017), the land-related emission estimates included here are not necessarily directly comparable with countries' estimates at global level . [Giacomo GRASSI, Italy]	Accepted - we included the following sentence in the caption of the table where emission values are reported: Given the difference in estimating the "anthropogenic" sink between countries and the global carbon modelling community (Grassi et al, 2017), the AFOLU CO2 estimates reported here are not necessarily directly comparable with countries' estimates.
186	33		33	2	The unit of ordinate in the left figure in Figure 2.8 is GtCO2-e while it is GtCO2 in other figures. It is better to use same unit. [Mingshah Su, China]	Noted - when appropriate. In this case, one figure shows CO2 emissions and the other figure CO2-equivalent emissions.
11030	33	1	33	2	Include in Figure 2.8 boxes for BECCS and CCS deployment to visually compare and substantiate their contribuions (ref Fig 2.9 in First Draft) [Wilfried Maas, Netherlands]	Rejected -To not overload this figure these contributions were not included in these figures, but they are available in the overview table in this Section.
13496	33	1	33	2	space between chart and legend [Sergio Aquino, Canada]	Accepted

Comment No	From Page	From Line	To Page	To Line	Comment	Response
28048	33	1	33	8	Figure 2.8: sort of identifier for the six small boxes needed, in order to easily understand, which box is for which GHG, i.e. with (a), (b), (c),…; taking this from the caption only is very hard. However, a box for methane (as indicated on p.31, line 24) is not given. Is this captured by the FF&I or AFOLU-box? [Germany]	Accepted
51724	33	1	33	4	The explanatoin for these graphs could be more fulsome. Perhaps some sublabels for the graphs? This is hard to follow. [Jason Donev, Canada]	Accepted - All visual items are now fully described by either caption or legend.
53486	33	1			No chart key provided for the grey box plots (historical emissions). [Christian Holz, Canada]	Accepted - All visual items are now fully described by either caption or legend.
56092	33	1	33	1	y-axis of let-most panel: "emmissions" should be "emissions" [Patrik Winiger, Netherlands]	Accepted
44834	33	2	33	8	The explanation of left most box (grey) in each pannel is missing. [Hiroaki Kondo, Japan]	Accepted - This explanation was missing in the SOD. In the updated FGD figures now include 2020 ranges instead of 2010 ranges.
56094	33	2	33	8	This caption could be slightly improved by deconvoluting the sentences and including the abbreviations (e.g., "FF&I", "AR4GWP100"). At least the grey boxes should be explained. [Patrik Winiger, Netherlands]	Accepted - All visual items are now fully described by either caption or legend.
784	33	7	33	7	No explanation for gray box. I assume it is the historical emissions. [Robert Shapiro, United States of America]	Accepted - This explanation was missing in the SOD. In the updated FGD figures now include 2020 ranges instead of 2010 ranges.
44836	33	8	33	8	Ranges in the bottom-->Is this bottom only? [Hiroaki Kondo, Japan]	Accepted - this was incorrectly referring to only a subset of the panels. This has been corrected.
11754	34		34		What do the references 1 and 2 to footnotes actually refer to? From modelling frameworks and annual change. Also, should the BECCS numbers not be negative? [United Kingdom (of Great Britain and Northern Ireland)]	Accepted - footnotes were not necessary. BECCS numbers can be negative but then their annual rate of change also becomes negative, which is counterintuitive. No perfect solution is available here.
17914	34				This is a very important table as it gives many additional policy-relevant indicators in addition to the budget numbers. Some of the key numbers should appear in the SPM, e.g. the year when net-zero is achieved. I only miss the information how many models could NOT achieve a specific scenario class. [Brigitte Knopf, Germany]	Taken into account - numbers, when robust and appropriate have been lifted into the ES and SPM. The number of models that could not achieve a specific scenario class cannot be deduced from the information available in the literature. We could hence not report on this except for specific cases where multiple models ran a structured set of scenario experiments, like with the SSPs. These insights are discussed in Section 2.5.
35794	34				Column 2 add deg. sign and also include 50% or 66% Likelihood [India]	Noted - However, the scenario classes have changed names to reflect the precision of the temperature outcome here.
14030	34	1	34	1	Better to show median followed by the range as far easier to compare - eg "10.4/14.5/22.8" better shown as "14.5 (10.4-22.8)" [Ralph Sims, New Zealand]	Accepted - the median is shown first, followed by the interquartile range.
30928	34	1	34	11	I think this table is too crowded, and would remove the 4 columns on absolute annual change and annual change relative to 2010 [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - the table has been reduced in size
30930	34	1	34	11	It is not clear to me why the “CO2 from fossil-fuel use and industry” figures are largely negative in 2050 and 2100, if there are already separate rows for BECCS and CCS. I think it would be great for this table to set out how the various rows interact. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	This includes CDR from BECCS in the energy system.
34184	34	1	34	3	Table 2.7 caption: We think there is a mismatch between the first sentence about years for emissions levels (2010, 2030, 2050) and the years for annual emissions in the table (2030, 2050, 2100) in column 5-7. Please clarify this. [Norway]	Accepted - this has been corrected
34186	34	1	34	2	Table 2.7: The last row in the table shows the "Kyoto-GHG". Does this include CO2 as well? Please specify this. [Norway]	Taken into account - Kyoto GHGs include CO2, CH4, N2O, HFCs, PFCs, and SF6. The recently added NH3 is not included. This has been clarified in the caption.
34188	34	1	34	2	Table 2.7: The annual emissions in 2030, 2050 and 2100 from BECCS and CCS are given solely with a positive sign. We find this confusing as we would expect it to be negative. Please change the signs or explain the positive and negative values in the caption. [Norway]	Accepted
34190	34	1	34	2	Table 2.7: Please consider to colour shade the rows to mark similar scenario classes, in order to improve readability. [Norway]	Accepted - a layout suggestion in this direction has been made.
34192	34	1	34	2	Table 2.7: In the rightmost column, please consider to replace "interquartile range" with a more describing text. We understand this as the 25th and 75th percentile, and excluding the median. [Norway]	Taken into account.
44838	34	1	34	1	Foot note of the title of the forth column (modelling frameworks) is missing. [Hiroaki Kondo, Japan]	Accepted - no footnote was necessary.
51726	34	1	34	1	Label for table goes at the top. [Jason Donev, Canada]	Accepted
58612	34	1	34	1	Year 2100 high BECCS levels would lead to large-scale stranded assets. BECCS is associated with building significant amounts of fixed technical capital. High levels of BECCS in 2100 leads to a situation where the BECCS fixed capital would no longer be needed in the year 2101. [Kenneth Möllersten, Sweden]	Noted - however, this is not the focus of this section. CDR is being used to offset residual emissions as well as to achieve net negative emissions. Depending on the mitigation strategy some of this infrastructure would hence indeed either be stranded or not-
44840	34	3	34	10	The legend of Table 2.7 should be put above the table. [Hiroaki Kondo, Japan]	Accepted
56908	34	3	34	3	A lot of detail very difficult to read - break up, simplify or move to annex? [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - the table has been simplified, yet is still quite busy.
61764	34	19	45	20	further discussion… section 2.5… chapter 4. This is exactly what is not helpful for the reader. Where do we find the conclusions of these discussions, in which sections of chapter 4? [Valérie Masson-Delmotte, France]	Accepted - sections added.
46396	35	1	36	1	……. with median emissions reductions across scenarios of about 25–5% and 55–60% in 2030 and 2050, respectively…. Range needs correction as from the Figure 2.9 it looks 25%-35%. [Ijaz Ahmad, Pakistan]	Accepted - numbers have been double-checked and corrected.
50210	35	1	35	17	There are a few important messages in this paragraph that deserve to be in the Exec Summary and the SPM: 1) the statement that N2O accumulates in the atmosphere ; 2) the statement in lines 9-12 about the difficulty of eliminating N2O emissions; 3) the statement in lines 15-16 that N2O is already a present day concern due to unsustaibale levels of nitrogen pollution.. [Bert Metz, Netherlands]	Taken into account - the different nature and mitigation evolution of various climate forcers has been highlighted in the ES. At the same time, the fact the N2O accumulates in the atmosphere did not make it to the ES.
58200	35	1	35	17	N2O needs to be assessed in a whole-system view, by using units such as CO2eq (i.e. including N2O and CH4) per ton of grains or meat, rather than simply total emissions of N2O. This is because a higher use of N fertilizer can be positive in certain circumstances. For example, N fertilizers can substantially increase crop productivity (incl. feed) which in turn can reduce deforestation (or even freed up land for afforestation/reforestation and/or energy crops) etc., and ultimately the total emissions associated with the food produced may be lower than one may intuitively expect. This can be assessed by running sensitivity analysis of whole-system land use models. [Alexandre Strapasson, Brazil]	Noted - While the authors agree that this issue can be assessed by running sensitivity analysis of whole-system land use models, this report can only rely on the available literature. However, many of the models that provided pathways to the database of this report do include N2O emissions in their coupled land-energy-economy-environment system (see overview table of measures in the Technical Annex).

Comment No	From Page	From Line	To Page	To Line	Comment	Response
11756	35	4	35	4	Potentially due to… - do we not know what is driving this in the models? Why not? [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - we know that sustainable food consumption can reduce N2O emissions, we also know that not all models model this in much detail. This was edited so that it is clear that it is just not applicable to all cases.
42318	35	5			budget for 1.5 ===> budget of 1.5 [Egypt]	Accepted
54614	35	8	35	8	LLCF should be defined here [Qudsia Zafar, Pakistan]	Rejected - LLCF is defined at its first use, at the beginning of the section
62082	35	9	35	16	N2O emissions are a problem both for lack of a set of realistic policies for deep abatements, and also for lack of quantified modelling tools to represent them (as shown in table 2.8)..Both issues should appear in the paragraph. [Antoine Bonduelle, France]	Rejected - we can only include statements based on evidence. Within the time constraints of this report, there was no possibility to assess the availability or lack of realistic policies for deep abatement. However, the overview table of mitigation measures included in the scenarios assessed in this chapter (see Technical Annex) provides an indication of if and how measures are included in pathways. This has been cross-referenced.
44190	35	16	35	16	needs space between "2012). Section 2.4.3" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
56098	35	16	35	16	Insert space before "Section" [Patrik Winiger, Netherlands]	Accepted
11758	35	20	35	20	This paper ought to be considered here - "Climate Impacts From a Removal of Anthropogenic Aerosol Emissions" http://onlinelibrary.wiley.com/doi/10.1002/2017GL076079/full [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The paper was considered. This chapter focusses on the global mean temperature rise effects of emissions. The effect of the unmasking of GHG warming through the removal of aerosols is included in the assessment method, and the key insights of the paper are hence considered here.
19154	35	20			It is quite curious that the RF scenarios show a fairly large decrease in the positive RF by SLCF and a fairly small decrease in the negative RF by SLCF. Could this be due to a selective behaviour of the IAM that are optimized to follow a 1.5 or 2°C trajectory? [Olivier Boucher, France]	It is unclear how this comment connects to the indicated text, or what information this comment would refer to. We do discuss/assess the negative and positive contributions of SLCF. SOD Figure 2.9, however, shows that SO2 is strongly reduced in both 1.5°C and 2°C. It is hence unclear why the reviewer would conclude that scenarios would show "a fairly small decrease in the negative RF". No further action is taken.
34194	35	20	37	18	Trade-offs with reducing SLCP versus cooling air pollutants (like organic carbon OC) must be better explained in Chapter 2. The BC/OC ratio varies between sources. E.g. Biomass burning vs fossil fuel. [Norway]	Taken into account - while an in-depth assessment of this issue could not be carried out as it is not sufficiently specific to 1.5°C, this issue is now highlighted in the section.
51728	35	21	35	49	Once again, the framing should be imperative rather than descriptive. It confuses the issue if the implication is that will be mitigated. The must be doesn't mean that they will be. [Jason Donev, Canada]	Noted.
13498	35	22	35	22	space before scenarios [Sergio Aquino, Canada]	Accepted
22566	35	22			Insert space between "2ºCscenarios" [LUIS VALDES, Spain]	Accepted
39394	35	22	35	22	Between 2°Cscenarios there must be a free space: 2°C scenarios [Olga Alcaraz, Spain]	Accepted
44192	35	22	35	22	needs space between "2°C scenarios" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
56100	35	22	35	22	Insert space between "2°C" and "scenarios" [Patrik Winiger, Netherlands]	Accepted
58018	35	22	35	22	The spacing issue in phrases such as "2°Cscenarios" re-occurs in the chapter. [Siir KILKIS, Turkey]	Accepted
37834	35	25	35	26	This is a misleading statement, as there is no evidence for this for SLCFs in general, there's only evidence to support this statement for CH4. It should therefore be constrained to CH4: "While reductions of methane can contribute to limiting peak warming and can be of particular importance to limiting warming to 1.5°C," [Michiel Schaeffer, Netherlands]	Taken into account - this statement has been made more specific.
46582	35	26	35	26	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Accepted
13500	35	27	35	27	imissing: degrees celsiua [Sergio Aquino, Canada]	Accepted
62084	35	31	35	37	On methane reductions, maybe mention that a large share of methane reductions happen because of the decrease in hydrocarbon uses. Maybe this should be mentioned and/or the kind of additional mesaures on this part of the inventory. [Antoine Bonduelle, France]	Rejected - The data available from the integrated pathways does not allow to support such a precise statement.
28050	35	32	35	35	It should be made clear that the expected increase of the AFOLU emissions' share is a relative, not an absolute increase. [Germany]	Accepted - It has been clarified that this is a relative share. However, the authors' understanding is that a share is always relative, so this might introduce some redundancy.
56102	35	35	35	38	Could some of the "proposed measures to target methane" emissions or some of the "more speculative or experimental" measures be listed as examples in this paragraph? I honestly have no clue what is meant by "more speculative or experimental". [Patrik Winiger, Netherlands]	Taken into account - we now refer to an overview table of mitigation measures that is available in the Technical Annex
786	35	37	35	37	Table 2.8' should be 'Figure 2.8' [Robert Shapiro, United States of America]	Rejected - The reference to SOD Table 2.8 was correct, but is now changed to an updated table in the Technical Annex.
55468	35	37	35	38	I have some sympathy for this position, but frankly, not enough sympathy. So, BECCS deployed at 500 Gt CO2 is NOT speculative in comparison??? Whereas e.g. methane and nitrification inhibitors, which are ready for commercial deployment (in contrast to BECCS) and are being used commercially (in the case of nitrification inhibitors), are more speculative than 500 Gt CO2 of BECCS? I'm sorry, but this is a simple bias reflecting what already is in IAMs and what is not. Such a bias is not consistent with an IPCC obligation to provide a comprehensive and unbiased assessment, the chapter has to go wider than whatever IAMs say. I understand the authors won't have the time and expertise to undertake a detailed assessment of sector-specific mitigation technologies and disruptive changes, but to avoid blatant bias I feel the authors need to at least spell out the various technologies and options that are not considered, and then say that these technologies are not considerd in IAMs and hence, given the short time frame for the production of this report, could not be assessed in this report for the mitigation pathways. This includes the rapidly developing area of plant-based proteins potentially substituting for livestock products at much lower GHG footprints and novel technologies that are being developed very actively and could substantially reduce non-CO2 forcing from agriculture.Excluding those from any discussion based on them being 'speculative' is a cop-out that is not justified based on the existing literature. [Andy Reisinger, New Zealand]	Accepted - The authors have sympathy with the reviewer's point, and are also sympathetic to the view that the use of the word "speculative" might have been inappropriate. At the same time, this chapter cannot carry out in isolation, the assessment the entire report is tasked to do. This chapter hence focusses on the integrated pathway literature, the caveats of which are now more clearly expressed. In order to address the reviewer's suggestion for highlighting the measures that either included or not in IAM pathway analyses, we now refer to a dedicated table in the Technical Annex in which the level of inclusion of various measures in the contributing models is shown. Throughout the section, we attempt to consistently communicate these limitations.
13502	35	40	35	40	imissing: degrees celsiua [Sergio Aquino, Canada]	Accepted
18066	35	40	35	49	Duplication: both this paragraph and lines 1-18 establish that a 1.5°C appears to require greater HFC reductions than those agreed under the Kigali Amendment. There is therefore scope for rationalising the text. [Andrea TILCHE, Belgium]	Accepted - The texts have been rationalized

Comment No	From Page	From Line	To Page	To Line	Comment	Response
56110	35	40	35	40	It could be helpful to give a short list of the most common sources for fluorinated gases or at least refere to a publication or chapter witihin this report. [Patrik Winiger, Netherlands]	Accepted - A reference to a recent paper on this topic was included, as well as to several larger reports on the topic.
37836	35	41	35	42	... below 1.5C 50' scenarios showing reductions of that magnitude already by 2030. Importaintly, the level in 2030 is below "Most feasible reductions" and therefore this aspect of below 1.5°C 50 scenarios seems invalidated by other literature, which makes the statement "low confidence" at best. This should be mentioned, as it measn that overall there's only weak evidence that HFCs contribute to 1.5°C in addition to what is achieved for 2°C [Michiel Schaeffer, Netherlands]	Accepted - due to the limited literature basis for this particular statement, this point has been removed.
60076	35	45	35	49	Provide context to explain why the noted HFC reductions projected in the 1.5°C scenarios are below the reduction targets of the Kigali Amendment. The baseline years for the Kigali Amendment are much later than the 2010 baseline year used in the IPCC scenarios, and the Kigali Amendment includes an HCFC component. [United States of America]	Taken into account - The baseline years for the Kigali Amendment are much later than the 2010 baseline for Article 5 countries which is equally taken into account in the cited analysis. The baseline of the Kigali amendment considers the average consumption level of HFC's and HCFC's as shown reference: UNEP. 2016. Further Amendment of the Montreal Protocol: Submitted by the Contact group on HFCs. Twenty-Eighth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer, United Nations Environment Programme (UNEP), UNEP/OzL.Pro.28/CRP/10, Kigali, 10–14 October 2016.
62086	35	47	35	49	In the text, reductions are "below" what the Kigali Amendment would achieve means that the modelling uses less stringent reductions. Is this what the authors mean ? Or that final emissions would be under what the KA requests ? [Antoine Bonduelle, France]	The latter. We hope the current text makes this point clearer.
62088	35	47	35	49	Maybe mention that the EU present framework is already more ambitious than the Kigali text, thus making deep reductions of HFCs realistic [Antoine Bonduelle, France]	Rejected - we prefer not singling out countries or regions if no full assessment of the issue was carried out.
42320	35	52			in addition ===> , in addition, [Egypt]	Accepted
32758	35	56			Black Carbon (BC) emission reach similar ... write "emissions" [Manfred Treber, Germany]	Accepted
42322	35	56			reach ===> reachs [Egypt]	Accepted
35796	36	1			Change to - 25-50% [India]	Accepted - numbers have been double-checked and corrected.
13114	36	3	36	9	Delete the text "Because the dominant sources of certain aerosol mixtures are emitted during the combustion of fossil fuels (Bond et al., 2013), the rapid phase-out of unabated fossil-fuels would also result in removal of these short-lived climate forcers. Some caveats apply, for example, if residential biomass use would be encouraged in industrialised countries in stringent mitigation pathways without appropriate pollution control measures, aerosol concentrations could also increase and affect regional and global climate change (Sand et al., 2015; Stohl et al., 2015). Simultaneously,". [Eleni Kaditi, Austria]	Rejected - To the best of our assessment, these sentences are appropriately reflecting the literature in this area.
56104	36	9	36	10	Suggestion. Change "Simultaneously, cooling air pollutant species are being reduced by the transformations required to limit CO2 emissions." to "Simultaneously, cooling air pollutant species are being reduced by the transformations required to limit CO2 emissions and reduce particulate air pollution" [Patrik Winiger, Netherlands]	Accepted - the point about air pollutants also being reduced due to air quality policies is now made explicitly.
60078	36	10	36	12	Revise sentence to read: "For example, median SO2 emissions, precursor of sulphate aerosols, in the three 1.5°C ..." [United States of America]	Accepted
42766	36	12	36	13	Unmasking citation: Ramanathan and Xu (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1002293107. [Kristin Campbell, United States of America]	Noted. We have included a more recent study.
42324	36	13			warming ===> warmings [Egypt]	Rejected
36656	36	16	36	18	Methane mitigation not only increases allowable budget of CO2 emissions, it also has benefits for human and ecosystem health since it reduces surface ozone concentrations. A paper in review at ERL (Collins et al. "Increased importance of methane reduction for a 1.5 degree target") identifies an increase of allowable emissions (0.27-0.28 GtC/ppb of CH4) due to CH4 mitigation. Up to 12% of the increase in allowable emisisons was due to incresaed CO2 uptake by ecosystems due to the lower ozone levels. Global ozone was reduced in the scenario by on average 3 ppb. [Anna Harper, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - This new study was references in relation to its identified ecosystem health benefits. Note, however, that this section was moved to section 2.5.3 on sustainable development linkages in order to rationalize the overall flow of the chapter.
55964	36	16	36	16	Add, "…and to reduce regional impacts, particularly from black carbon sources, on snow and ice loss in the Arctic and alpine regions (World Bank, 2013 and Painter et al, 2013). Cite: Painter, T. et al. 2013. End of the Little Ice Age in the Alps Forced by Indistrial Black Carbon. PNAS 110(38) 15216-15221. [Pamela Pearson, United States of America]	Accepted - this addition was included. Note, however, that this section was moved to section 2.5.3 on sustainable development linkages in order to rationalize the overall flow of the chapter.
45352	36	20	36	22	This should be open up a bit. What kind of differences in the baselines here are referred? [Tuomo Kalliokoski, Finland]	Accepted - Assumptions about pollution controls, general environmental awareness, technology development and societal preferences. This has been clarified in the sentence. Note, however, that this section was moved to section 2.5.3 on sustainable development linkages in order to rationalize the overall flow of the chapter.
11760	36	22	36	22	Clarify what is meant by baseline assumptions? Do you mean by socioeconomic development? [United Kingdom (of Great Britain and Northern Ireland)]	Accepted - Assumptions about pollution controls, general environmental awareness, technology development and societal preferences. This has been clarified in the sentence. Note, however, that this section was moved to section 2.5.3 on sustainable development linkages in order to rationalize the overall flow of the chapter.
187	36	23	36	34	F-gases are expressed in units of CO2-equivalence computed with 100-year Global Warming Potentials reported in IPCC AR4 (line 30-31) but it is stated in section 1.2.5.4 that AGWP is applied in this report. [Mingshah Su, China]	Noted. Chapter 1 made a mistake, and has been made aware of this mishap.
5332	36	23	36	24	The colour of some letters in the legend, it seems a bit grey. I suggest changing it to black colour. [Sulistyawati Sulistyawati, Indonesia]	Accepted
56112	36	23	36	23	y-axis of F-gas panel: "emmissions" should be "emissions" [Patrik Winiger, Netherlands]	Accepted
10508	36	24	36	35	Figure 2.9 provides interesting results, however it needs more explanation and discussion. [Hong Yang, Switzerland]	Noted. Without specifically indicating which aspects of the results need more explanation and discussion it is difficult for the authors to make an informed and adequate decision here.
42326	36	25			CO2emissions ===> CO2 emissions [Egypt]	Accepted
56106	36	25	36	25	Insert space before emissions [Patrik Winiger, Netherlands]	Accepted
56108	36	25	36	34	Please also indicate what the grey boxes depict. [Patrik Winiger, Netherlands]	Taken into account - the grey boxes depicted 2010 values. All visual items are now fully described in the caption or legend. (check)
58020	36	25	36	25	The spacing issue in phrases such as "CO?emissions" re-occurs in the chapter. [Siir KILKIS, Turkey]	Accepted

Comment No	From Page	From Line	To Page	To Line	Comment	Response
464	36	26	36	26	Here and elsewhere 'data are' not 'data is' [David Reay, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
44842	36	27	36	27	CH4-->CH4 [Hiroaki Kondo, Japan]	Accepted
47792	36	27	36	27	Kindly use: methane (CH4) [Sarah Connors, France]	Accepted
42328	36	30			minimum maximum ===> minimum-maximum [Egypt]	Accepted
60080	36	31	36	34	Describe the assumptions that the Hoglund-Isaksson et al. (2017) paper made in estimating the "most feasible reductions" for HFCs from 2018-2050. [United States of America]	Accepted - In the maximum technically feasible reduction (MFR) scenario, the abatement potential encompasses reductions in emissions through the application of technologies that are currently commercially available and already tested and implemented, at least to a limited extent. In the near-term, abatement opportunities within refrigeration and air conditioning are partially restricted because many of the abatement options identified apply only to newly manufactured equipment and are thus limited by the turnover rate of the existing refrigeration and air-conditioning stock. Unless already regulated in the baseline and therefore already adopted to a large extent, the general assumption in the MFR scenario is that developed countries (i.e., non-Article 5 countries under the MP) can replace at least 75% of its use of HFCs in refrigeration and air-conditioning equipment by 2025 and 100% from 2030 onwards. For developing countries (i.e., Article 5 countries under the MP) the corresponding assumptions are 25% in 2020, 50% in 2025, and 100% from 2030 onwards (Purohit and Hoglund-Isaksson, 2017). For the use of HFCs in aerosols, a general additional limit on applicability of alternative substances is set to 60%, reflecting the difficulties with replacing HFC-134a and HFC-227ea in medical dose inhalers for all patient groups as no other compounds are proven to meet the stringent medical criteria required (IPCC/TEAP, 2005). A short description was added to the caption
42768	37	1	37	18	Past amendments to the Montreal Protocol, however, have allowed for a revision of the initial phasedown schedule, furthering the idea that the Montreal Protocol “start-and-strengthen” treaty that is amenable to increasing the mandated reductions. Zaelke, Andersen, & Borgford-Parnell (2012) Strengthening Ambition for Climate Mitigation: The Role of the Montreal Protocol in Reducing Short-lived Climate Pollutants, RECIEL doi: 10.1111/reel.12010 (“Another important feature is the trea- ty’s ‘start and strengthen’ philosophy. Throughout its 25-year history, the Montreal Protocol has started by addressing a problem, learned by doing, gained experi- ence and confidence, and then done more.41 This phi- losophy has allowed the Protocol to build confidence in the parties and their industries that progress is pos- sible, to facilitate the fast development and deployment of technologies that make action easier and cheaper, and to build the ambition, momentum and political courage to do more.”). [Kristin Campbell, United States of America]	Noted. Wherever we refer to the Montreal protocol in general, care has been taken to refer to actual amendments or the present, and not make too general a statement about what could potentially be achieved under the protocol.
42992	37	1	37	18	Past amendments to the Montreal Protocol, however, have allowed for a revision of the initial phasedown schedule, furthering the idea that the Montreal Protocol “start-and-strengthen” treaty that is amenable to increasing the mandated reductions. Zaelke, Andersen, & Borgford-Parnell (2012) Strengthening Ambition for Climate Mitigation: The Role of the Montreal Protocol in Reducing Short-lived Climate Pollutants, RECIEL doi: 10.1111/reel.12010 (“Another important feature is the trea- ty’s ‘start and strengthen’ philosophy. Throughout its 25-year history, the Montreal Protocol has started by addressing a problem, learned by doing, gained experi- ence and confidence, and then done more.41 This philosophy has allowed the Protocol to build confidence in the parties and their industries that progress is possible, to facilitate the fast development and deployment of technologies that make action easier and cheaper, and to build the ambition, momentum and political courage to do more.”). [Durwood Zaelke, United States of America]	Noted. Wherever we refer to the Montreal protocol in general, care has been taken to refer to actual amendments or the present, and not make too general a statement about what could potentially be achieved under the protocol.
60082	37	2	37	4	Since ODSs influence stratospheric ozone, decreases in ODS would make stratospheric ozone forcing more positive. Is this effect considered here? If not, then it should be at least mentioned that this is an uncertainty. [United States of America]	Noted. The decline in stratospheric ozone is taken into account in the climate assessment of the emissions pathways.
42330	37	3			and ===> , and [Egypt]	Accepted
37838	37	7	37	8	There is not evidence that this is the case for other SLCFs than CH4 and ozone, hence name CH4 and ozone, instead of suggesting there's evidence for all SLCFs [Michiel Schaeffer, Netherlands]	Taken into account - this statement has been made more specific.
788	37	8	37	8	Scenario' should be 'Scenarios' [Robert Shapiro, United States of America]	Taken into account - the section now consistently refers to pathways.
56114	37	8	37	8	Scenario should be in plural. [Patrik Winiger, Netherlands]	Taken into account - the section now consistently refers to pathways.
37840	37	11	37	11	Reference to figure 2.11 seems incorrect: 2.10? [Michiel Schaeffer, Netherlands]	Accepted - Correct this reference was incorrect.
37842	37	11	37	12	net cooling of up to –0.2 W m–2 by 2100 Either the numerical value, or the figure is incorrect. The Figure shows values of 0.1, 0.09 and 0.05 for the scenarios listed. That is far below 0.2. Also, if the numerical value of the scenario with the largest number is taken, name only that scenario, instead of listing 3 scenarios and thereby suggesting this highest value is somehow typical across all those scenarios, when the others show lower, or substantially lower values. Writing "up to" does not compensate for tendentious reflection of data. [Michiel Schaeffer, Netherlands]	Taken into account. This section was heavily edited in response to other reviewer comments so that this value is not cited anymore.
45354	37	11	37	11	This should be Figure 2.10 lower panel not Figure 2.11. Why not a) and b). [Tuomo Kalliokoski, Finland]	Accepted
45356	37	11	37	12	This is the maximum cooling observed in scenarios, i.e. the lower limit of uncertainty. [Tuomo Kalliokoski, Finland]	Taken into account - This is correct. In order to better reflect the uncertainties, we have edited this sentence so that it does not cite a specific number anymore.
13504	37	12	37	12	spacing issues [Sergio Aquino, Canada]	Accepted
22568	37	12			Remove empty space [LUIS VALDES, Spain]	Accepted
35798	37	12	37	12	Remove extra space between to and -0.2 [India]	Accepted
39396	37	12	37	12	Between to and –0.2 W m–2 there are many free spaces, it must be revised [Olga Alcaraz, Spain]	Accepted
44194	37	12	37	12	large space after "to" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
51730	37	12	37	12	Extra space [Jason Donev, Canada]	Accepted
42332	37	13			forcing is ===> forces are [Egypt]	Rejected. We like to refer to forcing here.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
60084	37	14	37	14	Remove "out" and replace with "down the production and consumption of" so that the sentence reads: "... Amendment on phasing down the production and consumption of hydrofluorocarbons ...". As amended, the text will more accurately describe the goals set out in the Kigali Amendment to the Montreal Protocol. [United States of America]	Accepted - this suggestion was implemented
60086	37	16	37	18	Clarify the meaning of the phrase "based on the evidence available" and/or change the sentence to read: "Recent research estimates that achieving this forcing level as projected for 1.5°C scenarios would require reductions beyond those mandated by the Kigali Amendment (Figure 2.9) (Hoglund-Isaksson et al., 2017)." This suggested change more precisely clarifies the scope of the evidence being referenced. [United States of America]	Accepted - this suggestion was implemented
44844	37	21	38	7	The explanations for dots, box, red line and broken line in the bottom pannel are missing. This is the first figure of a sequence of similar figures and the explanation should be shown here. [Hiroaki Kondo, Japan]	Accepted - The caption has been updated so as to describe all aspects of the figure.
44196	37	22	37	22	there is an extra commer after nitrate [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Accepted
56116	37	22	37	22	remove one comma after nitrate [Patrik Winiger, Netherlands]	Accepted
56118	37	22	38	1	The list of aerosols should only contain aerosols, i.e. "and indirect aerosol forcing" should be removed. [Patrik Winiger, Netherlands]	Accepted - this has been corrected
56120	37	22	37	22	What does "net total of sulphate" mean? Is sea-salt sulphate excluded from this? Maybe rewrite to non-sea salt sulphate. [Patrik Winiger, Netherlands]	Taken into account - the "net total of" refers to all species that follow that phrase, including sulphate, nitrate, OC, BC, …
56124	37	22	38	7	Please be more specific about which color belongs to which group of the upper panel [Patrik Winiger, Netherlands]	Accepted - The caption has been updated so as to describe all aspects of the figure.
56122	38	1	38	1	What is comprising mineral dust? [Patrik Winiger, Netherlands]	IPCC AR4 WG1 Chapter 2, section 2.4.4.6 explains that: "Mineral dust from anthropogenic sources originates mainly from agricultural practices (harvesting, ploughing, overgrazing), changes in surface water (e.g., Caspian and Aral Sea, Owens Lake) and industrial practices (e.g., cement production, transport) (Prospero et al., 2002)." As this is a special report and not a full assessment report. It would be too much of a diversion to include definitions of each of these well-established terms.
42334	38	2			vapour ===> vapor [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
18068	38	10			2.3.2 In this section we are limiting to 5 scenarios and not covering the entire set of scenarios presented in Table 2.2. All these 5 scnarious were run by 5 IAM modelling teams. Therefore this should be written upfront for readers to understand the analysis. [Andrea TILCHE, Belgium]	Rejected, but also accepted - The section is presenting archetype pathways next to ranges over all scenarios. The reviewer is hence incorrect that the section would not be covering all scenarios. At the same time, introducing this set of pathway archetypes early on is indeed useful and is now done in Section 2.1 so that they can be used consistently throughout the chapter.
39132	38	10	40	16	So much of this is science-speak about whether or not models are efficient, when what policy makers need is an educated collation on choice of HOW to mitigate, what policies would be most effective and fair, honest science talk on unsustainable human activities and the sustainable alternatives, including our economic and social paradigms, lifestyles, etc. Otherwise this is an inward models discussion, not a reality check for us on how we are living on the earth, and what actions we can take to live more sustainably - ensuring that the IPCC does not become part of the problem of reflecting back our human inability to engage in how our actions are creating this crisis and feeding us suggestions that address some symptoms but not the disease, failing to guide a transformation. [Lindsey Cook, Germany]	Noted. The goal of this section is to provide the reader with background information on key assumptions and modelling approaches underlying the analysis of 1.5°C pathways. A discussion of the findings is provided in the entirety of Sections 2.3-2.5. Nevertheless, we revised the section and shortened the pathway modelling introduction to highlight the policy relevance more clearly.
56126	38	10	143	1	NOT REVIEWED [Patrik Winiger, Netherlands]	Noted
60088	38	12	38	32	The two "important" concepts discussed here are common sense. If previous assessments had concluded otherwise, they would be completely discredited. [United States of America]	Taken into account. We have shortened the text, now focusing on the fact that a large variety of 1.5°C pathways exist.
55536	38	13	38	14	The following reference supports the idea of no single pathway: Giannakidis G., K. Karlsson, M. Labriet, B. Ó Gallachóir (eds.), 2018. Limiting Global Warming to Well Below 2°C: Energy System Modelling and Policy Development. Springer, Lecture Notes in Energy, in press. This book shows that a well below 2°C world is feasible but extremely challenging. [Maryse Labriet, Spain]	Rejected. There are many references in support of this, we restrict ourselves to the AR5 assessment. The reference was cited at other places in the Chapter.
790	38	14	38	14	achieves' should be 'achieve' [Robert Shapiro, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
30934	38	14	38	15	This sentence doesn't appear to be grammatically correct. Also, it needs to be clear that some of these pathways are “below” 1.5, some “return”. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Sentence was removed.
56910	38	16	38	16	not just societal choices but patterns of development that are serendipitous beyond human agency [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Added "development processes" to the text.
30932	38	21	38	24	“A key finding is that 1.5°C pathways could be identified under a considerable range of assumptions in model studies despite the tightness of the 1.5°C emissions budget” – this seems to be a critical conclusion, and should be in the ES. Many people in the policy/politics world appear to have given up on 1.5 degrees. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Finding has been included in the ES
22570	38	26			Insert space between "2014)is" [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44198	38	26	38	26	needs space between "2014) is that" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
50644	38	26	38	28	Add biodiversity conservation in societal objectives along with a suitable citation [Jagdish KRISHNASWAMY, India]	Underlying paragraph was removed to shorten text. This is general matter to be discussed in Section 2.1.
58022	38	26	38	26	The spacing issue after references such as "(Clarke et al., 2014)is" re-occurs in the chapter. [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
18070	38	28	39	28	food security should be replaced by "food and nutrition security", a more comprehensive and inclusive definition in line with SDG 2 [Andrea TILCHE, Belgium]	Underlying paragraph was removed to shorten text. This is general matter to be discussed in Section 2.1.
63196	38	30	38	32	You mean?: "The variety in 1.5°C pathways suggests that policy decisions and societal choices can be made shaping pathways while supporting multiple societal objectives". [Greg Rau, United States of America]	Sentence was removed.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
4564	38	46	39	44	Please make the growth-assumptions (by region if possible) more transparent, e.g. via a table featuring other socio-economic drivers as well. [Kai Kuhnhenn, Germany]	Accepted. We have included a figure showing economic growth assumptions in available pathways.
4566	38	46	39	44	How come no scenarios with negative economic growth are presented? [Kai Kuhnhenn, Germany]	1.5°C Pathways with negative economic growth are not discussed in the academic literature. However, pathways with negative energy demand growth are considered.
42336	38	53			behavioural change and ===> behavioral change, and [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
56912	38	53	39	12	describe the SSPs in a table? [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. SSP Table was included.
3328	39	2	39	2	should be low population growth [Kamel Bennaceur, United Arab Emirates]	Noted. It is low population by the end of the century (after a peak)
3330	39	2	39	2	should high economic/more distributed growth [Kamel Bennaceur, United Arab Emirates]	Noted. It is high economic growth per capita with convergence.
31858	39	3	39	3	Here and elsewhere there is reference to 'food demand' and whether this is 'low' or 'high'. Perhaps this is implicit to the techniques used and wider context, but is it not more a question of the resource-intensiveness of food demand than whether it is low or high? - e.g. largely plant-based diets vs large component of meat in diets. This point applies in a number of places, but might be worth addressing for overall clarity as it's not really that the amount of food eaten is 'low' or 'high' (except where population varies). This distinction is already mentioned in other places - e.g. top p. 35 and top p. 52 re "GHG-intensive foods". [Stuart Capstick, United Kingdom (of Great Britain and Northern Ireland)]	This is a fair point. For the sketch of the SSPs we kept the description, but clarified the meaning in the text as needed.
42338	39	8			and ===> , and [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42340	39	10			modelling ===> modeling [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
28052	39	18	39	18	While it is clear that "female educational attainment" has a dominant role in the population growth projections, it is not the only factor. Please reference other factors that constrain population growth rates, or rephrase in order to clarify the dominant role of education for women and girls in population growth projections more clearly. [Germany]	Taken into account. We have rephrased to make clear that it is an important, but not the only factor.
22572	39	22			What does it mean "2005USD"? do you mean USD in data obtained in 2005 or otherwise you mean in USD according to the currency value in 2005? I think that it is unclear [LUIS VALDES, Spain]	Accepted. The currency value is meant. This is clarified in the text.
18072	39	24	39	25	Better provide a graph that illustrates the range of regional variations [Andrea TILCHE, Belgium]	Taken into account. We removed the sentence.
51732	39	27	39	27	This is a curious statement. How are the economic growth and population growth being decoupled here? [Jason Donev, Canada]	Noted. It is not implied that the two are decoupled. If economic growth was mostly driven by population growth, energy emissions would still respond. Only if it did not drive economic growth (e.g. because productivity is assumed to decline with growing population), energy emissions would not be strongly affected by population growth. The cited literature conducted a sensitivity analysis which varied population and per capita(!) economic growth.
62294	39	27	39	29	This sentence is ambiguous. What literature does it refer to? Checking the reference, it seems to refer only to the IAM literature. In this case, it reflects modeling assumptions rather than empirical findings. The question of the relationship of GDP and energy use/CO2 emissions is an important empirical question with a rich econometric literature, which seems to be neglected here. I would like to refer to the work of David I Stern, Environment and Development Economics 22 (6), 699-724; Ecological Economics 124, 17-24; Energy Journal 37 (2), 223-255) [Edgar Hertwich, United States of America]	Taken into account. Sentence was reworded to explicitly refer to baseline projections in scenarios.
49594	39	29	39	29	A more balanced view is important here. Depending on demand-side developments, land-demand (and thus C emissions from the land sectors) are not necessarily following population dynamics (Erb et al., 2016 10.1038/ncomms11382, Muller et al 2017, 10.1038/s41467-017-01410-w). Similar relation relate to wood fuel (Krausmann et al. 2013 doi10.1073/pnas.1211349110), but here the communication between energy carriers is important. [Karlheinz ERB, Austria]	Accepted. We qualified the statement to refer to baseline projections assuming unchanged productivity and per capita demand.
11762	39	30	39	32	That reaching 1.5ºC in scenarios with high population growth is so difficult feels worth bringing out more prominently (inc in the summaries). [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. We have revised the discussion of socio-economic impediments to deep mitigation.
60090	39	30	39	34	This is a result of the IAM scenario comparision that is worth highlighting more. It is intuitive,which is good, but also consisent across many different models and model simulations (which were set up to analyze a variety of issues). [United States of America]	Taken into account. We have revised the discussion of socio-economic impediments to deep mitigation.
51734	39	38	39	38	Exponent is broken across two lines [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
22574	39	39			The number 2 at the very start of this line should be an exponential in m-2 at the end of previous line [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
17690	39	47	44	5	The mitigation / policy options are based on the Global model. The uncertainty of these models need to be written. In order to be applied to a specific area, it is necessary to consider regional characteristics. Although the IPCC report needs to be written as overall point of view, I hope the statement on these characteristics need to be added [Republic of Korea]	Noted. We added a statement that regional characteristics are important. Regional variations are reflected in global models to varying degrees.
45870	39	47	44	5	Would the reader benefit from a slightly deeper discussion of why a significant number of Mitigation Measures listed are omitted from Pathway Literature, and the consequences of this? I am aware that the passage signposts that a deeper discussion of mitigation technologies is in Chapter 4, however, a slightly more comprehensive discussion of the taxonomy (figure 2.8) may benefit the reader at this stage. [Louis Brown, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. We added a statement on technology choices in pathway modelling and discuss the potential consequences of less covered mitigation technologies on pathways.
3280	39	53	39	55	The reference given here which helps the reader understand how IAMs are structured, how they work, and key methodological issues is extremely important, but I feel it comes a bit too late. I suggest this reference is included in section 2.1.2 where the crucial role of IAMs is first elaborated upon, and again to the beginning of section 2.3. [Vassilis Daioglou, Netherlands]	Taken into account. The discussion of IAM assumptions has now been moved to Section 2.3.1 and is also taken up in an own Annex to the Chapter.
11764	39	53	39	54	A brief outline of these points here would be useful. Not just a reference to AR5. [United Kingdom (of Great Britain and Northern Ireland)]	Noted. The half sentence was removed, and the focus put on advances since AR5. An Annex with an extensive review of IAMs was added.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
28054	40	2	40	2	With "these mitigation options" you seem to refer to CDR, too. But not all CDR-options are existing mitigation options, some are speculative regarding their potential, side-effects and implementation at large scale. Please differentiate, and see also our general reservations of classifying all CDR options as mitigation technologies. [Germany]	Accepted. Sentence was removed during the rewriting of the Section.
792	40	4	40	4	Table 2.8' should be 'Figure 2.8' [Robert Shapiro, United States of America]	Rejected. It truly is a table, now moved to the Annex.
30830	40	4	40	4	I do not understand how the reference (van Sluisveld et al., 2016) relates to the sentence. [Érika Mata, Sweden]	Reference was removed here and re-assigned at the appropriate location in the text. .
30832	40	4	40	6	Can one reasonably claim "increasing attention" if only 2 references are given? Both Grubler et al. (2017) and van Vuuren et al. (2017d) are only submitted. My personal interpretation is that, although 2 references are indeed more than none, the list of demand side measures compiled in Table 2.8 is rather limited, in particular if the measures are attributed to sectors. [Érika Mata, Sweden]	Noted. There is a robust literature on dietary changes and energy demand measures. Two references (McCollum, van Sluisveld) are provided as an example, we added a third one on land use options.
42342	40	5			modelling of behavioural ===> modeling of behavioral [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
40028	40	12	40	14	Here the terms disruptive and speculative are mentioned. These have completely different meanings and it is not clear how they relate to the options in Table 2.8. The table just checks whether and how the various options are included in models, but not whether they are speculative or disruptive. I suggest to leave out these terms and just be factual about inclusion or not. [Kornelis Blok, Netherlands]	Accepted. Terms are removed.
55470	40	12	40	16	This statement would be ok if it were true. Table 2.8 and section 2.3.3.4 makes no mention of specific technologies that are well advanced (certainly more advanced than BECCS), and chapter 4 is almost devoid of any relevant discussion. See my comment on page 35 lines 37ff. To avoid this chapter giving a very biased treatment simply on the basis of what current IAMs include and don't include (and pretending that this then reflects whether technologies are speculative or not), please ensure that somewhere in this chapter you have a discussion of the substantial range of mitigation options especially in the land sector that are not generally included in IAMs and the quantifications that underpin this chapter. [Andy Reisinger, New Zealand]	Accepted. We have updated the discussion originally in 2.3.3.4 (now moved to 2.3.1.2) to include a paragraph on land use. We have expanded the table to include advanced land use mitigation options.
60092	40	12	40	14	Would it not be fair to say that IAMs do NOT account for rapid, unknown (or non-characterizable via economics and performance) technology or behavioral changes? Technologies which may be feasible but are not yet commercial (with a plausible future cost/performance path) are not included. Question the use of the word 'disruptive'. [United States of America]	Noted. We clarified what we meant with disruptive. Such technologies are not unknown, there prospects are uncertain. We introduced a sentence explaining IAM choices, including the availability of cost/performance data.
42344	40	13			modelling ===> modeling [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
794	40	14	40	14	Table 2.8' should be 'Figure 2.8' [Robert Shapiro, United States of America]	Rejected. It truly is a table, now moved to the Annex.
1698	41		41		It is very strange that a missing row in the energy demand set of measures is the addition/improvement of buildings' insulation - this measure is critical for improving the energy performance of buildings, for reducing enerhy consmption and for improving thermal comfort in buidlings. It is of primary importance for many countries that have a rather old building stock, and its effect on energy consumption and GHG emissions has been extensively examined in the literature. [Greece]	Taken into account - The improvement of building insulation is part of the item "Reduced energy and service demand in buildings (e.g., via behavioural change, reduced material and floor space demand, infrastructure and buildings configuration)"
7228	41		41		In the table of the page 2-41 in the raw "CCS in industrial process applications", please, add after the reference "Fischedick et al., 2014" the reference "Tsupari et al. 2015." Tsupari, E., Kärki, J., Arasto, A., Lilja, J., Kinnunen, K., Sihvonen, M.. 2015. Oxygen blast furnace with CO2 capture and storage at an integrated steel mill. Part II: Economic feasibility in comparison with conventional blast furnace highlighting sensitivities: Elsevier. International Journal of Greenhouse Gas Control, Vol. 32, pp. 189 - 196 doi:10.1016/j.ijggc.2014.11.007 [Ilkka Savolainen, Finland]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
11766	41		41		In the table, quite a few things are A and D. How is this possible? [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - the level of inclusion has been clarified in the revised version of this table. As this revised table now reports the level of inclusion per model and per mitigation option, it is now hopefully clear that different models can include different mitigation measures in different ways.
11768	41		45		Level of inclusion in integrated pathway literature - what exactly does this mean? E.g. for CCS, it's an A/D. Does that mean all studies either have it endogenously, or not at all? And for reduced enegy and service mobility, all studies include it as a B or C, and no studies ignore it entirely? [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - the level of inclusion has been clarified in the revised version of this table. As this revised table now reports the level of inclusion per model and per mitigation option, it is now hopefully clear that different models can include different mitigation measures in different ways.
11770	41		45		It's not clear what the difference between the last two columns is [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - the revised table now only includes the level of inclusion in the models that actually contributed scenarios to this assessment.
11772	41		45		What kind of options are included in "Fuel switching and replacing fossil fuels by electricity in end-use sectors (partially a demand-side measure)" - e.g. cookstoves are already covered above? [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - As indicated in the item's description, this option is already partially covered by demand-side measures. However, options that can be considered under this umbrella are switching to less carbon-intensive liquids for transport or less carbon intensive fossils for heating.
11774	41		41		It's not clear what the difference between A and B is for the two types of endogenous measures. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The table caption now clarifies this.
15740	41		44		It would be helpful if the table could also indicate which of these options are included in the specific models used in this chapter. Re table caption: meaning of last sentence is not clear. [Australia]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6).

Comment No	From Page	From Line	To Page	To Line	Comment	Response
18076	41		41		Table 2.8: the appearance of more than one 'taxonomy score' is confusing. e.g. when a measure scores 'A/D' does this mean that at least one pathway represents the measure explicitly AND at least one does not represent it all (and the B & D scores do not apply in any pathway identified)? [Andrea TILCHE, Belgium]	Taken into account - the level of inclusion has been clarified in the revised version of this table. As this revised table now reports the level of inclusion per model and per mitigation option, it is now hopefully clear that different models can include different mitigation measures in different ways.
19606	41		44		Table 2.8 about the mitigation options doesn´t really list forest restoration or forest management despite their significant potential (eg Griscom et al 2017 or Kartha and Dooley 2016) [Jennifer Morgan, Netherlands]	Taken into account - These examples have been included.
39134	41		44		If D represents actions 'not represented', it is of concern that the following effective policy actions include 'D' categorization: urban avoided transport and building energy demand, hydrogen, solar and geo-thermal heating, livestock and grazing management, changing agricultural practices to enhance soil caron, conservation agriculture, afforestation/reforestation, restoration of wetlands. [Lindsey Cook, Germany]	Noted. Glad the table provided the reviewer with the necessary information required to reach these insights.
45576	41		44		I suggest including urban and peri-urban agriculture in the table (Kulak et al., 2013; Lee et al., 2015; Benis and Ferrao, 2017). Include as well urban and peri-urban forestry and specially afro-forestry. [Adela M Sánchez-Moreiras, Spain]	Taken into account - These examples have been included.
54892	41		42		The hydrogen should be included in decarbonization of electricity too even though hydrogen is included in decarbonization of non-electricity fuels(electricity from fuel cell using hydrogen made from renewable energy sources is an example of decarbonization of electricity) [Dong-Woon Noh, Republic of Korea]	Taken into account - These examples have been included.
63198	41		44		Somewhere you will have to define and differentiate (or not) AFOLU and CDR that in some cases seem identical and have similar mechanisms of action and outcome(?) You've clearly abandoned the CDR = mitigation definition in Chapter 1. [Greg Rau, United States of America]	Noted. The differentiation is done in Sections 2.3.2.2 and 2.3.4.1.
30828	41		41		I do not understand the headings in table 2.8. Several questions: 1) What is "integrated pathway literature"? Maybe "studies that use integrated assessment models"?. 2) what is the difference between the two rightmost columns? and how do they relate to the classification in Table 2.2. "multi-model" and "single-model"? 3) in the column Level of inclusion, how can a measure at the same time be D (not represented) something else? I would understand if several references are given, but e.g. (looking at Demand side measures only) in "CCS in.." there are 3 levels and only 2 references, and it is the othereway round in "Urban form..." for which there are 2 levels and many references. 4) how does the table relate to the modelling dicotomy IAM-sectoral used later in the paper? Could, or are already, the"IEA-ETP studies" be included in the table? [Érika Mata, Sweden]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks.
55538	41		44		The following reference could be inserted (I will be pleased to let Lead Authors know where it would apply): Giannakidis G., K. Karlsson, M. Labriet, B. Ó Gallachóir (eds.), 2018. Limiting Global Warming to Well Below 2°C: Energy System Modelling and Policy Development. Springer, Lecture Notes in Energy, in press. This book shows that a well below 2°C world is feasible but extremely challenging. [Maryse Labriet, Spain]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
1576	41	1	44	70	More detailed references presenting, assessing, and exploring most of these measures include (1) Jacobson, M.Z., and M.A. Delucchi, Providing all Global Energy with Wind, Water, and Solar Power, Part I: Technologies, Energy Resources, Quantities and Areas of Infrastructure, and Materials, Energy Policy, 39, 1154-1169, doi:10.1016/j.enpol.2010.11.040, 2011; (2) Delucchi, M.Z., and M.Z. Jacobson, Providing all global energy with wind, water, and solar power, Part II: Reliability, System and Transmission Costs, and Policies, Energy Policy, 39, 1170-1190, doi:10.1016/j.enpol.2010.11.045, 2011; (3) Jacobson, M.Z., M.A. Delucchi, Z.A.F. Bauer, S.C. Goodman, W.E. Chapman, M.A. Cameron, Alphabetical: C. Bozonnat, L. Chobadi, H.A. Clonts, P. Enevoldsen, J.R. Erwin, S.N. Fobi, O.K. Goldstrom, E.M. Hennessy, J. Liu, J. Lo, C.B. Meyer, S.B. Morris, K.R. Moy, P.L. O'Neill, I. Petkov, S. Redfern, R. Schucker, M.A. Sontag, J. Wang, E. Weiner, A.S. Yachanin, 100% clean and renewable wind, water, and sunlight (WWS) all-sector energy roadmaps for 139 countries of the world, Joule, 1, 108-121, doi:10.1016/j.joule.2017.07.005, 2017 [Mark Jacobson, United States of America]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
18074	41	1			Comments on the table: The "level of inclusion" does not seem to be correct and it is contradictory across measures. It is claimed that "bioelectricity", biofuels and BECCS are fully and edogenously modelled. That is unlikely to be correct or possible. The GHG performance of these technologies activities depends crucially, inherently and predominantly on their land use impact. The models clearly ignore the CO2 emissions from the combusiton of biomass for energy (consider it zero), but actual emissions are comparable to or higher than fossil emissions (except for BECCS, which can sequester some of the emissions at a significant energy, and therefore land use cost), and therefore ALL the benefits must accrue in the land sector (as increased sequestration) or as reduced emission from waste. See, for example, Haberl et al. 2012. Correcting a fundamental error in greenhouse gas accounting related to bioenergy. Energy policy, Vol: 45-222, Issue: 5, Page: 18-23 Given that these energy sources compete for the same land base with each other and with all other uses of land and biomass (food, raw material and sequestration), the quantification and truly "explicit and endogenous" modelling of these energy sources would only be possible if the modelling included a complete, explicit and endogenous model of land use. That is clearly not the case, see, e.g.: Haberl, Helmut, 2013. Net land-atmosphere flows of biogenic carbon related to bioenergy: towards an understanding of systemic feedbacks. Global Change Biology Bioenergy, 5, 351-357Biomass for energy only implies removals only if (and to the extent that) it is ADDITIONAL, that is to the extent the use of biomass for energy triggers assitional removal by the vegetation (or if it reduces losses, like from natural decomposition). Moreover, the table shows that forest management, land degradation/restoration, grazing, agroforestry and wetlands (that is, the most critical determinants of the land carbon balance) are represented only partially, exogenously or not at all. This makes it impossible for bioenergy to be represented explicitly, endogenously and CORRECTLY. [Andrea TILCHE, Belgium]	Taken into account - The reviewers assertion is incorrect. Most IAMs do include the emissions from combustion, with a carbon content between that of oil & coal. IAMs also model LUC emissions from bioenergy. Moreover, the table reports the level of representation of mitigation "options" but does not report the processes underlying these options. For example, if options to change grazing or wetland practices are only allowed to change through exogenous assumptions, this does not mean that the land models do not account for the implied carbon fluxes. if emissions from bioenergy would be considered zero, no model would combine it with CCS to achieve negative emissions.
42346	41	1			modelled ===> modeled [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
45926	41	1	41	1	The table misses bio-based materials to replace fossil fuel uses as feedstock in the production of chemicals and polymers. [Deger Saygin, Turkey]	Taken into account - this option has now been included as "Carbon Capture and Usage – CCU; bioplastics (bio-based materials replacing fossil fuel uses as feedstock in the production of chemicals and polymers), carbon fibre"
47888	41	1	44	5	Please check the citations in Table 2.8: Pietzcker et al., 2017a; Fuss et al.; Minx et al.; Strefler et al.; ……..not available in reference section [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
50708	41	1	41	1	Box "electrification of energy demand". The reviewer does not see any mitigation effect in the use of electric stoves. It should be changed perhaps to "induction stoves". [Francisco Javier Hurtado Albir, Germany]	Taken into account - This example was considered and included.
21450	41	1	44	5	In Table 2.8 it remains unclear what the column "Level of inclusion in integrated pathways literature" (rating A-D) is based on. I would suggest to move to a more formal definition of metricss, for example by counting referneces or using documentation or meta information on the models that contributed scenarios to the SR1.5 report. [Volker Krey, Austria]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
28056	41	1	45	5	Table 2.8 shows a sort of "taxation of mitigation options" in literature. References are divided into those which assess measures in general and those, which refer to particular measures. However, the potential to increase readability should be explored, i.e., measures which are not represented (identifier "D") in any study should be listed at the bottom of the resp. section of the table. In addition the use of several identifiers, i.e. B/C/D in one box is confusing in regard to the relevance of which sort of reference (see above) and should be explained further in the caption of table 2.8. A rather general issue is, whether this relatively long table should be better placed in a supplementary document to Ch 2. [Germany]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6).
37370	41	1	44	5	In my view this Table is not balanced. Demand-side options receive too little treatment, given the importance of demand-side options in the overall portfolio (also mentioned in the chapter summary: it is clear that without strong demand-side changes 1.5 cannot be reached. But in this table, demand side is less than a page, supply side almost three. This sends a strong message which may not even be intended by the authors of the draft. [Helmut Haberl, Austria]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table. Several additional demand-side measures have been considered for the table.
50710	41	1	41	1	Box "electrification of industrial energy demand". The list should be completed with "extensive use of motor control, induction heating, industrial use of microwave heating" [Francisco Javier Hurtado Albir, Germany]	Taken into account - These examples have been included.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
50712	41	1	41	1	Box "higher share of useful energy in final energy" it reads "coupled heat and power generation", but the correct, most acknowledged term is "combined heat and power generation or CHP". Add "district heating" to the list [Francisco Javier Hurtado Albir, Germany]	Taken into account - This example was considered and included.
50714	41	1	41	1	Box "reduced material demand" add within the brackets, "use of locally available building materials" [Francisco Javier Hurtado Albir, Germany]	Taken into account - This example was considered and included.
50716	41	1	41	1	Box "urban form" add "Integration of district energy or distributed on-site energy generation in urban Green Infrastructure" [Francisco Javier Hurtado Albir, Germany]	Taken into account - This example was considered and included.
56914	41	1	41	1	very useful table [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Noted. However, it has now been updated and moved to the Technical Annex.
37372	41	1	44	5	p. 42: why are bio-electricty and biofuels listed under "de-carbonization"? In fact, burning biomass is a more carbon-intensive technology than almost any other electricity generation option respectively fuel, including burning gas and oil, perhaps with the exception of coal (which is similar). See e.g. Holtsmark, 2012. Climatic Change 112, 415–428; Holtsmark, 2015. GCB Bioenergy 7, 195–206; Holtsmark, 2015. GCB Bioenergy 7, 984–997. Searchinger, 2010. Environ. Res. Lett. 5, 024007. Searchinger et al 2017. Energy Policy 110, 434–446. Haberl et al. 2012. Energy Policy 45, 18–23. Bird et al. 2012. GCB Bioenergy 4, 576–587. Moreover, in order to reduce CO2 from fossil fuel combustion, introduction of bio-electricity must be explicitly shown to replace fossil fuels, which is not necessarily the case. For example, York, 2012. Nature Climate Change 2, 441–443 showed that adding one unit of bioenergy to the system only reduces fossil fuels by a small fraction of one, perhaps 0.1-0.2 In addition many other technologies listed under "decarbonization" are characterized by very few refs, often the same ref for several technologies. Even if these are examples, I think this does not fully reflect the breadth of literature out there. Biofuels are a case in point where the literature is endless, but not even one ref listed under "assessing measures". I propose that it is hugely importance to carefully select refs covering the full spectrum of opinions, in particular in cases where there is as much disagreement as with biofuels or bio-electricty. [Helmut Haberl, Austria]	Taken into account - Bio-electricity and biofuels are listed with the understanding that the CO2 released during the combustion processes related to these sources of energy is captured from the atmosphere by photosynthesis during the growth of biomass. Trade-offs with land-use change are considered under the AFOLU measures.
37374	41	1	44	5	p 43, last line: I suggest to cite Rockström et al. 2016. Earth's Future 4, 465–470 when discussing BECCS [Helmut Haberl, Austria]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
37378	41	1	44	5	Unbalanced citations for "forest management". Consider adding Kurz et al. 2016. Unasylva 6; Schulze, 2012. GCB Bioenergy 4, 611–616, Naudts et al. 2016. Science 351, 597–600. Holtsmark, 2012. Climatic Change 112, 415–428, Böttcher et al. 2012. GCB Bioenergy 4, 773–783 (there are many more). [Helmut Haberl, Austria]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
45400	41	1		1	Reference for "CCS in industrial process applications (cement, pulp and paper, iron steel, oil and gas refining, chemicals": Environment, August 2016. https://doi.org/10.1016/j.trd.2016.07.003. Kuramochi, Takeshi, Andrea Ramírez, Wim Turkenburg, and André Faaij. "Comparative Assessment of CO2 Capture Technologies for Carbon-Intensive Industrial Processes." Progress in Energy and Combustion Science 38, no. 1 (February 2012): 87–112. https://doi.org/10.1016/j.pecs.2011.05.001. [Gunnar Luderer, Germany]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
45402	41	1		1	Table entry "Energy efficiency improvements in energy end uses (appliances in buildings, engines in transport, industrial processes, …)". There are a number of relevant bottom-up studies assessing efficiency potentials in industry that should be cited here, e.g.: Kermeli, Katerina, Wina H. J. Graus, and Ernst Worrell. "Energy Efficiency Improvement Potentials and a Low Energy Demand Scenario for the Global Industrial Sector." Energy Efficiency 7, no. 6 (December 1, 2014): 987–1011. https://doi.org/10.1007/s12053-014-9267-5. Worrell, Ernst, Lenny Bernstein, Joyashree Roy, Lynn Price, and Jochen Harnisch. "Industrial Energy Efficiency and Climate Change Mitigation." Energy Efficiency 2, no. 2 (May 1, 2009): 109–23. https://doi.org/10.1007/s12053-008-9032-8. [Gunnar Luderer, Germany]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.

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45404	41	1		1	Table Entry "Reduced material demand via higher resource efficiency, structural change, behavioural change and material substitution (e.g., steel and cement)". Suggest adding as a reference on material efficiency Allwood, Julian M., Michael F. Ashby, Timothy G. Gutowski, and Ernst Worrell. "Material Efficiency: Providing Material Services with Less Material Production." Phil. Trans. R. Soc. A 371, no. 1986 (March 13, 2013): 20120496. https://doi.org/10.1098/rsta.2012.0496. [Gunnar Luderer, Germany]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
50706	41	1	41	1	Box "electrification of transport demand". Within the brackets adding a reference to "more electric aircraft" or MEA (Rosero et al. "Moving towards a more electric aircraft" IEEE Aerospace and Electronic Systems Magazine, Volume: 22, Issue: 3, March 2007) also to the all-electric aircrafts (Amir S.Gohardani, Georgios Doulgeris, Riti Singh "Challenges of future aircraft propulsion: A review of distributed propulsion technology and its potential application for the all electric commercial aircraft", Progress in Aerospace Sciences Volume 47, Issue 5, July 2011, Pages 369-391). [Francisco Javier Hurtado Albir, Germany]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
62296	41	6			I do not understand what "higher share of useful energy in final energy" means. The examples in parenthesis do not help [Edgar Hertwich, United States of America]	Useful energy is the energy directly providing the energy service (such as room temperature mobility) after losses of final energy delivered to the end use device.
62298	41	8			The "level of inclusion" for "reduced material demand .." is D for most scenarios and IAMs. The only reference provided here where this is allegedly done is to a work not yet published, by Grubler et al. I did not know that the IPCC was allowed to refer to unpublished work; it seems like the rules have changed since I contributed to AR5. [Edgar Hertwich, United States of America]	Grubler et al. was accepted by the time of the report's deadline and is now published.
19556	42		44		Table 2.8. Mitigation measures representation in integrated pathway literature page (table). The table is missing key sources e.g. regarding nuclear energy, like ones that show the challenging economics of SMRs - The Economic Failure Of Nuclear Power And The Development Of A Low Carbon Electricity Future: Why Small Modular Reactors Are Part Of The Problem, Not The Solution, Institute for Energy and the Environment Vermont Law School May 2014, Mark Cooper, Ph.D. seehttp://www.ourenergypolicy.org/wp-content/uploads/2014/05/Cooper-SMRs-are-Part-of-the-Problem-Not-the-Solution-FINAL2.pdf [Jennifer Morgan, Netherlands]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
50718	42		42		Box "hydrogen", replace with "hyrogen technology and fuel cells" [Francisco Javier Hurtado Albir, Germany]	Taken into account - These examples have been included.
50720	42		42		Box "electrical transmission efficiency improvement", replace with "Efficient and reliable electric energy transport and distribution (FACTs, smart grids)". Literature reference for FACTs: Klaus Habur, Danal O'Leans, "FACTS-Flexible Alternating Current Transmission Systems: For Cost Effective and Reliable Transmission of Electrical Energy". World Bank document. August 2004. Literature reference for smart grids IRENA (International Renewable Energy Agency) 2013, "Smart Grids and Renewables" http://www.irena.org/documentdownloads/publications/smart_grids.pdf [Francisco Javier Hurtado Albir, Germany]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
58458	42		42		In table 2.8, for " Reduced gas flaring and leakage in extractive industries" , suggest to add as IEA World Energy Outlook 2017 as a key reference (first-of-a-kind analysis of CH4 abatement potential in oil and gas sector) [Andrew Prag, France]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
14032	42	1	42	1	Is there really no solar power included under "Decarbonisation of electricity" section of the Table? Think this is an omission. Note that this sub-heading needs to be inserted in row 2 as currently missing. And how can you have an A/D entry? This needs clarifying. [Ralph Sims, New Zealand]	Taken into account - Solar PV and CSP are included as options in the table.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
51736	42	1	42	1	The literature on small modular reactors (SMRs) does not seem to have been reviewed at all. There is extensive literature on this subject which has been entirely ignored and inaccurately represented here. [Jason Donev, Canada]	Taken into account - This option has been included in the table. However, due to the new goal of this overview table, it only provides an overview of the level of integration of these options in the models that provided scenarios supporting the assessment in this chapter.
57200	42	1	42	1	line solar PV of table: the two following literature pieces should be added documenting a full decarbonisation of electricity supply, mainly based on solar energy: DOI: 10.1002/pip.2950 and Ram et al. (2017) (ISBN: 978-952-335-171-4) link: https://www.researchgate.net/publication/320934766_Global_Energy_System_based_on_100_Renewable_Energy_-_Power_Sector [Christian Breyer, Finland]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
57202	42	1	42	1	line: Power-to-gas, methanisation, synthetic fuels: Fasihi et al., 2017 can be added: doi:10.3390/su9020306 [Christian Breyer, Finland]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
3332	42	7	42	7	Add the IEA Report: The Future if Trucks [Kamel Bennaceur, United Arab Emirates]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
3334	42	8	42	8	Add Urban Design (IEA/ETP 2016) [Kamel Bennaceur, United Arab Emirates]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
3336	42	15	42	15	Add the IEA CCS Book (20-years of CCS - 2016) [Kamel Bennaceur, United Arab Emirates]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47794	43		43		Please check: Table 2.8: incomplete citation: Fuss et al.; Minx et al. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
15742	43				Suggest delete or explain terminology here: "and so on" when refering to methane reduction; "Livestock and grazing management, protein feed" (is it about manpulating diet?); re Nitrogen: "substitution of nitrogen with mineral fertilizer" makes no sense. A key study re biocar and bioenergy that should be cited: Woolf, D., Lehmann, J. and Lee, D.R., 2016. Optimal bioenergy power generation for climate change mitigation with or without carbon sequestration. Nature communications, 7, p.13160. [Australia]	Taken into account - This has been clarified with actual examples. The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
35800	43		43		Add 'feeding management or feed additives for reducing methane and ammonia emissions' (ref: Feeding strategies to reduce methane and ammonia emissions. David R. Yáñez-Ruiz, Diego Morgavi, Tom Misselbrook, Marcello Melle, Silvija Dreijere, Ole Aes, and Mateusz Sekowski. 2017. https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/fg18_mp_feeding_strategies_2017_en.pdf. in the Table in 5th row on Livestock and grazing management..... [India]	Taken into account - These examples have been included. The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
40824	43		43		add 'feeding management or feed additives for reducing mentahne and ammonia emissions' (ref: Feeding strategies to reduce methane and ammonia emissions. David R. Yáñez-Ruiz, Diego Morgavi, Tom Misselbrook, Marcello Melle, Silvija Dreijere, Ole Aes, and Mateusz Sekowski. 2017. https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/fg18_mp_feeding_strategies_2017_en.pdf. in the Table in 5th row on Livestock and grazing management..... [NARESH KUMAR SOORA, India]	Taken into account - These examples have been included. The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
28058	43		44		With "these mitigation options" you seem to refer to CDR, too. But not all CDR-options are existing mitigation options, some are speculative regarding their potential, side-effects and implementation at large scale. Please differentiate, and see also our general reservations of classifying all CDR options as mitigation technologies. [Germany]	Taken into account - the revised table now lists mitigation measures, without suggesting that they are an "option".
50724	43		43		Box "agroforestry", replace with "agroforestry and silviculture" [Francisco Javier Hurtado Albir, Germany]	Taken into account - These examples have been included.
50726	43		43		Box "Increasing agricultural productivity", add "sustainable fertilisers" [Francisco Javier Hurtado Albir, Germany]	Taken into account - These examples have been included.
50728	43		43		Box "fire management and pest control" insert "(ecological)" before "pest" [Francisco Javier Hurtado Albir, Germany]	Taken into account - These examples have been included.
50722	43		43		Box "livestock and grazing management …". Add "interactions of renewable energies in livestock; reuse of food processing refuse for fodder production". Literature reference for the fodder issue M. Wadhwa M. P. S. Bakshi, "Utilization of fruit and vegetable wastes as livestock feed and as substrates for generation of other value-added products", FAO 2013. http://www.fao.org/3/a-i3273e.pdf. For renewables, referencecould be International Fund for Agricultural Development (IFAD), "Livestock and renewable energy". 2012 [Francisco Javier Hurtado Albir, Germany]	Taken into account - These examples have been included. The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
50730	43		43		Insert box for "food processing (use of renewanble energies, efficient foor processing, storage or conservation)". Literature reference Organisation for Economic Co-operation and Development; "IMPROVING ENERGY EFFICIENCY IN THE AGRO-FOOD CHAIN "; May 2017 [Francisco Javier Hurtado Albir, Germany]	Taken into account - These examples have been included. The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
49598	43	1	43	1	Please make sure that with increasing agricultural productivity all GHG, also including the increased use of mineral fertilizers and loss of soil carbon are taken into account. [Karlheinz ERB, Austria]	Taken into account - These examples have been included.
49600	43	1	44	1	I wonder why manure managment is not listed [Karlheinz ERB, Austria]	Taken into account - These examples have been included.
49596	43	1	43	1	Table: Forest management seems not be qouted on balanced terms see e.g. Kurz et al., 20126, Unasylva 4, Pingoud et al. 2018 doi 10.1016/j.jenvman.2017.12.076 [Karlheinz ERB, Austria]	Taken into account - The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
15744	44				Wood burial is not a soil carbon enhancement option. [Australia]	Accepted - This example was removed from the item "soil carbon enhancement"
47796	44		44		Kindly check: Table 2.8: incomplete citataions: Fuss et al.; Minx et al.; Strefler et al.; [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
50732	44		44		Box "soil carbon enhancement …". Add "Enhancing carbon sequestration in biota and soils, e.g. plants with high carbon sequestration potential" [Francisco Javier Hurtado Albir, Germany]	Taken into account - These examples have been included.
51738	44	1	44	1	Label for table goes at the top. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
3286	44	1	44	5	table 2.8 is important, but it is quite general, could not be identified for 1.5? studies? [Xiu Yang, China]	Accepted- The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
5246	44	1	45	27	I did not have time to carefully review section 4.4, but it looks to be focused on whether it might be possible to managa a transition to 1.5 C without exceeding it, and yet the world is pretty clearly on a path to a very significant overshoot, indeed, quite possibly, to over 3 C and then a slow pull back to 1.5 C (a level that itself has quite a number of impacts associated with it). Thus, it seems to me that either (a) the section is not facing up to the overshoot warming that it certainly appears is going to result; or (b) there is a hidden reliance on climate intervention being used to keep the temperature at 1.5 C or below. It seems to me that the reality that lies ahead needs to be made vey clear, openly presenting real the dilemms that society faces, and this is if the target is 1.5 C (a politically selected value that I think the scientific community, through assessments, need to explore and explain the implications of, noting that it was when the global average temperature rose above about 0.5 C when some of the most serious consequences started to emerg, so that returning to below 0.5 C is really the value to return to. [Michael MacCracken, United States of America]	Noted. There are no hidden assumptions about climate interventions in the 1.5°C pathways. Chapter 2 is striving to bring out the key characteristics, enabling and impeding factors of 1.5°C pathways. This includes overshoot pathways.
22576	44	1			The fourth entry in the table remits to "blue carbon" therefore some literature on blue carbon should be cited in the third and fourth columns, my recommendations are: Column 3 (studies presenting/assesing): Nellemann, C., E. Corcoran, C. Duarte, L. Valdés, C. De Young, L. Fonseca and G. Grimsditch. 2009. Blue Carbon: the role of healthy oceans in binding carbon: a rapid response assessment. UNEP, Grid Arendal. ISBN: 978-82-7701-060, 78pp. Column 4 (studies explicitly exploring specific measures): Howard, J., Hoyt, S., Isensee, K., Pidgeon, E., Telszewski, M. (eds.) (2014). Coastal Blue Carbon: Methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrass meadows. Conservation International, Intergovernmental Oceanographic Commission of UNESCO, International Union for Conservation of Nature. Arlington, Virginia, USA. [LUIS VALDES, Spain]	Taken into account - This has been clarified with actual examples. The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
51740	44	1	44	1	Wait, how are the last two options 'D' with the citations provided? Could this be explained a little more in the table? [Jason Donev, Canada]	Taken into account - This has been clarified with actual examples. The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
56458	44	1			A this paper could be added to table 28, it investigates CO2 uptake by mineralisation of Olivine sand, spread on coasts, beaches article. An estimate should be made houw spreading Olivine sand on many beaches can help protect that coast and capture CO2 at the same time. In the Netherlands adding sand to beaches is standard practice to protect sandy coasts, replacing natural sand with Olivine sand captures a significant part of the Dutch CO2 reduction ambition. https://www.researchgate.net/publication/314662834_Olivine_Dissolution_in_Seawater_Implications_for_CO2_Sequestration_through_Enhanced_Weathering_in_Coastal_Environments [Henk Daalder, Netherlands]	Taken into account - This has been clarified with actual examples. The intention of SOD Table 2.8 was to provide a taxonomy of mitigation measures covered in the integrated pathway literature. However, during the revisions for the final government draft, this was considered outside the scope of this Special Report. Instead, a table has been included in the Technical Annex of Chapter 2 which details the inclusion of specific measures in the models that provided scenarios to the database supporting the Chapter 2 assessment (Table 2.A.6). This table now serves a different goal. Instead of attempting to provide an overview of all different measures that can be represented in models, it provides a factual elicitation of measures as included in the contributing modelling frameworks. The references to more general literature on mitigation measures have thus not included anymore in the revised version of this table.
11776	44	3	44	4	Measures with several characters in the last column are treated differently by different models. - there aren't any? Is a column missing? [United Kingdom (of Great Britain and Northern Ireland)]	No. "Last" should read "latter".
30834	44	3		3	In table 2.8 caption, what is meant by "several characters in the last column"? And would that be the last column to the left or to the right? [Érika Mata, Sweden]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
3218	44	4	44	4	By "last column" I assume you mean "second column"? [Vassilis Daioglou, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
29634	45	2	45	2	Please insert after "put in place": (see Michaelowa et al. 2018 for a discussion about appropriateness of policies for a 1.5°C scenario)." Reference: Michaelowa, Axel; Allen, Myles; Fu Sha (2018): Policy instruments for limiting global temperature rise to 1.5°C – can humanity rise to the challenge?, in: Climate Policy, 18, p. 275-286 [Mareike Blum, Germany]	Accepted. Reference included

Comment No	From Page	From Line	To Page	To Line	Comment	Response
37440	45	2	45	2	Insert after "put in place": (see Michaelowa et al. 2018 for a discussion about appropriateness of policies for a 1.5°C scenario)." Reference: Michaelowa, Axel; Allen, Myles; Fu Sha (2018): Policy instruments for limiting global temperature rise to 1.5°C – can humanity rise to the challenge?, in: Climate Policy, 18, p. 275-286 [Matthias Honegger, Germany]	Accepted. Reference included.
42348	45	4			scenarios, ===> scenarios [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42350	45	5			applicable ===> applied [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
4314	45	6	45	6	… other sectors (e.g., the agricultural or the land-use sector) This is confusing, please revise. [Gensuo JIA, China]	Not clear what is confusing. These are just examples of other than energy sectors.
54544	45	19	45	19	replace general with detailed [Paolo BERTOLDI, Italy]	The discussion in Chapter 4 is both general detailed, we stuck with "general".
8336	45	23	53	34	Section 2.3.3 deals with the “whole system transition". However, this section only assesses the transition in the energy sector without assessment of the industrial system or the consumption system. It is suggested to make an appropriate addition. [China]	Taken into account - This is an excellent suggestion. The revised draft includes discussion on demand reductions (Section 2.3), as well as reduction in end-use sectors (Section 2.4). The broader discussion and assessment of the consumption system fall outside the scope of the integrated pathway literature, and is hence not covered in this chapter.
34196	45	34	49	29	Consider paying closer attention to the different characteristics of the "below" and "return" scenario groups. The 2020-2030 timeframe should receive special attention. Very large changes must occur in this sector very fast, and this will probably not happen without rapid and profound change in policy. [Norway]	Taken into account. Figures and text components were moved to Section 2.4.
28060	45	35	45	35	The term "… produces and uses energy" is physically incorrect. It is rather meant "… uses and transforms energy …" . [Germany]	not applicable: text removed
60094	45	35	45	37	In all world's, not just the 1.5°C one. [United States of America]	not applicable: text removed
58024	45	36	45	36	The word "of" may be inserted in the phrase "a key determinant how" to read "a key determinant of how..." [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42352	45	37			end points ===> end-points [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
60096	45	37	45	39	Not 'today' but over the next decades. [United States of America]	not applicable: text removed
42354	45	39			preferences ===> preferences, [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
60098	45	39	45	41	This sentence overstates the uncertainty. Don't the scenarios all say that the energy system must be transformed to low/zero carbon options (high confidence)? But the details of that system are highly variable depending on the scenario? [United States of America]	noted: this paragraph is not specific to 1.5 pathways and is introductory to the figure and therefore not appropriate for ES
42356	45	41			therefore ===> , therefore, [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
30938	45	45	45	50	this para is a critical point, and should be in the ES [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	accepted: this section is merged with section 2.4
1706	46	2	46	2	It would be perhaps better to say 'end-use fuel mix' instead of 'residual fuel mix'. [Greece]	Noted. Text components were moved to Section 2.4.
45928	46	2	46	2	Instead of saying residual fuel mix, why not directly say the use of fuels in non-power sectors? Perhaps it is easier to communicate it with the readers. [Deger Saygin, Turkey]	Noted. Text components were moved to Section 2.4.
51742	46	2	46	3	Does this fuel use include transport? If so, could that be explicitly stated? It says elsewhere (and I agree), that the electricfication of our transport sector is necessary but won't be easy. [Jason Donev, Canada]	Noted. Text components were moved to Section 2.4.
1708	46	4	46	4	It would be useful to repeat here the number of pathways mentioned in page 25/lines 6-7 ('With a 50% likelihood, 118 mitigation pathways out of 578 limit median temperature below 1.5°C by 2100. ') instead of 'very few'. [Greece]	Noted. Text components were moved to Section 2.4.
42358	46	5			carbon ===> the carbon [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
1710	46	7	46	9	Figure 2.11 reveals that it is after 2050 that the magnitude of differences between ‘below 1.5C 50’ and other pathway classes is very uncertain. This should be added, as it has an important effect on policy choices to be made and implemented before 2050 (and especially before 2030, as the lifetime of some choices made in the energy sector is well above 20 years). [Greece]	not applicable: text removed
46584	46	7	46	8	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
35484	46	10	46	12	The energy demand in the 1.5C 50 scenario seems a little strange - it increases from 2014 to 2020 (understandable), then falls to 2030 and then again increases to 2100. Would be good to explain such a pattern. [Ashok Sreenivas, India]	taken into account: axis now given in %
40030	46	10	46	11	Please add a CO2/kWh scale to the top right figure, as that is the more commonly used measure. [Kornelis Blok, Netherlands]	Noted. Text components were moved to Section 2.4.
44846	46	10	46	10	Is it OK that the unit of vertical axis in the bottom left panel is %? [Hiroaki Kondo, Japan]	taken into account: axis now given in %
51250	46	10	46	12	In the bottom left chart in Figure 2.11, the vertical axis title "Eletrc Share in FE" may be replaced with "Electricity Share in FE". [Muhammad Latif, Pakistan]	noted: there is a diversity of trends of final energy and a wide range as indicated in the chart; insufficient space to describe details
51252	46	10	46	12	In the bottom left chart of Figure 2.11, the units for the vertical axis should be fraction or the scale should be from 10% to 100%. [Muhammad Latif, Pakistan]	accepted: spelled out abbreviations
21452	46	11	46	18	Historical data for 2015 should be available from IEA to replace 2014 values currently shown in two of the panels. [Volker Krey, Austria]	not applicable: historical information removed
53488	46	11	46	11	In Fig 2.11, bottom left panel, the y-axis is in fractions while the y-axis title indicated percentage (y-axis labels need to be multiplied by 100) [Christian Holz, Canada]	Accepted. This was adjusted (Figure now in Section 2.4.1)
11778	46	12	46	12	In the figure, the top left image, the values above the scenario classes are not consistent with those in Table 2.7 - e.g. says 7 below 1.5 50% from 3 frameworks, not 10 from 5 as in the table. Is there a reason for this? If yes, needs to be made clear. [United Kingdom (of Great Britain and Northern Ireland)]	accepted: the scenario database has been revised in for the final draft
39398	46	13	46	13	Between CO2over there must be a free space: CO2 over [Olga Alcaraz, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
42360	46	17			modelling ===> modeling [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42994	46	21	48	27	While "Energy demand reductions are a key characteristic of 1.5°C pathways," there is no detailed discussion of different estimates for improvements in end-use efficiency, although figure 2.12 suggests widely varying assumptions. [Durwood Zaelke, United States of America]	Noted. This section has been deleted; a detailed discussion of demand is given exists in 2.4.3
45932	46	21	46	21	The text reads as if only energy efficiency will be solution to the energy demanding (or end-use) sectors. An effect can also be introduced by renewable energy technologies. [Deger Saygin, Turkey]	Yes, you are right. Added the sentence to say the importance of decarbonization.
1700	46	22	46	23	Limiting energy demand does not always lead to a smaller energy sytem. For example, if you use a lot of decentralized renewables to serve this lower demand, the decentralized new energy system may not be 'smaller' than the previous one (i.e. it may be much more dispersed). In my view it would be better to say that "Limiting energy demand USUALLY leads to a smaller energy system". [Greece]	We changed this part to avoid misunderstanding.
3338	46	22	46	22	Add electrification and SDG7 requirement [Kamel Bennaceur, United Arab Emirates]	Noted. Text components were moved to Section 2.4.
42362	46	25			end-use ===> end-user [Egypt]	No, end-use is meant here.
58428	46	25	46	26	Suggest to modify sentence thus: Energy demand reductions are particularly important because end-use efficiency improvements - as well as economic restructuring towards less energy-intensive activities, particularly in emerging economies - are able to leverage large upstream energy reductions (IEA, 2017, World Energy Outlook). [Andrew Prag, France]	We changed this part significantly and removed this sentence.
1712	46	26	46	27	The sentence 'These up-stream energy reductions can be several times to an order of magnitude larger than the initial end-use demand reduction' is true for energy systems where electricity is produced from technologies with a low conversion efficiency. As more and more efficient technologies are applied, this gap diminishes. [Greece]	thank you for the useful information.
45930	46	26	46	27	In my view it would help if the text tells the reader the magnitude differences are because of the high losses in conversion of energy from one form to another. [Deger Saygin, Turkey]	thank you for the comment, but the space is limited.
1714	46	29	46	31	It is not clear why a lower energy demand brings more flexibility to supply-side GHG mitigation. It may be, but not necessarily as flexibility depends on the existing structure of an energy system and energy choices already made. [Greece]	We changed this part significantly and removed this sentence.
18082	47		49		The finding that 1.5°C scenarios feature decarbonised electricity by 2050 is stated several times. As long as it is stated clearly, it only needs to be stated once. [Andrea TILCHE, Belgium]	changed
39136	47	2	47	2	I am trying to access the reference, but cannot find it in the source. Please check: Grubler, A., Wilson, C., Bento, N., Boza-Kiss, B., Krey, V., McCollum, D. L., et al. (2017). A Global Scenario of Low 49 Energy Demand for Sustainable Development below 1.5°C without Negative Emission Technologies. Nature 50 Energy submitted [Lindsey Cook, Germany]	Noted. Reference has been checked and is correct.
22578	47	4			Insert space between "yr-1)in" [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44200	47	4	47	5	some words are joind and need spaces [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
1716	47	8	47	10	It would be useful to add here in short what are the critical energy technologies/ choices for achieving this low-energy performance in the MESSAGE-GLBM pathway. This is not clear from figure 2.12, where the consumption of all energy forms (including electricity) is very low in this pathway, indicating that the low overall energy consumption is due largely to a very low energy demand; how (through which measures or other factors) such a low demand is achieved? [Greece]	We changed this part significantly and removed this sentence.
35802	47	8	47	9	It is mentioned that low energy demand pathway reduces energy demand by about 40% compared to today by mid-century. [India]	We changed this part significantly and removed this sentence.
62090	47	9	47	10	A reduction by 50% of enegy demand across sectors is mandatory by French law. Maybe mentionr that the deep energy reductions are in line with countries such as France or many countries in the EU. [Antoine Bonduelle, France]	thank you for the comment, but the space is limited.
42364	47	10			at level ===> at the level [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42366	47	12			modeling ===> modeling [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
18078	47	13	47	13	Indeed, rebound is an important factor and should be given more prominence. Pathways should also take into consideration this: Krausmann, Fridolin, Dominik Wiedenhofer, Christian Lauk, Willi Haas, Hiroki Tanikawa, Tomer Fishman, Alessio Miatto, Heinz Schandl, Helmut Haberl, 2017. Global socioeconomic material stocks rise 23-fold over the 20th century and require half of annual resource use. Proceedings of the National Academy of Sciences of the USA, 114(8), 1880-1885, doi/10.1073/pnas.1613773114 It shows that material stocks (i.e. the mass of buildings, infrastructures, cars, machinery, human bodies, livestock, etc. we accumulate grows 1:1 with GDP and that the foreseeable growth of global human material stocks requires superfast decarbonization of all infrastructure development else the entire C budget will be required by building up and using all the cities, factories and roads we will build in the next decades. [Andrea TILCHE, Belgium]	noted; details on the rebound effect is discussed later.
54546	47	13	47	13	there is also a large literature showing that the rebound effect is quite limited to a few percent points, si fore example https://aceee.org/files/pdf/white-paper/rebound-large-and-small.pdf [Paolo BERTOLDI, Italy]	noted; details on the rebound effect is discussed later.
11780	47	17	47	19	The importance that the SSPs play in the scenarios is mentioned on a number of occasions, but isn't really developed sufficiently or the implications explored. This is a good example. It would be helpful to elaborate on how the underlying SSPs and their assumptions is influencing scenario outcomes, in this case energy demand (but the same point applies more widely). We can then better understand how 1.5 scenarios are influenced by these assumptions. At the moment it is not very transparent. [United Kingdom (of Great Britain and Northern Ireland)]	The space is limited. Detailed analysis will come in the following AR6 assessment reports.
18080	47	19	47	19	But all scenarios do not follow the SSP methodology [Andrea TILCHE, Belgium]	noted; details will be discussed in the AR6 assessment report.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
45396	47	19		21	Suggest rephrasing to "The structure of this demand as well as chcoices of end use technologies (e.g., gas boilers vs. heat pumps) drive the 20 composition of final energy use in terms of energy carriers (electricity, liquids, gases, solids, hydrogen 21 etc.)." [Gunnar Luderer, Germany]	We changed this part significantly and removed this sentence.
58122	47	23			There is an interesting indicator that is worth to explore and discuss. Comparing the baseline CO2 emissions with the net CO2 emissions in stabilization scenarios shows the overall emission reduction. Dividing the CDR amount by this number delivers the share of CDR in the overall emission reduction. It would be interesting to know how this share changes between 2°C and 1.5^C scenarios. Frequently, CDR is discussed in a way that exagerates its role in the overall mitigation portfolio and that it becomes the most important, if not the only, mitigation option to achieve stringent climate targets. Hence, this indicator would help to put CDR in a proper perspective of the overall mitigation challenges. [Nico Bauer, Germany]	Details are discussed in section 2.4.2.3
58124	47	23			I am missing a discussion about the use of bioenergy in the energy sector. EMF33 found that bioenergy is predominantly used to produce liquids (in combination with CCS) because liquid supply is most difficult to decarbonize. This is doen altough liquids production has a smaller carbon capture and storage fraction than electricity. This means that bioenergy is not only used because of its carbon value (CDR), but also because of its energy value. This is very important, because in AR5 a considerble share in the audience equated BECCS with electricity. I see that the information is included in the figures, but the text does not spell it out explicitly. [Nico Bauer, Germany]	The space is limited. Detailed analysis will come in the following AR6 assessment reports.
13506	47	26	47	26	projected by [Sergio Aquino, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
36692	47	26	47	37	It is true that most studies have shown that the share of electricification in a particular sector is likely to be highest in the commercial and residential sectors and lower in transportation and industry. However, the report should clarify that the current share of electricity use in the residential and commercial sectors is already much higher than transportation and industry, and therefore the potential for future electrification and corresponding increases in electricity demand is much greater in the transportation sector. For example, see: Steinberg, D., et. al. 2017. Electrification and Decarbonization: Exploring U.S. Energy and Greenhouse Gas Emissions in Scenarios with Widespread Electrification and Power Sector Decarbonization. National Renewable Energy Laboratory. NREL/TP-6A20-68214. [Steve Clemmer, United States of America]	discussed in section 2.4.3
36696	47	27	47	30	It would be useful to also include the % of electrification and increase in electricity demand in 2050 to show how increased electrification contributes to 2050 emission reduction targets and changes over time. A recent NREL study projects U.S. electricity demand to more than double by 2050 under a high electrification, deep decarbonization scenario, with most of the increase coming from the transportation sector. see: Steinberg, D., et. al. 2017. Electrification and Decarbonization: Exploring U.S. Energy and Greenhouse Gas Emissions in Scenarios with Widespread Electrification and Power Sector Decarbonization. National Renewable Energy Laboratory. NREL/TP-6A20-68214. [Steve Clemmer, United States of America]	discussed in section 2.4.3
54548	47	31	47	41	end-use efficiency and sufficency help in reducing energy and electrcity demand and in many cases it is more cost-effective than decarbonising electricity. In addition, reduction in energy demand will reduce cost of decarbonising electricity. [Paolo BERTOLDI, Italy]	discussed in section 2.4.3
35486	47	33	47	37	The rapid improvement in storage technologies is likely to enable the decarbonisatoin of shipping and road freight in future. So it is not clear why transport decarbonisation (except aviation) is considered difficult even for the long time horizons considered. [Ashok Sreenivas, India]	As discussed in section 2.4.3.3, the electrification of road transport is not so easy as people consider.
42368	47	33			industry ===> the industry [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
45934	47	34	47	35	This is also a question to which extent electricity-based technologies are included in the assessment. Examples exist for shipping and freight and recent examples also emerge for aviation. [Deger Saygin, Turkey]	discussed in section 2.4.3.3
42370	47	35			and ===> , and [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
45398	47	35		36	Highly relevant recent reference: Edelenbosch, O.Y., D.L. McCollum, D.P. van Vuuren, C. Bertram, S. Carrara, H. Daly, S. Fujimori, et al. “Decomposing Passenger Transport Futures: Comparing Results of Global Integrated Assessment Models.” Transportation Research Part D: Transport and Environment, August 2016. https://doi.org/10.1016/j.trd.2016.07.003 [Gunnar Luderer, Germany]	Thank you for useful information, but we changed this part significantly and removed this sentence.
14070	47	39	47	39	Suggest including the following sentences: "Fuel switching to Hydrogen and increased share of electrification should be accompanied by CCS. Hydrogen and electricity produced from fossil fuels or biomass should include CCS deployment to ensure as low carbon footprint as possible." [Aage Stangeland, Norway]	Thank you for useful information, but we changed this part significantly and removed this sentence.
21454	47	41	48	10	It is unclear why in Figures 2.11 and 2.12 an IEA B2D scenario is shown in stead of REMIND SSP5 that is one of the five example scenarios. More broadly, a more systematic introduction to the five example scenarios is needed with a logic for their choice (currently only available for two of the scenarios (see page 29, lines 37-52). [Volker Krey, Austria]	Accepted. This has been revised and the example scenarios (now four) are introduced in Section 2.3.2.1.
36694	47	41	48	10	More explanation is needed in the text as to why the range in projected electricity demand by 2100 is so wide across the model scenarios in Figure 2.12. In particular thie first two scenarios at the top of the Figure shows a reduction in final energy use by 2100 of up to 40%, while the third an fourth scenarios show a huge increase by 2100. [Steve Clemmer, United States of America]	discussed in section 2.3.1
54616	47	41	48	10	The two figures in 'Figure 2.12' should be labelled as 'a' and 'b' and discussed acorrdingly in the figure caption [Qudsia Zafar, Pakistan]	This figure is not included in revised draft.
44202	47	42	47	42	this is "upper panal" yet on a different page. Se my general not about how this chapter lables th epart sof Figures [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
34198	48	1	48	10	Figure 2.12 caption: Please explain what the model names in the legend means in the figure caption. Also, please consider to explain what the red lines represent? We expect them to refer to the numbers in page 47, line 3-6. [Norway]	Not Applicable. Figure has been removed
35488	48	1	48	10	It would be good to mention what normative assumptions these models make regarding energy distribution around the world. For example, do they make any assumptions about a minimum amount of household and/or per-capita energy consumption by everybody? Does current energy demand include non-commercial sources such as biomass (it doesn't seem that it does)? [Ashok Sreenivas, India]	Not Applicable. Figure has been removed
40032	48	1	48	1	By Source should be replace with "By Energy Carrier" [Kornelis Blok, Netherlands]	Noted. Text components were moved to Section 2.4.
40034	48	1	48	1	Hydrogen is also a gas [Kornelis Blok, Netherlands]	Noted. Hydrogen as an energy carrier has very different properties from methane and therefore is treated separately.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
44848	48	2	48	10	(bottom pannel)' is missing. [Hiroaki Kondo, Japan]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51744	48	2	48	2	End use consumption may be better than 'final energy consumption' here because the term 'final energy' is confusing and ambiguous. [Jason Donev, Canada]	Noted. Text components were moved to Section 2.4.
58430	48	2	48	3	Please remove "IEA's B2D scenario (IEA /IRENA, 2017)" and replace with "the IEA's Faster Transition Scenario (IEA 2017x [World Energy Outlook 2017]). Note - it is the same scenario [Andrew Prag, France]	Not Applicable. Figure has been removed
44204	48	7	48	9	discription uses "Other" but that word is not on Figure [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Figure was removed.
58432	48	7	48	10	The following sentences ("The category 'Industry Other' includes all non-electric fuel use except of solids in the industry sector (liquids, gases, hydrogen), 'R&C Other' includes all non electric fuel use in buildings (liquids, gases, hydrogen, central heat), and 'Transport Other' includes all non-liquid, non-electric fuel use in the transport sector (hydrogen and gases)"). do not seem to refer to the graph, as the categories mentioned in the phrases do not appear in the figure [Andrew Prag, France]	Not Applicable. Figure has been removed
42372	48	14			than end ===> than the end [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42374	48	16			are ===> is [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
11782	48	17	48	18	Most integrated assessment models currently foresee bioenergy as the sole means to decarbonise these fuels… - would be nice to have some further context here. Are there emerging technologies that have potential to decarbonise these sectors but are not yet captured by IAMs, for example? [United Kingdom (of Great Britain and Northern Ireland)]	Noted: this text has been deleted, but section 2.4.3 includes a discussion of carbon intensity by sector.
40514	48	17	48	27	It is true that in the medium-term most IAMs rely upon bioenergy to decarbonise transport, however the role of electrification in the long-term should not be underplayed. Since this report focuses on 1.5ºC pathways I believe that this is important and should be pointed out. In addition to the Grubler et al. 2017 paper, there are other IAM results that show that electrification is needed to obtain difficult carbon targets. For example, with a RCP2.6 scenario the amount of electrification in the private car sector may need to be notable - refer to Longden (2014) for an example. Figure 9 of this paper shows a large increase in electrification to achieve a RCP2.6 scenario. https://doi.org/10.1016/j.enpol.2014.04.034 This also occurs in the freight sector - Figure 10 of Carrara and Longden (2017). https://doi.org/10.1016/j.trd.2016.10.007 [Thomas Longden, Australia]	Taken Into Account: this text has been deleted, but a section on electricity has been added to 2.4.2.2
53262	48	17	48	20	relevant to * Impossibility of capturing most emissions from biomass converted to liquid biofuels* About transport fuels, this section states, "Most integrated assessment models currently foresee bioenergy as the sole means to decarbonise these fuels, which would lead to bioenergy demand of a few hundred EJ per year to completely eliminate emissions from their combustion." The report should highlight the following problem: how is the extensive use of biomass for transport fuels to be reconciled with projections that bioenergy is used in conjunction with CCS? Biofuels burned in the transport sector will emit CO2 at the point of combustion; this CO2 is thus NOT AVAILABLE for capture and storage via CCS. Additionally, biofuels are not carbon neutral – their net carbon impact has been well-characterized. The report should also explain clearly that lifecycle emissions from biomass harvesting, processing, and transport cannot be captured using CCS. This report and all others by the IPCC utilize modeling that appears to assume a carbon benefit from collecting and burning agricultural residues (Creutzig, Ravindranath et al. 2015). However, it is not possible to simply collect agricultural residues and burn them in power plants – they must be processed first. There are significant emissions from collecting, processing, storing, and transporting biomass fuels made from residues that significantly offset any carbon benefits from burning a fuel that is assumed to "decompose anyway" (Whitman, Yanni et al. 2011). Further, there is solid evidence that collecting soil residues can lead to depletion of soil carbon (Liska, Yang et al. 2014), an effect that can outweigh all others (Whitman, Yanni et al. 2011). Fuss et al (submitted) state that "Importantly, biomass is nearly always assumed to be produced at zero life-cycle emissions. But life-cycle emissions related to direct or indirect land use pose a 10-30% efficiency penalty on carbon abatement, and hence on costs of negative emissions, even in the optimistic cases where biomass is derived from cellulosic sources, or dedicated bioenergy crops." This is just the emissions penalty from land-use change – it does not include the emissions penalty from collecting, drying, pelletizing, transporting, and storing biomass, which can impose another large penalty. (Pehl, Arvesen et al. 2017) states that lifecycle emissions for bioenergy are ?100 gCO2eq kWh?1 and lifecycle emissions from BECCS are even higher. Such emissions could not be captured and stored. There are also N2O emissions from fertilizer and the need to add additional fertilizer if N is taken off fields as residues; additionally, carbon depletion in soils with residue removal makes soils less able to retain N. It is also well-known in the biomass industry (Melin 2008) that storing raw biomass fuels and processed fuel pellets can lead to large methane emissions from both biogenic (Research 2002) and abiotic processes (Kuang, Tumuluru et al. 2008, Röder, Whittaker et al. 2015). These lifecycle emissions must be discussed in a transparent fashion. [Mary Booth, United States of America]	Noted: this text has been deleted, but section 2.3.4 includes a discussion of CDR in pathways. A discussion of LCA studies and their relation to IAMs is limited by chapter length.
2084	48	18			ignores power-to-gas and power-to-liquids, both of which are useful for storing renewable over-generation - see https://www.sciencedaily.com/releases/2017/08/170808182423.htm and ITM Power [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	Taken Into Account. Text has been removed.
60100	48	18	48	20	forsee' is an interesting and likely inappropriate word here. There are many options to create low-carbon, high-density liquid fuels, but IAMs only model bio, or show that bio is economic, since IAMs do not account for "disruptive" or known, but non commercial (today) technologies. Isn't this similar for SMRs, "disruptive" approaches to CCUS, etc.? [United States of America]	Taken Into Account. Text has been removed.
3220	48	22	48	24	I don't understand this sentence. It seems to state that CDR via BECCS is important even if BECCS doesn't exist. [Vassilis Daioglou, Netherlands]	Taken Into Account. Text has been removed.
45358	48	22	48	24	I don't understand this sentence. How bioenergy can provide CRD via BECCS whether BECCS is available or not? [Tuomo Kalliokoski, Finland]	Taken Into Account. Text has been removed.
35804	48	35	48	37	It is mentioned that "while fossil fuel use for electricity generation is phased out around mid-century in 1.5°C pathways, their use for providing liquids and gases to the transport and industry sector can persist until the end of the century. The development of trajectory for emissions needs to be modified as developing countries are still dependent on fossil fuels for electricity generation. [India]	Taken into account - This statement does not feature anymore in the revised version of the chapter.
1718	48	41	48	41	Delete the second 'with' in '..with fossil fuel use with remains limited…'. [Greece]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
11784	48	41	49	1	CCS combined with fossil fuel use with remains limited in many 1.5°C pathways…as the very high decarbonisation requirements penalize CCS technologies with less than 99% capture rates. This seems important - should the implications be brought out stronger? Additionally, a number of scenarios do see quite a lot of CCS as subsequent discussion show. So it's a bit unclear what role CCS has to play - could this be clarified in this chapter a bit more clearly. [United Kingdom (of Great Britain and Northern Ireland)]	taken into account: 99% capture removed
29666	48	41	49	2	Capture rates are usually assumed to be 90% in models, and this statement is correct based upon the work cited. However higher rates can be achieved, 99% and above, but the focus of R,D&D to date has been on reducing costs not increasing rates. This can easily be changed for future R,D&D. Evidence that >99% capture rates can be achieved is provided in the reports 'Near zero emission technology for CO2 capture from power plants', IEAGHG 2006-13 (2006), and in NETL 'Cost and performance of PC and IGCC plants for a range of carbon dioxide capture' DOE/NETL-2011/1498 . I suggest that it is added to the end of that sentence that "(it is acknkowledged that >99% capture rates are technically achievable now at higher cost, however the work to date had focussed on cost reduction of capture (IEAGHG 2006 and DOE/NETL 2011))." [Tim Dixon, United Kingdom (of Great Britain and Northern Ireland)]	accepted: reference added
36698	48	41	49	7	Deep decarbonization modeling by NREL and the Union of Concerned Scientists using NREL's Regional Energy Deployment Systems Model show natural gas with CCS (wiht 90% capture rates) making a meaningful contribution to achieving CO2 reductions scenarios in the United States of 83-90 percent below 2005 levels by 2050. see: Steinberg, D., et. al. 2017. Electrification and Decarbonization: Exploring U.S. Energy and Greenhouse Gas Emissions in Scenarios with Widespread Electrification and Power Sector Decarbonization. National Renewable Energy Laboratory. NREL/TP-6A20-68214 and Cleetus, R., A. Bailie, and S. Clemmer. 2016. The U.S. Power Sector in a Net Zero World: Analyzing Pathways for Deep Carbon Reductions. Union of Concerned Scientists. [Steve Clemmer, United States of America]	taken into account: some additional text added
58296	48	41	48	41	Changej "fuel use with remains" to "fuel use which remains"? [Peter Marcotullio, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
54618	49		50		The two figures in 'Figure 2.13' should be labelled as 'a' and 'b' and discussed acorrdingly in the figure caption [Qudsia Zafar, Pakistan]	Editorial
45394	49	1		2	...as the very high decarbonisation requirements pe 1 nalize CCS technologies with less than 2 99% capture rates. Please add that this is also due to the substantial indirect CO2 and non-CO2 GHG emissions of fossil coal and gas. Reference: Pehl, Michaja, Anders Arvesen et al.. “Embodied Energy Use and Lifecycle Greenhouse Gas Emissions of Future Electricity Supply Systems.” Nature Energy 2, no. 11 (December 8, 2017). https://doi.org/10.1038/s41560-017-0032-9. [Gunnar Luderer, Germany]	accepted: reference added and mention of lifecycle and non-CO2
32760	49	2			Most of the fossil fuel use with CCS occurs at point sources in the industry sector ... what about industrial process emissions? They should be mentioned in this context. [Manfred Treber, Germany]	not applicable: text removed
42376	49	8			carbon neutral ===> carbon-neutral [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
18084	49	11	49	29	This paragraph is very important in terms of policy making, because it fixes objectives about the future energy-mix and energy supply/demand under 1,5°C pathways. It merits to be reproduced both in the executive summary and in the SPM. [Andrea TILCHE, Belgium]	Noted. Text components were moved to Section 2.4.
60104	49	11	49	29	The discussion of bioenergy should be aligned with the discussion on page 4-21. [United States of America]	not applicable: text removed
60102	49	11	49	29	IAM results generally present the potential GHG mitigation potential of wind and solar power in very optimistic terms. Conversely, they present the potential of nuclear power as being very limited. But these results are completely an artifact of how these three types of power are built into the IAMs, which reflect the sustainable development community's current views of and preferences for these systems. Large-scale deployment wind and solar systems (i.e., meeting national and global electricity demands) have yet to be tried. Yes, they have real potential to be an important part of a low-emissions future but the downsides have yet to become well understood. For example, it appears both systems have very negative impacts on bird populations – particularly migratory birds. Additionally, some communities have blocked installation of wind turbines to preseve the value of their scenic landscape. Conversely, nuclear power is the only zero-GHG-emitting form of electricity generation that has been implemented on a large enough scale to know what national and global pluses and minuses would be, and what the costs would be of converting to nuclear on a scale needed to stay under 1.5°C. Note that, whatever this scale is, it would be within the 1.4-3.8 trillion USD annually from 2016-2050 (page 2-5, lines 55-56), and could be accomplished by 2050 (or quicker if needed). As noted later in the text, social views of nuclear power may change in the future as the need to reduce CO2 emissions become more clearly recognized and the time achieve these reductions gets shortened. These points should be made clear in the discussion of the IAM results; otherwise, the presentation appears biased and incomplete. [United States of America]	noted: issues associated with nuclear energy addressed elsewhere
35806	49	12	49	16	Large scale solar - wind deployment will require energy storage. The report alludes to this briefly in Chapter 4. It is important to quantify the amount energy storage requirement to make the scenario realistic. [India]	not applicable: text removed
58436	49	12	49	13	After "electricitity is predominantly provided by wind and solar". suggest adding "This would need to be accompanied by a major effort to redesign electricity markets to integrate large shares of variable renewables, alongside rules and technologies to ensure flexibility." (IEA 2016 - "Repowering Markets") [Andrew Prag, France]	not applicable: text removed
3340	49	13	49	13	Add Energy storage [Kamel Bennaceur, United Arab Emirates]	Noted. Text components were moved to Section 2.4.
188	49	15	49	16	There are no publicaation year for reference of Pietzcker et al.. [Mingshah Su, China]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47798	49	15	49	16	Kindly check: Citation incomplete; year missing; Pietzcker et al. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47890	49	15	49	16	Please check the citation: Pietzcker et al……not available in reference section [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
54620	49	15	49	16	Pietzcker et al. Reference correction [Qudsia Zafar, Pakistan]	not applicable: text removed
18086	49	16	49	17	If non-biomass renewables account for 60-90% of electricity genrtation by 2100, what is all the BECCS used for? Industry? (this appears to be case in the high CDR scenarios of Figure 2.15). [Andrea TILCHE, Belgium]	not applicable: text removed
22580	49	16			add "year" in citation or delete the reference (one case in this line) [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
8338	49	17	49	18	"Nuclear power plays a much smaller role in the electricity sector with large disagreement between models and scenarios" stated in this sentence and "Nuclear power exhibits a moderate increase in the future for the average of these scenarios. In some mitigation pathways, however, both the absolute capacity and share of power from nuclear generators declines" stated in lines 22-23, P62 in this chapter are inconsistent in meaning, with the latter indicating that the development of nuclear power remains fairly uncertain. Therefore, the description of nuclear power in this sentence is suggested to be reformulated as "There is still much uncertainty about the role that nuclear power will play in the future". [China]	taken into account: : text has been removed and the topic shifted to 2.4.2
11786	49	17	49	22	I think the role of SSPS warrant further discussion here. I appreciate that some scenarios still see a role for nuclear, but is it reasonable that the narratives of the SSPs are constraining things so much that a major low carbon power source is being downplayed. I know that SSPs are just ways of generating scenarios to explore different future possibilities but you could construct an alternative narrative in which nuclear becomes favoured and it wouldn't necessarily be significant less plausible, simply an alternative story about the future. Would it not be worth also presenting least cost pathways (for example) with no influence from SSPs, to compare and contrast? At the very least I think more transparency about the role of SSPs would be helpful to policy makers [United Kingdom (of Great Britain and Northern Ireland)]	not applicable: text removed
35808	49	17	49	20	It is not clear whether the low deployment of nuclear power is because of cost considerations or whether "societal preferences" as mentioned in the text. The model outputs should be mainly based on cost considerations. (Bradford P (2012). Energy policy: The nuclear landscape Nature 483, 151–152. doi:10.1038/483151a; Lovering, J. R., Yip, A., & Nordhaus, T. (2016). Historical construction costs of global nuclear power reactors. Energy Policy, 91, 371-382; Lovering, J. R., Nordhaus, T., & Yip, A. (2017). Apples and oranges: Comparing nuclear construction costs across nations, time periods, and technologies. Energy Policy, 102, 650-654.) [India]	not applicable: text removed
51746	49	17	49	22	The authors must learn more about nuclear power, the discussion of nuclear power reflects a significant reliance on preconceptions and mis-information. This treatment of nuclear power is uneven and insufficient. Nuclear power has provided roughly half of the 20th CO2 free energy for the 20th century. Yes, there are many models that propose phasing out nuclear power, but this is due to public fear and insufficient public understanding of the consequences of climate change. While there are trade-offs, we must set aside our preconceptions about nuclear power and see how much reliable base-load electricity it can provide with considerably less environmental consequences than coal, oil or natural gas. [Jason Donev, Canada]	noted: as stated and referenced, assumed preferences are one factor
51748	49	17	49	20	This is inconsistent with page 62 lines 22-24. [Jason Donev, Canada]	taken into account: : the role of nuclear differs in the archetypical pathways that are highlighted in the energy supply section 2.4.2
1720	49	20	49	20	Not only societal preferences but also policy choices (including regulatory limitations). This is already the case in countries like Germany. [Greece]	noted: societal preferences is used as a general term encompassing regulations
51750	49	20	49	20	Public perception of carbon taxes are not included, why does this document talk about public perception of nuclear power? I live in a place where the carbon tax has caused incredible backlash for elected officials, but that's not considered. Removing coal-fired power plants is remarkably unpopular in a lot of places, but that's not considered. The construction of wind turbines is often quite unpopular, but that's not considered in this document. If we are going to mitigate climate change we will make energy more expensive for everyone, that will not be popular. Fighting climate change will involve uncomfortable trade-offs, but at the end of the day, those trade-offs must be made. Many things will be unpopular, so why is unpopular nuclear power such a show-stopper? [Jason Donev, Canada]	noted: there is no reference to public perception.
37376	49	21	49	27	Given the critical role of bioenergy and BECCS for being able to reach the 1.5 goal in the scenarios discussed here, I think a critical examination of the feasibility of achieving such enormous biomass production levels (see also Fig 2.13 on p50) must in my view be explicitly discussed. 200-300 EJ/yr bioenergy depends either on assumptions of strong growth of bioenergy crop yields (e.g. similar to food crop yields) or on large-scale increases in the use of biomass from forests or will entail massive feedbacks with other land-based services, in particular food. See e.g. Erb et al. 2016, Nat. Comm. 7, 11382. The feasibility of achieving very high energy crop yields in the future is highly contested, e.g. see Haberl et al. 2013. Environ. Res. Lett. 8, 031004; Smith et al. 2012. BioScience 62, 911–922; Searle, Malins, 2015. GCB Bioenergy 7, 328–336. Searle, Malins, 2014. Biomass and Bioenergy doi: 10.1016/j.biombioe.2014.01.001. The full C balance effects and other sustainability considerations strongly speak against massive rises in biomass supply from forests, see e.g. Schulze, 2012. GCB Bioenergy 4, 611–616, Naudts et al. 2016. Science 351, 597–600. It is also important to explicitly discuss to what extent the full C costs of sourcing these enormous amounts of biomass have been considered. Such assessments need to take not only changes in forest area into account, which is responsible for only about half of the full C effects of land management, see Erb et al., 2018, Nature, 553, 73-76. 200-300 EJ/yr of biomass is about the entire amount of biomass harvested and used by humans in the year 2000, see Krausmann et al., 2008, Ecological Economics 65, 471–487, so in order to reach that level, biomass harvest for human purposes would have to more than double (assuming increases required for food and timber supply), see Krausmann et al., 2013, PNAS, 110(25), 10324ff. Such large-scale changes in global ecosystems are bound to have all sorts of effects on the C balance of biota and soils, and it is important to robustly assess how much we know about them. In my view the gaps are enormous as systemic effects can have huge impacts, see e.g. Erb, et al. 2008. Journal of Industrial Ecology 12, 686–703; Haberl, 2013. GCB Bioenergy 5, 351–357. [Helmut Haberl, Austria]	not applicable: text removed
1722	49	22	49	22	It would be useful for the reader to mention briefly which are the dominant sources of bioenergy in the pathways. [Greece]	taken into account: this section has been removed and the discussion of biomass and land resides in other sections
35490	49	22	49	24	The models seem to be very optimistic about the amount of bioenergy that can be harvested - in practice it's likely to be very contentious and difficult (as mentioned elsewhere in the report) [Ashok Sreenivas, India]	not applicable: text removed
35810	49	22	49	25	The high dependence on bio-energy in the scenario is unrealistic because of the obvious linkages with food, land, water. The report discusses the qualititative implications of such a pathway in Chapter 4. However, it is important to assess the possibility of high level of bio-energy. Also, it is important to quantify the land requirements. [India]	taken into account: this section has been removed and the discussion of biomass and land resides in other sections
45936	49	22	49	24	Please clarify if the total biomass use is for power/BECCS only or also includes the end-use sector applications. [Deger Saygin, Turkey]	not applicable: text removed

Comment No	From Page	From Line	To Page	To Line	Comment	Response
51752	49	22	49	22	The statement about nuclear power providing 200-270 EJ/yr is not cited. [Jason Donev, Canada]	taken into account: this section has been removed and the discussion of biomass and land resides in other sections
51754	49	22	49	22	Why has Heard's paper not been included, as it is elsewhere, as a possibility of nuclear power growing considerably? [Jason Donev, Canada]	taken into account: this section has been removed and the discussion of biomass and land resides in other sections
44850	50	1	50	1	What means by black broken line in upper pannel of Fig.2.13? [Hiroaki Kondo, Japan]	taken into account: described in figure legend
49348	50	1	50	1	the legends are too small [Spyros Schismenos, China]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
14034	50	3	50	3	This would be better as two figures since top 6 scenarios have no direct links with IEA ones below yet the reader tends to look for links but they are not comparable (top row shows total primary energy; bottom shows different fuels). [Ralph Sims, New Zealand]	Editorial
46622	50	3	50	11	Colourblind check for this figure. Please avoid using greens and reds together in figures as they are hard to distinguish between. [Sarah Connors, France]	taken into account: figure moved; both panels show primary energy
58438	50	3	50	4	Please remove "IEA's B2D scenario (IEA /IRENA, 2017)" and replace with "the IEA's Faster Transition Scenario (IEA 2017x [World Energy Outlook 2017]). Note - it is the same scenario [Andrew Prag, France]	Taken into account: scenario referred to as suggested
42378	50	4			the ranges for 1.5° ===> the ranges of 1.5° [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44852	50	8	50	10	The sentence 'Scenarios from … Section 2.3.2.1' is duplicated. [Hiroaki Kondo, Japan]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58026	50	10	50	10	The direction of the parenthesis in ")2017b)" may be corrected as "(2017b)" in the reference. [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
28062	50	14	81	17	Please give more clarity and maintain consistency with terminology. This section uses the terms "terrestrial CDR", "AFOLU-CDR" and "technical-CDR". In some instances it seems like BECCS belongs to technical CDR and not to terrestrial CDR (in other instances it seems like BECCS is terrestrial-CDR). If that is the case, then it is unclear what the difference between "AFOLU-CDR" and "terrestrial-CDR" is (or how this differs from "land-based-CDR" on p 81 l 17). It would be helpful to clarify all of these terms in this chapter as well as in the glossary. Also what is the difference between "removals", "sequestration" and "negative emissions"? Unless something other than carbon dioxide is being removed from the atmosphere, it seems like there are many terms for the same idea. It would increase clarity, if the diversity in terms is reduced, except when a different term is necessary for further specification. But then it must be clarified how that term differs from what otherwise seems to be a synonym. [Germany]	Taken into account - This section takes into account all available integrated pathway literature on 1.5°C where appropriate. For example, Holz et al do not provide detailed energy system descriptions and are hence not always a useful inclusion.
51018	50	14	60	44	The discussion in this section should include consideration of Holz et al. Environmental Research Letters. (mentioned earlier in the chapter), and more broadly look beyond IAM output. It would be useful to be much more explicit when statements are being made that are solely reliant on IAM output and when statements rely on a more diverse approach to the question. The limitations of IAMs have been laid out at various points in this report, pointing to the need to explicitly call attention to places where they are the sole source of a statement. [Doreen Stabinsky, United States of America]	Agreed - We changed the wording from 'technologies' to current the evolution of agricultural practice'
55472	50	14	51	30	Please state the various disruptive technologies that are not being considered in these model runs, namely the advent of plant-based and synthetic proteins, and the development of technologies such as methane inhibitors and vaccines in livestock, AWD in paddy rice (only some models), nitrification inhibitors, GM crops/forages etc. [Andy Reisinger, New Zealand]	Taken into account - We have restructured the sections to consolidate the text on AFOLU. Additionally, we have had input from some of the SRCCL LAs on what will be included in SRCCL.
45872	50	15	50	16	Is the role of the Agricultural and Land System' - My query is that could there be a necessity for a plural here? For example 'is the role of agricultural and land systems'. [Louis Brown, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
61766	50	15	51	19	The elements related to the AFOLU sector are dispersed across sections (2.3.5.2, but also aspects of 2.6 for what is not dealt with in IAMs, and section 2.3.4). It makes it quite challenging to read and understand how these various elements are combined to infer conclusions. This part of the assessment has to be considered carefully, given the parallel preparation of the SRCCL report. [Valérie Masson-Delmotte, France]	Accepted - the production of wood has been included as suggested
18088	50	17	50	18	The system is responsible… should read "The system is the main responsible…", since aquatic systems are also supplying food, feed and biomass [Andrea TILCHE, Belgium]	Noted. We feel this qualification is not necessary as the responsibility of the land system does not exclude that other systems could contribute to.
29500	50	17	50	17	Suggested addition here or elsewhere in the text (bold red): Given the difference in estimating the "anthropogenic" sink between countries and the global carbon modelling community (Grassi et al. 2017), the land-related emission estimates included here are not necessarily directly comparable with countries' estimates at global level . [Giacomo GRASSI, Italy]	Accepted - the supply of non-provisioning services has been included has been included as suggested
60106	50	17	50	19	This sentence might also reference the use of wood in buildings and infrastructure, given the likelihood of increased demand, and potential value in displacing higher emissions building materials and in storing C02 within harvested wood products. [United States of America]	Accepted. This clarification has been added
49602	50	18	50	19	Please also mention that also the supply of non-provisioning ecosystem services is closely intertwinned, and also biodiversity [Karlheinz ERB, Austria]	Rejected - Due to the scope and focus of this Special Report, as well as the strict length limitations of the ES, including this in the ES was not possible.
11788	50	22	50	25	Is it afforestation and reforestation purely for these purposes, or for use with BECCS? Very important to always keep clear the distinction between differening land use issues, to avoid confusion and conflation of often very different things. [United Kingdom (of Great Britain and Northern Ireland)]	Rejected - While land-use competition is important, it lies outside the scope of this Special Report as it would venture far into the scope of on of the other IPCC Special Reports that is being prepared, in particular, the Special Report on Climate Change and Land.
4350	50	22	50	25	The report mentioned that the woodland area increases 20% by the end of the century in one of the land use development path in 1.5 ° C scenarios. We suggest to add references to support it, etc. Negative emissions from bioenergy (with CCS) and reforestation are crucial to limit temperature increases to 1.5? in 2100. Doelman, J. C., Stehfest, E., Tabeau, A., van Meijl, H., Lassaletta, L., Gernaat, D. E., ... & van der Sluis, S. (2018). Exploring SSP land-use dynamics using the IMAGE model: Regional and gridded scenarios of land-use change and land-based climate change mitigation. Global Environmental Change, 48, 119-135. [Xiangzheng Deng, China]	Taken into account - This section has been merged with the AFOLU section in Section 2.4. This text has been merged and condensed so that the statement in question is not present anymore.
30936	50	22	51	19	are a great explanation of the various land-use issues, and a shortened version should go into the ES [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - This section has been merged with the AFOLU section in Section 2.4. This text has been merged and condensed so that the statement in question is not present anymore. The reference has been included, however, where we present the literature on SSP and land.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
37380	50	22	50	22	In my view, systemic effects in land use, e.g. land-use competition arising from potentially conflicting claims on fertile land or biomass resources needs to be addressed here as well as they are hugely important in this context, see e.g. IPCC, AR5, WGIII, ch11, Smith, et al. 2010. Phil. Trans, Royal Society B: Biological Sciences 365, 2941–2957; Erb et al., 2016, Nature Communications, 7, 11382, Haberl, 2015. Ecological Economics, 119, 424-431 [Helmut Haberl, Austria]	Agreed - We changed the wording from 'technologies' to current the evolution of agricultural practice'
62092	50	26	51	4	This sentence may be improved by replacing "technology" (there is not indeed a techno fix for N2O) by "evolution of agricultural practice and food use" which is closer to actual difference between options used in modelling. [Antoine Bonduelle, France]	Agreed - We changed the wording from 'technologies' to "the evolution of agricultural practice'
44854	51	1	51	1	Isn't the unit of left vertical axis GtCO2/yr? [Hiroaki Kondo, Japan]	No, it is percentage change, indicated by "% change rel. to 2010". However, this panel has been removed after merging this section with the AFOLU section 2.4.
1724	51	3	51	5	Not all lifestyles limiting food waste limit also the demand for GHG-intensive foods. For example, increasing the recycling of organic waste (e.g. through composting) reduces food waste that is disposed on land (and produces CH4 when degraded) but not the demand for GHG-intensive foods. [Greece]	Agreed - We have edited the text so that this is not implied.
15746	51	3	51	15	Are these options/assuptions explictly modelled in at least some of the models presented? Producing cultured meat? For scenarios with high ag yields, is the additional fertiliser production and soi emissions included? [Australia]	Taken into account - Fertilizer use is accounted for (as is irrigation if that is how yields are increasing). Cultured meat is typically assumed endogenously and reduces demand for animal protein. However, due to the limited literature available on this topic, this example has been removed.
34768	51	3	51	14	This section should cite recent research by Bajželj et al. (2014) which shows that business as usual trends of rising agricultural emissions alone almost reach the full 2?C target emissions allowance in 2050 (https://www.nature.com/articles/nclimate2353). Analysis by Wellesley and Froggatt (2015) comes to the same conclusion, noting that current dietary patterns of rising meat and dairy consumption are incompatible with a two-degree pathway: https://www.chathamhouse.org/publication/changing-climate-changing-diets - this is important to cite as several researchers have noted that business as usual trends of dietary shifts toward rising meat consumption will make the 2-degree pathway impossible. [Helena Wright, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - We have added a citation to Bajzelj et al. (2014). We have also noted that this issue will be addressed further in the IPCC Special Report on Land
45938	51	3	51	4	The issue of defining what health is sensitive. I am not entirely sure if there sufficient level of detailed analysis to suggest which diets are healthier and therefore which ones should be preferred. [Deger Saygin, Turkey]	Noted - The WHO has a healthy diet definition: http://www.who.int/en/news-room/fact-sheets/detail/healthy-diet
45578	51	4	51	6	I suggest including also changing food systems from exclusive rural and intensive commercial agriculture to urban and peri-urban agriculture. [Adela M Sánchez-Moreiras, Spain]	Rejected - due to limitations in space and scope, this cannot be included here. However, these options have been included in the overview table of measures that is included in the Technical Annex. A more in-depth discussion of these aspects can be included in the Special Report on Climate Change and Land.
31860	51	5	51	5	suggest also including DOI 10.1007/s10584-015-1329-y [Stuart Capstick, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The discussion was revised with an expanded reference list.
44856	51	5	51	5	It does not seem to be 'lighter grey' for REM-Mag|SSP5-19 in Fig.2.15 [Hiroaki Kondo, Japan]	Figure was removed due to overlapping information with other figures.
49604	51	5	51	10	in Erb et al. 2016 doi 10.1038/ncomms11382 and Muller et al. 2017 doi 10.1038/s41467-017-01410-w) we show that demand-side options are key and a prerequisite for ghg-saving land-practices such as organic farming and deforestation reduction. [Karlheinz ERB, Austria]	Taken into account - We have added these citations, as well as a note that this issue will be discussed further in the IPCC Special Report on Land
11792	51	6	51	7	A 1.5C consistent pathway within AFOLU or an overall 1.5C consistent pathway? [United Kingdom (of Great Britain and Northern Ireland)]	It is unclear what the reviewer is precisely asking here. In order to be 1.5°C consistent emissions of all sources and all activities need to be taken into account. Consistency would be hard to define within the AFOLU only.
11794	51	6	51	10	Appears to be inconsistency in the two choices presented in this sentence. 1) "increasing forest cover over 21st century" 2) "keeping forest cover approximately constant or higher". Isn't the second half of 2) the same as 1)? If this isn't the intention, I think it needs to be made clearer what this means (and in the context of "yet still decreasing agricultural..."). Clarity over this issue impacts on our next two comments on this section. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The sentence has been edited to provide a clearer distinction between increasing forest cover and forest covers staying approximately constant.
11796	51	6	51	10	So the second of these two scenarios seems to suggest that you could be 1.5C consistent by reducing agriculture emissions and not significant increasing forest cover (e.g. for BECCS)? If this is the correct interpretation (it isn't entirely clear and could do with clarifying, as discussed in the previous comment) then this seems like a major claim given the reliance and focus on BECCS and should surely be justified further. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - This section has now been merged with the AFOLU section, which provides more space to discuss how various land-use future can develop. Both Section 2.3 and the AFOLU section highlight the marked impact of different strategies and policy choices on land use development and reliance on negative emissions.
35492	51	6	51	10	It is not clear whether forest cover / afforestation are only seen as a source of carbon (capture/retention) but also as an important asset for biodiversity protection, source of livelihoods/resources for indigenous peoples, its cultural/religious connotations etc. [Ashok Sreenivas, India]	Taken into account - The SSP models at present only view it as a carbon sink, but the SRCCL will discuss co-benefits for biodiversity, as well as including biodiversity-focused scenarios (assuming they are published in time). We have highlighted this caveat at the beginning of the consolidated AFOLU section.
18090	51	6	59	33	The likely CDR requirement needs to be described in more policy relevant terms: e.g. annual (rather than cumulative) gross & net negative emissions, for comparison with today's positive emissions. Also, there needs to be greater integration between the parts of this section and parts of the chapter that cover total land requirement. Both are extremely important - but the land area required, and the interaction between forest cover and AFOLU mitigation and the total CDR requirement is particularly tangible to policymakers so should be stated and quantified as clearly as possible. The areas should also be placed in context (e.g. compared to current agricultural area, potentially usable degraded land etc). [Andrea TILCHE, Belgium]	Accepted. Connections with complementary discussion of CDR in the report have been highlighted more clearly, rates of deployment are discussed more prominently and area numbers are placed in context of current cropland area.
39138	51	6	51	6	This states 'depending on societal choices and preferences', but this should also include 'depending on policies', as behaviour change needs policy when so much is at stake. The point (p 50, sentence 26 'hard to eliminate', is untrue with effective policies on healthy and low emission diets. [Lindsey Cook, Germany]	Noted. Text components were moved to Section 2.4.
4352	51	7	51	8	The report mentioned that “1.5 ° C pathway could be achieved while increasing forest cover over the 21st century and strongly reducing GHG emissions from agriculture (a reduction of 40% and more relative to 2010 by 2050). Can you add reference to support it? Contradiction exists between agricultural emission reduction and the requirement of food security. How to achieve 40% of agricultural emission reduction is still a challenge. Some research has considered the resolution for this contradiction on a global scale. Frank, S., Havlík, P., Soussana, J. F., Levesque, A., Valin, H., Wollenberg, E., ...& Smith, P. (2017). Reducing greenhouse gas emissions in agriculture without compromising food security? Environmental Research Letters, 12(10), 105004. [Xiangzheng Deng, China]	Taken into account - The increased forest cover is a direct results from the IAM results reported in Rogelj et al (2018), which is explicitly discussed in the consolidated Section 2.4.4. The Frank et al. reference has been cited and discussed. The Special Report on Climate Change and Land will discuss synergies & trade-offs between efforts to mitigate and food security.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
35812	51	7	51	8	It is important to put the figures for forest cover and bio-energy to understand the feasibility of targets. [India]	Noted - This section addresses the land transition, while bioenergy is discussed in Section 2.4 as part of the energy system transformation.
11798	51	10	51	15	Spells out agriculture reduction options and then says that they are identified to "allow forest expansion". In the context of the sentence previously (i.e. that you reduce agri emissions so you don't need forest expansion - again assuming this interpretation is correct), should this be to avoid forest expansion? [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - This sentence has been moved to a consolidated section on AFOLU strategies so that it becomes clearer that this speaks to the interplay of demand and developments in various subsectors. If pressure on agricultural land is reduced by the measures listed in the chapter, it is easier for models to consider forest expansion.
58202	51	11	51	12	The full adoption of cultured meat in 2050 does not sound a plausible scenario for modelling, although cultured meat may become a viable option one day. In this context, one should also consider fusion energy for example, which by the way is apparently not considered even in 2100 scenarios. [Alexandre Strapasson, Brazil]	Accepted - The expression 'full adoption of cultured meat' has been deleted from the text
60108	51	12	51	12	What is cultured meat? Many readers will not know what you are talking about. [United States of America]	Accepted - The expression 'full adoption of cultured meat' has been deleted from the text
7666	51	14	51	18	Range of estimates in the literature are between 2 to 11 Gt C/CO2 /yer (paper submitted Roe et al 2017). Even the more modest bottom up estimates (around 3.5 Gt) in the paper of Griscom et al 2017 are overestimating the potential for reforestation globally. Since they assume a standard forest definition (<25% tree cover) which leads to exclude and suggest to replace some dry and semi dry forest ecosystems that include numerous endemic species (i.e. in the Mediterranean climate), and uses too high values of removal factors (unrealistic values for Spain with 188, 111 for Italy or 92 for Greece, TgCO2eq/yr). Recent papers also alert about potentiall irreversible changes in the biosphere through extensive land use change, water use and altteration of the biogeochemicla flows (Heck et al. Nature Climate Change, 8: 151-155). More conservative estimates or alerting of the fact that it is unlikely that this potentials will be reachable should be introduced. [Maria Jose Sanz Sanchez, Spain]	Taken into account - The limitations highlighted by the reviewer are valid, yet space and scope restrictions for the SR1.5 prevent introducing a significant assessment of these issues in this report. However, these issues are to some degree covered in Chapter 5, and will undergo an in-depth assessment in the SRCCL. In Chapter 2, these limitations have been taken into account in the assessment of the level of confidence in the reported insights.
11800	51	15	51	18	It would be more helpful to not just say that things are missing from models but what the implication of this is. e.g. how much feasible mitigation potential might be missing? [United Kingdom (of Great Britain and Northern Ireland)]	Noted - In the interest of space, we refer the reader to the IPCC Special Report on Land, which will be assessing the mitigation potential of these options. At the same time, the chapter text highlights the identified options and includes these limitations in its assessment of the level of confidence.
19610	51	15	51	18	Important statement that the AFOLU sector offers additional mitigation potential including via land restoration and improved land management which has not been adequately represented in mitigation scenarios so far. [Jennifer Morgan, Netherlands]	Noted
1726	51	18	51	18	The deployment OF terrestrial carbon' [Greece]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
11790	51	18			The land transformation section (2.3.3.2) should clarify the role of sustainable forest management in timber production which acts as a carbon store if used in long-lived products – requiring the overall pool to increase. There are also opportunities for SFM to reduce emissions in other sectors, that should be mentioned, through substituting for materials with higher GHG emissions associated with their production. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - We have added forest management to the list of other potential land mitigation measures in this sentence. We have also added a note that the IPCC Special Report on Land will further address these issues.
63200	51	18	51	19	Rewrite: " The deployment terrestrial carbon dioxide removal can impact the deployment of other CDR technologies, like BECCS (Section 2.3.4). Such impacts could be reduced through the use of marine-based CDR, though these have yet to be incorporated into assessment models..." (see my suggested addtions to chapt 4). [Greg Rau, United States of America]	Taken into account - More efficient cross-referencing to Section 4.3.8 now points to these additional possibilities to remove CO2.
1728	51	20	51	20	What is the green bar in the right sub-figure of Figure 2.14? There is no legend. [Greece]	Accepted. The information was added. Figure was moved to Section 2.4.4.
5334	51	20	51	21	The colour of some letters in the legend, it seems a bit grey. I suggest changing it to black colour. [Sulistyawati Sulistyawati, Indonesia]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
62094	51	20	51	31	For non CO2 gases in the context of a 1.5°C the metrics of GWP-100 is problematic, because these gases seem less important than they are among the set of mesures to prioritize to avoid or limit overshooting. This could be mentioned in the text with more clarity, beause for example the costing of a temperature overshoot would be affected. In chapter 4 the avoidance of the overshoot nearly justifies SRM in the text!. The present chapter discusses at lengh the economics of 1.5 path (e.g.p2-96) but for this discussion to be complete there should be mention of a "premium" or "bonus" on the short term impacts of policies aimed at Short Lived gases.. See for example Le Treut, Dessus, Laponche, Colombier "Emergency care for the climate: reducing methane emissions", IDDRI Conference on http://www.iddri.org/Themes/Climat/Emergency-care-for-the-climate-reducing-methane-emissions [Antoine Bonduelle, France]	Taken into account - Aspects of emissions weighting and metrics are discussed in a dedicated box in Chapter 1. Due to space constraints, this discussion is not repeated or further elaborated here.
51756	51	22	51	29	This figure caption is unclear and needs to be re-explained. [Jason Donev, Canada]	Noted. Figure now moved to Section 2.4.4 and caption revised.
42380	51	28			forest ===> the forest [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
18092	51	32			2.3.3.3 This scenario duplicates what has already been discussed in Section 2.3.1.2 . Therefore can be merged or removed [Andrea TILCHE, Belgium]	Accepted. Section has been merged with similar content in 2.3.1.2 in a revision of the structure of the section (now 2.3.2.1)
50646	51	33	51	40	Tranformation of water or aquatic ecosystems should be explicitly included as an outcome of some pathways [Jagdish KRISHNASWAMY, India]	Rejected. The pathway literature focus on the transformation of energy and land use, manufacturing and the economy as a whole. There is no information on the role of aquatic ecosystems in 1.5°C pathways. While we acknowledge that coastal waters and aquatic ecosystems will be transformed as well, they play a smaller role for overall emissions reductions. The significance of algae and blue carbon is mentioned at other places in Chap. 2 (now in Section 2.3.1.2) and Chap. 4
58442	51	33	52	33	Suggest additig "A fundamental reorientation of energy supply investments and a rapid escalation in low-carbon demand-side investments will be necessary. This can be supported by an ambitious set of policy measures, introduced immediately and comprehensively across all countries, including the rapid phase out of fossil fuel subsidies, CO2 prices rising to unprecedented levels, extensive energy market reforms, and stringent low-carbon and energy efficiency mandates." (IEA 2017x World Energy Outlook 2017) [Andrew Prag, France]	Noted. This is relevant for Section 2.5 on challenges, opportunities and co-impacts of 1.5°C pathways.
42382	51	36			for ===> in [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
11802	51	37	51	39	This sentence talks about options within a given sector to pursue stringent decarbonisation, but the remaining discussion in this section talks about division of effort between sectors. The two things aren't quite the same (though obviously the latter emerges from the decisions on the former), so it would be good to be clear that this really is a focus on effort between sectors, not a detailed discussion of mitigation options within a sector. [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. We have made clear that the detailed discussion of options within a sector are provided in Section 2.4
11804	51	37	51	39	It would be useful to have a clearer sense of how many options there ultimately are (within sectors and between). The use of "multiple" implies quite a lot, but ultimately not very many 1.5C pathways have been found. [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. We have included a reference to a table in the Annex on mitigation measures that are considered in pathway modelling. Another subsection (now 2.3.1.2) discusses a set of key options for deep decarbonisation.
796	52	5	52	5	except of a study' should be 'except for a study' [Robert Shapiro, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42384	52	5			except of a study ===> except a study [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
13508	52	6	52	6	space before some [Sergio Aquino, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51758	52	6	52	6	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
3222	52	13	52	13	...which MITIGATE CO2…" [Vassilis Daioglou, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
35494	52	17	52	18	I think what is meant here is that the "electricity" (not energy) system would be decarbonised by 2050? [Ashok Sreenivas, India]	No, it is indeed the energy supply system, including refineries etc. Energy use in end-use sectors is not fully decarbonized by mid-century.
39140	52	17	52	18	This key point needs highlighting. [Lindsey Cook, Germany]	Taken into account. This is highlighted in the Chapter including the ES.
42386	52	17			agree ===> agrees [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58444	52	17	52	18	suggest citing: WEO 2017 at the end of the sentence ending in "by mid-century" [Andrew Prag, France]	Rejected. Sentence refers to 1.5°C pathways, so references should explicitly discuss 1.5°C pathways as well.
42388	52	20			end use ===> end-use [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
22582	52	21			Remove space after ")" and add a space before "However" [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42390	52	21			industry) .However ===> industry). However [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51760	52	21	52	21	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58028	52	21	50	21	The spacing prior to the punctuation may be addressed in "industry) .However," to read "industry). However," [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
11806	52	27	52	29	So if you assume all things equal (policy, societal choices etc), what are the cost optimal choices? Would differences still emerge if these assumptions remain the same? [United Kingdom (of Great Britain and Northern Ireland)]	The point here is that cost optimal choices differ depending on development and demand choices. And costs and challenges of the transformation are significantly lower in low demand scenarios.
42392	52	28			near term ===> near-term [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
20520	52	29	52	31	Please add here: pathways that assume limited or no contribution of BECCS imply at least halving global fossil fuel and industrial CO2 emissions by 2030. [Jennifer Morgan, Netherlands]	Noted. Emissions were categorized according to no, low or high overshoot.
15748	53				The mitigaiton pathways all include substantial reliance on bioenergy. Yet there is a persistent, and growing, argument presented in the scientific and public domains claiming that bioenergy has negative climate impacts. Therefore, please provide some text explaining how bioenergy contributes to climate change mitigation in these pathways. Explain what bioenergy systems are assumed - what type of biomass feedstock and production system, what type of energy conversion process(es). [Australia]	Taken into account - Fertilizer use is accounted for (as is irrigation if that is how yields are increasing).
54726	53		55		The prominence of BECSS as a CDR technology and the connected notion for degraded forest reclamation are among the key game-changing climate strategies in this report that apparently must accompany rapid emissions reduction. The report does not engage to the extent necessary with the design principles that should guide the deployment of these technologies in a manner consistent with Sustainable Development Goals (SDGs). [Henry David Venema, Canada]	Noted. We have highlighted the coverage of sustainability implications of bioenergy deployment across the report and also provided a reference to the Special Report on Climate Change and Land.
21456	53	1	53	10	Add "2016" lable to history line in Figure 2.15 (currently only in figure caption). [Volker Krey, Austria]	Figure was removed.
18094	53	2	53	10	Figure 2.15 mostly repeats Figure 2.8. Can their messages be combined? [Andrea TILCHE, Belgium]	Accepted. Fig. 2.15 has been removed.
46624	53	2	53	10	Colourblind check for this figure. Please avoid using greens and reds together in figures as they are hard to distinguish between. [Sarah Connors, France]	Accepted, but Fig. 2.15 has been removed due to overlap with Figure 2.8.
11808	53	13	53	13	This section doesn't really say very much. Could be dispensed with. Or, alternatively, if it is intended (it's actual purpose is unclear) to note that alternative, non-IAM based scenarios exist, then this would be very helpful. But would need a lot more elaboration and discussion. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The section has been merged with the section on technology assumptions in models, making clearer its relevance for contextualizing the pathway assessment in this chapter
18096	53	13			when discussing "energy systems", it would be important to define the system boundaries. For bioenergy, land use must be within the boundary (and it is generally fully credited to the energy sector), but then it cannot be separated from the rest of the LULUCF sector (risk of double-counting of sinks or ignoring emissions). It is also important to clarify whether the production of the capital stock of the energy sector (bulding powerplant, power lines, etc) are part of the system and, if so, how they are taken into account. [Andrea TILCHE, Belgium]	Noted. We removed the discussion from the energy section and merged with the discussion of mitigation technology coverage in IAMs, including both energy and land use mitigation measures.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
18098	53	13			The term "carbon neutral" is particularly unhelpful in this context, as "carbon neutrality" most often used to describe the assumption that carbon emissions from biomass combustion in the energy sector can be considered (unconditionally) zero. That assumption is generally incorrect, as it misrepresents the system-level impacts, which is what this secton should be dealing with. [Andrea TILCHE, Belgium]	Rejected. We acknowledge that several criteria have to be fulfilled for bioenergy production to be carbon neutral (e.g. avoiding indirect land use change emissions). Whether or not these conditions can be fulfilled depend in large parts on effective governance of land use, which is notoriously difficult. But there is no principal reason why 2nd generation bioenergy cannot be carbon neutral. Sophisticated IAMs model system-level impacts and thus can explore the indirect LUC emissions risk from bioenergy if land is not well protected (e.g.. Wise et al., Science, 2009).
36700	53	13	53	34	What role does energy storage play in achieving carbon nuetral energy systems that have high penetrations of wind and solar? How is energy storage treated in the models used to achieve 1.5C scenarios. Could this energy storage facilitate higher levels of wind and solar and less BECSS than shown in the scenarios? Some discussion of energy storage should be added to this dicussion and/or earlier in this chapter. [Steve Clemmer, United States of America]	Taken into account. The discussion here was merged with the subsection on technology coverage of IAMs, among which there is energy storage technologies. 100% electricity scenarios assume high storage capacities. A sentence on integration of VRE was added.
42394	53	13			carbon neutral ===> carbon-neutral [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42396	53	14			carbon neutral ===> carbon-neutral [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
60110	53	14	53	15	There are no citations to support the statement "There are a number of alternative visions of carbon-neutral energy systems. Such visions are important as goal posts for the transition to a carbon-free future." If no such citations exist, the statement should be removed. In addition, the report is focused on mitigation pathways that lead to 1.5°C warming, and such scenarios may not necessarily have to be carbon-free. [United States of America]	Accepted. Sentence on goal posts was removed, usage of carbon free was changed to carbon neutral.
56030	53	15	53	17	Bioenergy as a whole cannot be assumed to be carbon neutral. The science on this has been moving away from seeing bioenergy as even a low carbon alternative, based on emissions not just from burning the biomass but land-use change (both direct and indirect) and distrubances in the soil among other impacts. Also see Mary S Booth Not Carbon Neutral: Assessing the net-emissions impact of residues burned for bioenergy. 2018 Environ. Res. Lett. 13 035001 [Kelly Stone, United States of America]	Noted. We acknowledge that several criteria have to be fulfilled for bioenergy production to be carbon neutral (e.g. avoiding indirect land use change emissions). Whether or not these conditions can be fulfilled depend in large parts on effective governance of land use, which is notoriously difficult. But there is no principal reason why 2nd generation bioenergy cannot be carbon neutral. The CO2 released during biomass combustion was coming from the atmosphere, so the net effect is zero. Sophisticated IAMs model indirect land use effects and thus can explore the indirect LUC emissions risk from bioenergy if land is not well protected (e.g.. Wise et al., Science, 2009).
60112	53	15	53	17	Why call out bioenergy here? Bio is an artifact of the modeling … not of technical options … or VISIONS. One can "envision" a system of zero carbon that does not have much bio in it, but the IAMs do not MODEL such a system. [United States of America]	Noted. We disagree that bioenergy use is an artefact of modelling studies. It is a critical option for reaching carbon neutrality in most studies. Alternatives exist and those are discussed in this subsection.
49606	53	16	53	17	It should be made clear in this statement that a simple use of biomass for energy is carbon neutral, but that biooenergy provision has to fulfil several criteria to be carbon neutral (see many publications from Searchinger et al., Haberl et al. 2012 doi10.1016/j.enpol.2012.02.051) [Karlheinz ERB, Austria]	Accepted. Added a qualifier.
42398	53	17			are ===> is [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
45940	53	17	53	20	Why does the text only refer to liquids and gases and not solid fuels like coal. [Deger Saygin, Turkey]	Accepted. Changed to non-electric
42400	53	18			modelling ===> modeling [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42402	53	20			first-of-its kind ===> first-of-its-kind [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
62096	53	21	53	22	The word "radical" suggests a value judgement and could be avoided; in particular, strong efficiency policies similar to those described in Grubler et al are official policy in several countries such as France, Switzerland or Denmark. [Antoine Bonduelle, France]	Noted. Replace the word radical with dramatic. We disagree that the very large energy efficiency improvements projected in Grubler et al. are official policies in some countries. They are without historical precedent on a large scale.
1580	53	24	53	25	Not only is this study (Jacobson et al, 2017) a pathway and a vision (rather than just a vision), it quantifies (in Sections S10.2) the fact that if this pathway is implemented (80% emission reduction by 2030 and 100% by 2050), "an additional cumulative 419 Gt-C emitted to the atmosphere, in the range of the maximum allowable to keep warming under 1.5oC." This pathway does not require carbon sequestration, biofuels, nuclear power, or geoengineering. [Mark Jacobson, United States of America]	Noted
1578	53	24	53	25	Other visions rely on a complete subsitution of liquids and gases use by electricity (Jacobson et al., 2017). Please change to "…by electricity and electrolytic hydrogen and add as references (1) Jacobson, M.Z., and M.A. Delucchi, A path to sustainable energy by 2030, Scientific American, November 2009; (2) Jacobson, M.Z., and M.A. Delucchi, Providing all Global Energy with Wind, Water, and Solar Power, Part I: Technologies, Energy Resources, Quantities and Areas of Infrastructure, and Materials, Energy Policy, 39, 1154-1169, doi:10.1016/j.enpol.2010.11.040, 2011; (3) Delucchi, M.Z., and M.Z. Jacobson, Providing all global energy with wind, water, and solar power, Part II: Reliability, System and Transmission Costs, and Policies, Energy Policy, 39, 1170-1190, doi:10.1016/j.enpol.2010.11.045, 2011. [Mark Jacobson, United States of America]	Accepted addition of electrolytic, but rejected addition of further publications from the same author that further elaborate a 100% electricity pathway. References in this subsection are provide to give entry points to the literature on the topic.
22584	53	25			Insert a space between "2017)or" [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
32762	53	25			hydrogen (Marbán and Valdés-Solís, 2007)or some other ... insert blank space before "or" [Manfred Treber, Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44206	53	25	53	25	needs space between "2007) or" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
42404	53	26			via combination ===> via the combination [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
14072	53	29	53	31	This sentence implies that there are uncertainties related to CO2 storage, but there are no references to literature. In fact, there has become a public opinion saying that there are uncertainties related to CO2 storage, but there are no scientific evidence for this. In a professional operated CO2 storage site there should not be any uncertainties related to CO2 storage. I suggest changing the sentence to "As an alternative to CDR measures including CO2 storage, CDR measures with permanent storage (mineralisation and enhanced weathering) are investigated" [Aage Stangeland, Norway]	Accepted. The sentence has been reworded, we no longer say "as an alternative to uncertain permanence of CO2 storage".
42406	53	32			and ===> , and [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
13510	53	33	53	33	simplify: can affect 1.5oC mitigation pathways [Sergio Aquino, Canada]	Text was removed.
42408	53	33			carbon neutral ===> carbon-neutral [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
28064	53	37	54	8	Whether CDR and its various approaches really work and can be implemented and to what extent is still highly speculative. There still are a lot of open questions concerning negative side-effects and broader sustainability considerations, governance etc. This caveat should be made more clear here at the beginning of 2.3.4, even if problems and limitations of integrating CDR/ negative emissions in 1.5 pathways are being discussed in more detail in Ch4 only. (This is even more important as they are expected to take a high share of CO2-reduction, see p 2-55, line 20-21). [Germany]	Accepted. Introductory paragraph has been reworded to include these caveats.
58610	53	37	59	38	This section should include important conclusions and consideration related to Aspects related to timing of mitigation actions/CDR, such as intergenerational equity and climate/environment safety, targets of early action on CDR technology portfolios, indirect land use effects and other cascading impacts of delayed actions in phasing out fossil fuel emissions as identified by Obersteiner et al, Nature Climate Change, VOL 8, Januaary 2018, 2-12 [Kenneth Möllersten, Sweden]	Taken into account. The discussion of CDR timing relates to the two uses of CDR in 1.5°C pathways and was strengthened. The interaction between CDR and delay is taken up in Section 2..3.5 (a reference to the section is now provided).
3766	53	39	53	39	Is CDR required for all 1.5C pathways? Some recent calculation suggests otherwise: an early and deep emission cut can do, such as Millar et al., (2017) Nature Geosciences. [Yangyang Xu, United States of America]	Noted. This statement refers to published 1.5C pathways in the literature, according to the classification of pathways used in SR1.5. See Chapter 2.2 for an assessment of the literature on 1.5C budgets.
53490	53	39	53	40	...all 1.5°C pathways in the literature deploy CDR technologies… -- is inconsistent with discussions elsewhere in the chapter, which mentiones several CDR-free scenarios (e.g. Grübler et al 2017, Holz et al 2017, etc) [Christian Holz, Canada]	Taken into account. Grübler et al. does not use BECCS, but uses afforestation which we also classify as CDR. Holz et al. presents one scenario that does not use CDR, but still includes substantial negative LUC emissions. We have changed the wording of the introductory paragraph.
11810	53	40	53	40	A fourth question would be helpful - "how does this differ from CDR in 2C pathways?" [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Question has been included.
1702	53	42	54	2	There are questions also regarding the economic attractiveness of CDR technologies in some cases. This point is also mentioned in lines 25-27. [Greece]	Noted. It is subsumed in "availability".
3342	53	42	53	42	What if one of the CDR technologies could not be deployed [Kamel Bennaceur, United Arab Emirates]	Noted. Section 2.3.4 discusses pathways with different choices of AFOLU CDR and BECCS.
53984	54		58		The inclusion of DACS in text and models should be deleted, as the energy demand and cost of DACS is as speculative as the other options mentioned in the same chapter. Furthermore, the high cost and high energy demand of DACS make it unfeasible. [Elenita Daño, Philippines]	Rejected. DAC is discussed in the literature and even developed commercially. It is also included in a few published examples of 1.5C and 2C pathways.
2074	54	11	57	13	SRM's potential contribution to CDR is completely ignored in this section, despite been clearly understood (albeit poorly constrained). It reduces STT aiding dissolution https://www.nature.com/articles/nclimate3376. It also prevents carbon excursion from permafrost melt. [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	Noted. This is discussed in Box 3.1 on SRM, it is not a topic of Section 2.3.4, which assesses CDR use in the IAM pathway literature. This literature does not consider SRM.
10510	54	11	57	10	In this chapter, many figures present results for five different scenarios namely: below 1.5C 50, return 1.5C 66, below 2C 66 and below 2C 50, while in some other parts of the text, the results are just presented for the 1.5C pathways. To keep consistency, the authors should provide results either only for 1.5C or add 2C results in all figures. [Hong Yang, Switzerland]	Accepted. We now only present results for the four illustrative 1.5C pathways.
56462	54	11	57	10	Par 2.3.4.1 I miss a technology that captures CO2 from industrial burning fossil fuel of bio mass, and converts this to a substance by having the gas react with Olivine. This reaction is speed up b using a Gravity Pressure Vessel)GPV), a 3 walled tube 1200 m into the earth, in goes water with olivine powder, and CO2, out come SiO2 and MgCO3 http://www.innovationconcepts.eu/Carbonisationminerals.htm The advantage of this method, over CCS is that the GPV method does not need a old fossil fuel well to store the CO2, and that the reaction is exotherm, so the heat can be used in the Capture part of the process, no the fossil fuel burning efficiency is maintained. TRL3 The GPV is easily deployed in multiple instances, when developed, upto the required capacity. Because the proces needs about the same amount of Olivine as coal, cost of this method can be estimated, using known technologies, coal transport and milling in the coal plant, and drilling upto 1200 m My preferred name for this solution is CCS2 Maybe this location in the report is not appropriate for this remark, But I think it should me mentioned somewhere, for further analysis, because of its large potential [Henk Daalder, Netherlands]	Noted. We have not included this specific proposal, it is subsumed in the large category of mineralisation.
62098	54	11	59	38	The whole CDR issue is treated with much more detail than is FOD and much more relevant to policy. But there was a sythesis table announced with simple list of policies, potentials and costs to be used in further modelling instead of pure BECCS… is it still planned? [Antoine Bonduelle, France]	Noted. A synthesis figures of potentials and costs is provided in Chapter 4.3.7
45580	54	12	54	16	I suggest including also reducing energy invested in food transport by promotion of urban and peri-urban agriculture [Adela M Sánchez-Moreiras, Spain]	Rejected. This is not a CDR option, but direct mitigation. It has been included in the overview table on mitigation measures covered in models (now in the Annex).

Comment No	From Page	From Line	To Page	To Line	Comment	Response
51022	54	12	56	45	This section should include discussion of Dooley and Kartha cited in comment 8. [Doreen Stabinsky, United States of America]	Accepted. The paper has been included as further reference on sustainability implications and moral hazard.
60114	54	12	54	13	Date for this reference missing. [United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
4270	54	13			write year for the reference Minx et al (2017) [Abanades Carlos, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
19584	54	13	54	13	Minx et al. reference needs a date [Jennifer Morgan, Netherlands]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
22586	54	13			add "year" in citation or delete the reference (one case in this line) [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
32764	54	13			in the literature (Minx et al.) ... year is missing [Manfred Treber, Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
33566	54	13	54	16	I would also add "organic farming" as another widely accepted technology for soil C sequestration. For more information on how organic farming (particulalry a long-term practice) can improve mitigation effort by sequestering more C into soil, see Sihi etal-2017-J of Plant Nutrition and Soil Science-Evaluation of soil health in organic vs. conventional farming of basmati rice in North India-180-389-406 f. [Debjani Sihi, United States of America]	Accepted - Due to space restrictions no more details on additional options not covered in the given scenarios can be discussed. However, in SOD Table 2.8 options not considered in IAMs are highlighted. In the updated version of this table also "conservation agriculture" is included. More details of these options will be discussed in the SRCCL
47800	54	13	54	13	Kindly check: Citation incompleter; year missing; Minx et al. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47892	54	13	54	27	Please check the citations: Minx et al.; Strefler et al.; Fuss et al.;……incomplete; no year; not available in reference section [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58204	54	13	54	13	"(Minx et al.)." reference missing year [Alexandre Strapasson, Brazil]	Corrected
58300	54	13	54	13	Remember here and other places to put the date on "(Minx, et al)"? Perhaps 2018? [Peter Marcotullio, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
15750	54	15	54	15	re biochar cite Woolf et al, 2010 here - it is the study on which Smith 2016 is based. [Australia]	Accepted. Reference included
18100	54	15	54	15	Biochar should not be mentioned here, as it is not related to the enhancement of natural carbon stocks. To the extent harvested biomass is available to be used as "biochar", other, alternative uses of that biomass should be considered, including the use of harvested wood products (both in terms of substituting for more emission-intensive products, and in terms in terms of the carbon stock they contain), and the various possibilities for sequestering biomass other than mixing charcoal into the soil. [Andrea TILCHE, Belgium]	Accepted - The text has been edited to remediate this issue.
22588	54	16			add citation on coastal restoration, e.g. Howard, J., Hoyt, S., Isensee, K., Pidgeon, E., Telszewski, M. (eds.) (2014). Coastal Blue Carbon: Methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrass meadows. Conservation International, Intergovernmental Oceanographic Commission of UNESCO, International Union for Conservation of Nature. Arlington, Virginia, USA. [LUIS VALDES, Spain]	Accepted. We have added Mc Leod et al., 2011
37222	54	16	54	19	The section 2.3.4.1 does not mention the required scale up of the capture, transport and storage of CO2 technology and infrastructure required for the deployments of CDR (BECCS and DACCS). Currently operating full-scale BECCS and DACCS projects is 1 (1 BECCS, Illinois CCS; Global CCS Institue, 2017). The learnings, cost reduction and technology optimisation from CCS deployment today until 2050 must be emphasised to enable the scale-up of BECCS and DACCS technology. For example, it is stated in Chapter 4, Page 35, Line 30: 1.5°C pathways assessed in Chapter 2 that BECCS wil remove 5 GtCO2yr–1 (median) by mid-century). This cannot be just switched on and will require upscaling of capture technology, transport standardisaiton and network optimisation as well as storage characterisation. [John Scowcroft, Belgium]	Accepted. Discussion on upscaling until 2050 has been added and reference to Section 4.3.7 provided.
56460	54	21			Integrating CO2 capture with coast maintenance because of sea level rise. This threatens sandy coasts, elevating the beach ans coastal seabed with sand is a standard approach in the netherlands. This sand can get a top layer of olivine sand, as a standard practice for beach elevation because of sea level rise, also see the previously mentioned article [Henk Daalder, Netherlands]	Noted. We have not included this specific proposal, it is subsumed in the large category of mineralisation.
32766	54	23			Krijgsman, 2006; Strefler et al.) ... year is missing [Manfred Treber, Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
22590	54	24			Remove dot after "example" [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44858	54	24	54	24	, for example.-->, for example, [Hiroaki Kondo, Japan]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
63202	54	24	54	25	Add: "...the sequestration of carbon dioxide in the oceans, for example. by means of ocean alkalinisation (Renforth and Henderson, 2017). se my additions to chapter 4 [Greg Rau, United States of America]	Accepted. Text included
1730	54	25	54	27	The costs, carbon removal potential and environmental side effects of several of these CDR measures have been investigated and compared ?? SOME EXTENT'. The level of investigation and comparison of CDR measures is far behind the level of investigation and comparison of direct GHG emission reduction measures, and this must be included in the sentence. [Greece]	Taken into account. Sentence now reads "are increasingly investigated and compared". The remaining large uncertainties are highlighted.
28066	54	27	54	27	These large uncertainties even more exist as for CDR usage on large scale level. Please add. [Germany]	Accepted. Has been added.
32768	54	27			remain (Fuss et al.; Psarras et al., 2017; ... year is missing [Manfred Treber, Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47802	54	27	54	27	Kindly check: Citation incomplete; year missing; Fuss et al.; [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
1732	54	28	5	29	Add that the effectiveness, the cost, and the impacts of such proposals have not been assessed yet. [Greece]	Accepted. Has been added.
42410	54	28			and ===> , and [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
62100	54	30	54	49	This paragraph gives with honesty the limits of present IAM results on the huge part of negative emissions. This should reflect in the abstracts in the chapter and also in the SRM. [Antoine Bonduelle, France]	Noted
28068	54	31	54	48	It is not clear whether only the accumulation of biomass on re- / afforested lands is concerned in the IAMs or whether subsequent management on these lands is also included. The latter would increase the supply of e.g. timber as construction material and biofuel. Please clarify. [Germany]	Forestry / forest management and timber production is included in several IAMs, e.g. GLOBIOM.
50214	54	31	54	48	This paragraph rightly notes that IAMs have not sufficietly covered natural land restoration and land management options Lines 37-38) . This is an important conclusion for the Exec Sumary and the SPM. For the potentail of these measures there is an inconsistency between what is said in lines 40-43 and what is in chapter 4 , section 4.3.8.4. This information from ch4 needs to be mentioned here, as it throws adifferent light on the sentence in lines 43-45. Is is incorrect to state that the (whole) assessment has to rely on the incomplete information on CDR from IAM studies. [Bert Metz, Netherlands]	Accepted. Reworded and reference to Chapter 4.3.7 included.
19588	54	33	54	35	it may not be clear to the reader what is meant by the statement that some well below 2 degrees and 1.5 degrees pathways including additional CDR measures such as DACS 'have become available' - presumably this means that these have since been modelled? DACS is not available to help deliver any pathway in any practical sense. [Jennifer Morgan, Netherlands]	Yes, those have been modelled and published.
22592	54	33			Add a space between "2014).Since" [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44208	54	33	54	33	needs space between "2014). Since" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42412	54	35	54	36	in particular ===> in particular, [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
63204	54	35	54	36	rewrite: "Other, less studied approaches, in particular ocean-based CDR and removal of Non-CO2 gases, have less presence in literature and modeling on mitigation pathways." [Greg Rau, United States of America]	Noted. As we refer to integrated pathway modelling here the statement is accurate as is.
42770	54	36	54	36	Specify the non-CO2 gases (methane). [Kristin Campbell, United States of America]	This does not appear necessary as the CH4 and N2O removal methods were just mentioned in the previous paragraph.
42996	54	36	54	36	Specify the non-CO2 gases (methane). [Durwood Zaelke, United States of America]	This does not appear necessary as the CH4 and N2O removal methods were just mentioned in the previous paragraph.
19614	54	37	54	48	Important statement that natural land restoration and management are not sufficiently covered in IAMs despite their low technological requirements and environmental co-benefits and that instead they rely on CDR from BECCS and afforestation/reforestation. [Jennifer Morgan, Netherlands]	Noted
42414	54	37			modelling ===> modeling [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
56032	54	40	54	40	In addition to the enviornemntal co-benefits, there are also possible social co-benefits for the community. [Kelly Stone, United States of America]	Accepted. Has been added.
18102	54	46	54	47	Land use is currently a strong sink of atmospheric CO2 (even if LUC emissions are deducted), so it cannot be converted to a sink. See most recently: "Le Quéré et al. 2017: Global Carbon Budget 2017" AR5 (WGI report) assumed that land would remain a sink until at least teh end of the 21st century under most scenarios. The high levels of bioenergy assumed in this report may turn land use into a source, but then this should also be properly acknowledged and attributed in the discussion of bioenergy and BECCS. [Andrea TILCHE, Belgium]	Accepted. Discussion has been clarified. The original wording was confusing and has been removed.
18104	54	47	54	47	Using net C uptake as a proxy for AR seems odd. The terrestrial C balance is currently dominated by the forest sink, which is mostly about from forest remaining forest. AR affects only a tiny fraction of land in any given year, and its impact remains limited compared to the management effects everywhere else. AR can only become significant if the affected land is taken into account cumulatively, for a period much longer than the 20 yr specifiedrecommended in the 2006 GL. If the land sink is attributed to AR, then it should be defined what is meant by AR (e.g., all lands to be afforested over the course of this century?). See: Erb, Karl-Heinz, Thomas Kastner, Christoph Plutzar, Anna Lisa S. Bais, Nuno Carvalhais, Tamara Fetzel, Simone Gingrich, Helmut Haberl, Christian Lauk, Maria Niedertscheider, Julia Pongratz, Martin Thurner, Sebastiaan Luyssaert, 2018. Unexpectedly large impact of forest management and grazing on global vegetation biomass. Nature, 553, 73-76 doi: 10.1038 [Andrea TILCHE, Belgium]	Accepted. Discussion has been clarified. The original wording was confusing and has been removed.
42416	54	47			as proxy ===> as a proxy [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
50220	54	50	55	3	It would be helpful for the reader to give an indication of the annual CDR rates that are implied in the different cumulative amounts of CDR. [Bert Metz, Netherlands]	Accepted. CDR rates are now included in the discussion
51020	54	51	54	53	following on comment 3 above with respect to feasibility. The amount of CDR noted here is not feasible. Just because IAMs spit out a number doesn't mean it is feasible or realistic. The discussion here should very explicitly state that these are huge numbers with no basis in biogeophysical reality. See Dooley, K. and S. Kartha, 2018. Land-based negative emissions: risks for climate mitigation and impacts on sustainable development. International Environmental Agreements: Politics, Law and Economics, Volume 18, Issue 1, pp 79–98 [Doreen Stabinsky, United States of America]	Noted. Dooley and Kartha has been cited.
11812	54	53	54	53	This range (740….) seems to be different from the values in table 2.6. Is there a reason why. It's confusing to have different values without explanation [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Table 2.6 was removed to avoid overlaps. CDR numbers were checked and harmonized

Comment No	From Page	From Line	To Page	To Line	Comment	Response
28070	54	53	54	53	In order to strengthen consistency in data presentation in different contexts (sections, paras, etc.) and to prevent any confusion about cumulative emission values incl. their respective ranges (e.g. Ch. 2 p. 54: 620-890 GtCO2 <-> Ch. 2 p. 6: 380-1130 GtCO2) we would appreciate a general explanatory remark (approach, benefit of resp. choice) on the use of diverse ranges to present figures, i.e. emissions or CDR levels, with respect to 5-95% percentile or (25-75%) interquartile ranges. This is particular the case in Ch 2 in sections 2.3.1 (i.e. table 2.6) and 2.3.4 (figure 2.16 and surrounding text). If possible, please align the presentation. [Germany]	Accepted. Table 2.6 was removed to avoid overlaps. CDR numbers were checked and harmonized
30940	54	53	54	53	says 740 (620-980) GtCO2 CDR, however it is not clear why these figures are different to those set out in page 6 line 36. It appears to be because the former is an interquartile range, and that the latter derives from Table 6, which is a 5-95 percentile range. Why does the Exec Summ 6 line 36 and Table 6 use a 5-95 percentile range for CDR, when it is more usual in the rest of the report to use interquartiles? Related, for either interquartiles or 5-95, should the higher values be included? There is little on feasibility of these higher values on chapter 2, but there is a reference to chapter 4, which says (ch4 p35, line 33) “most of the literature agrees on a BECCS potential range of 1.5-5.8 GtCO2/yr”, and (ch4 p35, line 30) “the 1.5 pathways assessed in chapter 3 remove 5 GtCO2/yr (median) by mid century and 15 Gt/yr (median) by 2100) through BECCS. Why are the higher values used in the scenarios, if most of the literature says it is way higher than the potential range for BECCS? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Table 2.6 was removed to avoid overlaps. CDR numbers were checked and harmonized
53494	54	53	55	3	Another study with very low CDR is Holz et al 2017, which presents two scenarios with CDR limited to AFOLU options (at around 200 Gt CO2) and one without any additional CDR beyond current pledges (resulting in 6 Gt total). While not an IAM study, these results should nonetheless be reported here to highlight the broad range of theoretically possible options available [Christian Holz, Canada]	Accepted. Study included in this paragraph
49608	55	3	55	3	A similar conclusion was documented by Haberl et al. 2011 doi 10.1016/j.biombioe.2011.04.035). The potential, however, could be significantly smaller if sustainability issues like political stability are reflected, too (Erb et al. 2012 doi 10.1016/j.enpol.2012.04.066). These corroboration of findings by another model family is a strong feature, as well as the sustainabiltiy constraitns in social systems, that can result in precarious dependencies of entire world regions (import dependency for food, e.g.; Erb et al. 2016 doi10.1038/ncomms11382). [Karlheinz ERB, Austria]	Noted. Reference to Haberl et al. has been included in the revised version of the section
50216	55	5	55	10	This explanantion about the two different uses of CDR is a very important message and needs to be in the Exec Summary and the SPM. [Bert Metz, Netherlands]	Accepted. It is included in the ES
56916	55	5	55	5	repetition - and don’t quiet see the point of this distinction [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	There are several important points here. First, it is different if you are trying to avoid overshoot or if you are working on enabling overshoot. Public perception on those two activities will differ. Second, it directly relates to the timing of CDR (pre or post-2050). And third, it is also a policy question. Incentivizing compensatory CDR with e.g. carbon pricing is possible, but where to take the money from when emissions are net negative?
60116	55	5	55	22	Not mentioning the potential role of nuclear energy, combined with an electric vehical fleet, as part of a 1.5°C strategy seems odd. [United States of America]	Rejected. The role of nuclear energy is discussed in Section 2.4, this section focuses on CDR.
798	55	9	55	9	thus can allow to establish a temporary overshoot' should be 'thus allow a temporary overshoot' [Robert Shapiro, United States of America]	Taken into account. Text was reworded.
11814	55	10	55	12	Presumably not equal as some scenarios (i.e. the non-overshoot ones), won't have the second role for CDR? If this equal use is a characteristic feature comapred to 2C pathways, this needs clarifying. Is it not that the defining characteristic that there is a greater likelihood of overshoot in 1.5 and so a greater chance that CDR will be deployed for this purpose? Apologies if I've misunderstood this point. [United Kingdom (of Great Britain and Northern Ireland)]	Noted. We mean "roughly equal on average" across 1.5°C scenarios. The proportion of the two can of course vary for individual scenarios. The intuition of the commenter is right.
800	55	11	55	11	Table 2.6' should be 'Figure 2.6' [Robert Shapiro, United States of America]	Noted. Table 2.6 was removed.
30418	55	13	55	13	Typo : add "[even] if [they reach the point of carbon neutrality] ? [France]	Text was removed.
30420	55	15	55	18	This is an important message that should be more emphasized better. [France]	Noted
63206	55	15	55	18	Please explain the assumption about "limitations on the upscaling of these [CDR] measures before mid-century in the integrated pathways" and with what confidence is this assumption made. Why is it more realistic to assume that emissions reduction can be scaled up to compensate for CRD "limitations"? [Greg Rau, United States of America]	Assumptions can differ across models and include technology specific specifications, e.g. ram-up costs, techno-economic assumptions and bioenergy / CDR potential constraints. Such assumptions apply also to mitigation technologies.
42998	55	18	55	22	Relate this amount to what is currently deployed and the timescale at which these technologies will need to be deployed to attain this targeted amount. [Durwood Zaelke, United States of America]	Noted. CDR is currently only deployed in negligible quantities at a few pilot and demonstration plants.
47804	55	19	55	34	Please use CO2 [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58030	55	19	55	20	CO2 should be formatted to include subscripts. There are two instances in the same sentence. [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42418	55	20			two thirds ===> two-thirds [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44210	55	21	55	21	what is ca. ? [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
50218	55	21	55	22	This point is important and needs to be in the Exec Summary and the SPM. [Bert Metz, Netherlands]	No longer applicable - sentence modified
58606	55	21	55	21	Delete "only" as it is a subjective statement. 30% may be perceived as substantial. [Kenneth Möllersten, Sweden]	Accepted. Deleted
802	55	22	55	22	than in probably 2°C pathways' delete probably [Robert Shapiro, United States of America]	Done
21458	55	24	55	38	Figure 2.16 is highly confusing as it all of a sudden presents 1.5 and 2 degree scenario variants of (most of) the example scenarios introduced in Figure 2.7. Only for the MES-GLOB|LED this is not the case, presumably because no such variant exists. I would suggests to stick with only 1.5C example scenarios to avoid confusion. [Volker Krey, Austria]	Accepted. Panels with associated 2°C scenarios of the examples were removed.
18106	55	25	55	37	The figure 2.16 has total and break up of the total. However the categories are overlapping and therefore confusing. Create categories that are not overlapping [Andrea TILCHE, Belgium]	Noted. We have clarified in the caption which categories add to the total and which not.
58032	55	30	55	34	CO2 should be formatted to include subscripts. There are multiple instances in these lines in the caption of Figure 2.16. [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

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44212	55	31	55	34	CO2, 2 should be subscript [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
7442	56	2	56	2	Insert after "Nemet et al. 2017": "Honegger and Reiner 2018". Reference: Honegger, Matthias; Reiner, David (2018): The political economy of negative emissions technologies: consequences for international policy design, Climate Policy, 18, p.306-321 [Axel Michaelowa, Switzerland]	Accepted. Reference inserted
11816	56	2	56	4	I don't think this necessarily negates the points that these authors are making. They are pointing to the moral hazard of reliance on future (unproven) tech. Even if you have to start now with CDR, that doesn't mean that even in stringent 1.5C scenarios that you couldn't implicitly rely more heavily on future effort to save us (that's effectively what the overshoot scenarios are). [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Text has been reworded
42420	56	3			future ===> the future [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42422	56	3			near term ===> near-term [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
22594	56	4			Insert a space between "2015).The" [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
32770	56	4			(Anderson and Peters, 2016; Geden, 2015).The 1.5°C pathway ... insert blank space before "The" [Manfred Treber, Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
60118	56	4	56	13	Good points, and developed from the scenario analysis. [United States of America]	Noted
11818	56	5	56	7	The point about the tightness of budgets meaning that ambitious mitigation happens rapidly and CDR is deployed immediately 1.5 should more be a focus on the rapidity of mitigation? In both 1.5C and 2C presumably CDR has to be deployed right away? If they do differ in near term deployment of CDR, this should be made clear (and why it doesn't contradict the point earlier statement (page 55, 14-15) that 1.5 don't deploy more prior to neutrality to 2C (albeit the point of neutrality differs)). [United Kingdom (of Great Britain and Northern Ireland)]	Noted. The discussion about timing of CDR has been reworded.
42424	56	6			as well as rapid upscaling of CDR deployment ===> , as well as rapid upscaling of CDR deployment, [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58608	56	7	56	9	Rephrase. Instead of describing a 30% increase in CDR in 1,5 compared to 2 degree scenarios using subjective the language "a limited increase", use objective language and state the percentage increase. [Kenneth Möllersten, Sweden]	Accepted. Reworded.
62102	56	7	56	9	The 1.5° littérature is more recent and thus includes more of the recent surge in Renewable Energy and cost plunge. This difference is substantial (e.g. the ETP series of IAE/OECD) to explain the new scenarios variants. [Antoine Bonduelle, France]	Noted. The new developments in the 1.5°C literature are discussed in Section 2.3.1 and in the discussion of IAMs in the Annex.
11820	56	9	56	11	This needs elaboration. What does it mean and what are the consequences? [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Clarified and consequences are stated.
11822	56	15	56	17	This doesn't sum to 740 [United Kingdom (of Great Britain and Northern Ireland)]	Noted. The sum of two median is not the sum of two medians. Footnote added.
19616	56	15	56	21	Greatest CDR contribution still from BECCS which is concerning given all the potential impacts it has. However it is seen as preliminary and expected to be reduced given the addition of further terrestrial CDR measures, which is good. [Jennifer Morgan, Netherlands]	Noted
37190	56	15	56	17	Policy-makers and the public are very much interested to know to what extent BECCS and to what extent afforestation is used in order to achieve CDR in the second half of the century. It would be good, if more content of this paragraph enters the executive summary on page 6 after line 32. [Thomas Bruckner, Germany]	Accepted. Numbers reported in ES.
50222	56	15	56	17	Add an indication of the annual CDR rates for BECCS and AFOLU CDR, and of the amount of biomass used per year in the scenarios (BECCS plus other) to make it easier to comare to emission levels and discussions about CDR options. [Bert Metz, Netherlands]	Accepted. Rates on CDR have been included in the text.
60120	56	15	56	31	BECCS is comprised of two components: bioenergy production and use, and carbon capture, utilization, and storage (CCUS). Bioenergy production and use might be done without CCUS, and CCUS may be applied to a number of different energy production facilities, including those using biomass. Each of these components is discussed separately in this report, and is included under b) and c) respectively in this paragraph. Suggest focusing on these two component parts here and throughout the report, rather than treating BECCS as a unique technology. [United States of America]	This seems to be a misunderstanding. We are discussing two different CDR approaches in the paragraph, not two components of BECCS.
11824	56	18	56	19	Why not make a rough quantification of these alternatives, along with an initial feasibility estimate? It is possible based on existing literature. The lack of representation in IAMs doesn't mean that these issues shouldn't be discussed in detail. It would be helpful to enable us to better contextualise model reliance on BECCS. If this is covered elsewhere then at at least warrants a brief mention here for clarity. [United Kingdom (of Great Britain and Northern Ireland)]	Noted. The CDR potential of these alternatives is assessed in Chapter 4.3.7.
18108	56	21	56	36	The discussion on permanence seems rather biased and should be reconsidered. The assumptions on CCS are very optimistic, as it has never been attempted at scale, and the limited experience we have is mostly with EOR, which cannot be an option towards a 1.5 degree world (or even 2 degrees). There are very serious doubts about the stability of storage and the ability to safeguard and monitor disposal sites (not to mention the inevitable incentive to cheat, cut corners and ignore expensive problems in a real-life environment). In contrast, forests have been around forever. Individually, all forests are vulnerable (and will be more vulnerable with climate change), but at the system level, the expansion of forest is likely to lead to an expansion of C stocks. Moreover, it can be monitored more easily and transparenly. Clearly, forest sinks should not be calculated from best-case forest growth estimates, but should take into account risks (incl. non-permanence) at the system level. But the same applies to BECCS. [Andrea TILCHE, Belgium]	Taken into account assuming that this comment refers to the discussion on permanence on pg. 58 of SOD Chapter 2. The assessment was updated to include latest literature on CCS leakage risk. We also cite literature on managing the forest carbon sink. At another place, we point out that carbon uptake by forests can be combined with wood harvesting, thus enabling continued carbon uptake on the same patch of land.
39142	56	21	56	23	This is an incredibly important point for policy makers to understand. It is therefore important to stress (as you begin in p. 58 15-36 for example) the environmental costs/benefits of both approaches, so that informed decisions can be made concerning the consequences of policy choices. [Lindsey Cook, Germany]	Noted. Text was revised in response to a multitude of reviewer comments.
2076	56	22	56	22	substitutes point is incorrect. Substitutes are defined by outputs, not input. Furthermore, there's not necessarily a conflict - as enhanced weathering, soil restoration and biochar can theoretically be combined with BECCS. [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The sentence was removed during the revision of the text. .
22596	56	24			Insert a space between "2014).There" [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
42426	56	24			correlation ===> a correlation [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
18110	56	25	56	26	It is questionable (so say the least) to consider "soil degradation" as a factor favouring CCS against enhancing terrestrial C pools. Bioenergy use is, has been (historically) and most likely will remain one of the biggest threats to soil and a major cause of forest degradation world-wide. BECCS, as the most extreme form of industrialised bioenergy production is likely to make it only a bigger threat, if not directly (e.g., on didicated plantations that will supply CCS-equipped biomass facilities), then indirectly (by displacing other land uses and biomass needs to other areas, wehre they will lead to intensification). Efforts to genuinely increase C stocks on land (through afforestation or other means) have increased and likely to continue to increase carbon stocks and improve the resilience of terrestrial systems. [Andrea TILCHE, Belgium]	Noted. It is neither said nor implied that soil degradation favours CCS. Section 2.3.4 includes a discussion of measures enhancing soil carbon and counteracting soil degradation, and points out that soil degradation is not well captured in IAMs (see box on bioenergy and land use modelling in IAMs). The SRCCL will discuss effects of BECCS on land degradation in greater depth.
18112	56	26	56	27	AFOLU is already a net sink of CO2. It is never going to be a net sink of other GHGs. [Andrea TILCHE, Belgium]	Taken into account. We have clarified the wording, it was not implied that the AFOLU sector is a net sink of Non-CO2 GHGs.
28072	56	26	56	31	The statement in line 29 "This reflects the fact that CO2 uptake from afforestation ceases once forests are grown." seems incorrect. First, even very old forests may accumulate biomass (and carbon), second, over the period of interest here (until 2050 or 2100), afforestation from today might not even reach an "equilibrium" (and even then C may be accumulated in dead organic matter and soil), third, afforestation can be managed and timber extracted to be used as material and fuel and thus be one of the sources of "BE" in "BECCS". Please make sure that the effects of landuse are also considered, not only effects of land-use change. Therefore we propose a slight modification of the resp. sentence and replace "ceases" by "decelerates". [Germany]	Accepted. We have removed the sentence and revised the text to point out that carbon uptake by forests can be combined with wood harvesting, thus enabling continued carbon uptake on the same patch of land.
2078	56	29	56	29	uptake doesn't necessarily stop when a forest is established, as soil carbon can still accumulate. Furthermore, wood products and biochar can be buried to aid this process. [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. We have removed the sentence and revised the text to point out that carbon uptake by forests can be combined with wood harvesting, thus enabling continued carbon uptake on the same patch of land.
11826	56	29	56	31	Can you elaborate a little more why this is the case. And provide further detail on the nature of the near term deployment of BECCS? i.e. how much BECCS are we having to be building in the coming decades. [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. We have provided an explanation for the timing of BECCS deployment.
19592	56	29	56	29	It may well be the case that net CO2 uptake ceases once terrestrial forests reach full maturity, though the situation is complex as this depends greatly on forest type and management regime. Not all species that could concievably be used for afforestation will have reached full maturity by 2100. The current statement should be qualified to some degree and supported by a suitable reference. [Jennifer Morgan, Netherlands]	Accepted. We have removed the sentence and revised the text to point out that carbon uptake by forests can be combined with wood harvesting, thus enabling continued carbon uptake on the same patch of land.
18114	56	29	56	29	Regarding "CO2 uptake from afforestation ceases": It should be clarified what is meant by "uptake" and "ceases". Holding on to forests until they can no longer grow (biological saturation) is highly unlikely, as it has rarely been the case in the past (most afforested areas are then used as managed forests, not as strictly protected areas), and seem to be highly unlikely in the future, due to the immense demand for biomass and for the serious impacts of climate change. If, however, forests are managed, then they will not stop taking up CO2. They will stop accumulating carbon (their C stock may stop increasing), but C stock change is not the same as CO2 uptake, it is just a proxy that may or may not be appropriate to use. The terminology in this report is rather inconsistent. [Andrea TILCHE, Belgium]	Accepted. We have revised the text to point out that carbon uptake by forests can be combined with wood harvesting, thus enabling continued carbon uptake on the same patch of land.
45360	56	29	56	29	This is oversimplification. What time span this "once forests are grown" describes? In temperate, and especially in boreal zone, forests of hundred of years have been found to be carbon sinks (e.g. Luyssaert et al. 2008). [Tuomo Kalliokoski, Finland]	Accepted. We have removed the sentence.
60122	56	29	56	29	The statement "This reflects the fact that CO2 uptake from afforestation ceases once forests are grown" lacks full context. CO2 uptake continues in healthy forests, including once mature. The rate of sequestration may slow over time. [United States of America]	Accepted. We have removed the sentence.
11828	56	33	56	45	Given the major concerns over CDR feasibility, it would be helpful to explore the topic raised in this paragaph in more detail. E.g. there is a pathway with minimal BECCS - what does this pathway look like in detail? We need to better be able to explore the implications of the reliance on CDR and what happens if it isn't available at the levels assumed. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account.. Pathways with no BECCS deployment exist and are assessed in Section 2.3.4.1.
13512	56	35	56	35	no '.' before and food demanad [Sergio Aquino, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
22598	56	35			Replace "." by an empty space [LUIS VALDES, Spain]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44214	56	35	56	35	states 2017).and ? [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44860	56	35	56	35	(Grubler et al., 2017).-->(Grubler et al., 2017) [Hiroaki Kondo, Japan]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51762	56	35	56	35	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42428	56	36			near term ===> near-term [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
804	56	43	56	43	scenarios' should be 'scenario' [Robert Shapiro, United States of America]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
32772	56	43			One scenarios specifically excludes ... remove the "s" to "One scenario" [Manfred Treber, Germany]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42430	56	43			One scenarios ===> One Scenario [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42432	56	43			excludes ===> exclude [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
44216	56	43	56	43	One scenarios? Should it be scenario [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
56034	56	43	54	45	In this discussion, it is worth mentioning the limCDR pathway in Holz et. al (2017) that limited CDR to afforestation and reforestation based on land availablility without impacting food security. Holz, Christian and Siegel, Lori and Johnston, Eleanor and Jones, Andrew and Sterman, John, Ratcheting Ambition to Limit Warming to 1.5°C – Trade-Offs between Emission Reductions and Carbon Dioxide Removal (October 31, 2017). Available at SSRN: https://ssrn.com/abstract=3063337 or http://dx.doi.org/10.2139/ssrn.3063337 [Kelly Stone, United States of America]	Taken into account. Holz et al. Is discussed.
42434	56	45			cases ===> cases, [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
54626	57				Figure 2.17. Figure text is not clear. High quality figure with larger font size sould be used [Qudsia Zafar, Pakistan]	Noted. High quality figure will be used in the publication.
21460	57	1	57	10	Figure 2.17 is too complicated to digest in its current form. It took me 5 minutes, carefully studying the legend, to get down to its message. In a way, Figure 2.7 conveys very similar information (i.e., the amount of residual fossil emissions, compensating negative emissions, etc.) in less quantitative, but much more easily accessible ways. From Figure 2.7 I can admittedly not read the cumulative amounts of emissions in quantitative terms, but due to its more conventional style of presentation, the qualitative insight is immediatly clear. A possibility to have both would be to include a small table with the quantitative sumulative emission numbers at the bottom of Figure 2.7. [Volker Krey, Austria]	Taken into account. We have tried to simplify the figure a bit. We believe the cumulative view is important to get an overview on the magnitudes of the individual components in relation to the remaining budgets.
30942	57	1	57	11	This is one of the best and clearest diagrams in the chapter (along with figure 2.4) – one thing: the notes have 6 sources, but only 5 scenarios in the diagram. Think needs to follow the descriptions used in figure 2.7, which are clearer. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Noted. Caption was adjusted. Literature citations for the example scenarios are now only provided when introduced for the first time.
30944	57	1	57	11	the blue reference line is for TPB, however 3 of the scenarios are for return 1.5 66%, which according to ES1 have a median/range of 910 (570-1210). I'm clearly missing something, but why do these scenarios bring net CO2 emissions so much lower than needed to get to this higher median/range? Is it because of differences in non-CO2? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The revised chapter no longer assesses threshold return budgets (TRB) due to the large uncertainties. Models reduce cumulative emissions after a peak to increase probability of being below 1.5°C by the end of century, thus hedging against such uncertainty. Further reasons for the peak and decline model behaviour are provided in an Annex to the Chapter in the Section on IAMs.
50224	57	1	57	10	why only show the 50% probability threshold for the TPB, suggesting that is the most policy relevant? Better to include also the 50 and 66% TRB thresholds. And why is there such a large range for the budgets for 66% return scenarios (AIM/SSP1, MES-GLOB/SSP2, REM-MAg/SSP19? Do add remarks on how the picyure would change if other land-based CDR options would be included. [Bert Metz, Netherlands]	Partially accepted. Remaining budgets are shown for both 50% and 66% chance of limiting warming to 1.5°C.. The large range of budgets in 2100 is due to the different levels of overshoot in peak budgets, (potentially) requiring deeper reductions later due to (uncertain) hysteresis in the temperature response to cumulative CO2.
11830	57	3	57	3	This figure is completely baffling! [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. Figure was revised to improve comprehensibility.
18116	57	3	57	10	The graph is complicated and quite difficult to follow [Andrea TILCHE, Belgium]	Taken into account. We have tried to simplify the figure a bit.
42436	57	5			explanation ===> the explanation [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42438	57	5			barplots ===> bar plots [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
44218	57	6	57	9	CO2, 2 should be subscript [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
47806	57	6	57	9	Please use CO2 [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42440	57	10			as blue line ===> as a blue line [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
11832	57	13	57	13	Some important literature on sustainability implications is missing. For example Strapasson et al http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12456/abstract (which is also relevant for the interlinked section in chapter 4), Boysen et al 2017 http://onlinelibrary.wiley.com/doi/10.1002/2016EF000469/full and another Boysen et al 2017 http://onlinelibrary.wiley.com/doi/10.1111/gcb.13745/abstract [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Literature added.
51024	57	13	59	33	Include discussion of Holz et al. and Dooley and Kartha in this section. [Doreen Stabinsky, United States of America]	Partially accepted. Dooley and Kartha was cited. Holz et al. is discussed in Section 2.3.4.1.
60124	57	13	59	36	Section 2.3.4.2 contains largely general discussions not specific to 1.5°C pathways. Suggest making this section more relevant to specific pathways (making associated uncertainties clear), or greatly reducing the text length. [United States of America]	Noted. Section 2.3.4.1 discusses CDR deployment in 1.5°C pathways, Section 2.3.4.2 puts this into a sustainability context, providing a gateway to further discussions in Chapters 3 and 4.Text length was kept at a minimum with the exception of land use for CDR, which provides examples of 1.5°C pathways.
53880	57	15	57	18	I suggest stronger language here since not everything is that uncertain. One recent assessment concludes that BECCS "would most likely steer the Earth system closer to the [planetary boundary] for freshwater use and lead to further transgression of the PBs for land-system change, bio- sphere integrity and biogeochemical flows" See Heck, V., Gerten, D., Lucht, W., & Popp, A. (2018). Biomass-based negative emissions difficult to reconcile with planetary boundaries. Nature Publishing Group, 1–7. http://doi.org/10.1038/s41558-017-0064-y [Grandin Jakob, Norway]	Accepted. Sentence reworded.
7444	57	19	57	19	Insert after "Shepherd 2012": "Honegger and Reiner 2018". Reference: Honegger, Matthias; Reiner, David (2018): The political economy of negative emissions technologies: consequences for international policy design, Climate Policy, 18, p.306-321 [Axel Michaelowa, Switzerland]	Rejected. Reference was cited in the context of implementation challenges in Section 2.3.4.1
42442	57	20			initial ===> an initial [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42444	57	23			modelling ===> modeling [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
19620	58	1	58	7	Important statement about the evolution and future necessity of pathways within a larger sustainable development context, which seems particularly important in the context of CDR. [Jennifer Morgan, Netherlands]	Noted. Sentence was retained and reference to Section 2.5.3 and Chapter 5 provided.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
42446	58	4			modelling ===> modeling [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
58120	58	4			It is interesting to add here that stronger near- and medium term emission reductions correlate with higher bioenergy demand in the near to mid-term. Most commentators on BECCS/CDR emphasise the intertemporal reallocation of the emission budget and relate BECCS/CDR to high bioenergy use. However, in the EMF33 cross-model comparison lower 2050 emissions correspond to higher 2050 bioenergy use. This finding can be found in Bauer et al (2017). It would be interesting, if the overall SR15 sample confirms this finding from the EMF33 sample. [Nico Bauer, Germany]	Noted. A discussion of the timing of CDR options was provided in Section 2.3.4.1, the continued high bioenergy use in many limited BECCS scenarios was noted in the text.
11834	58	5	58	7	And how do these pathways differ? There is a frustrating lack of specificity in much of this discussion of CDR and yet it is so crucial. [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Discussion extended
11836	58	9	58	19	Is a discussion of emissions implications of land use change warranted here as well? How is this accounted for in models? [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. The Annex and a newly added box on land use and bioenergy modelling in IAMs now describe how it is accounted for in IAMs.
60126	58	10	58	14	These sentences might be reframed to better reflect nuances. Weathered rock could be spread on any land, not just agricultural lands. Bioenergy can be produced on non-agricultural land (forest thinnings, municipal solid waste, etc., or use agricultural residues). Afforestation/reforestation may actually restore, not threaten, ecosystems. As written, these sentences may appear to exaggerate tradeoffs. [United States of America]	Accepted. Paragraph was revised and the possibility of synergies between different land uses was mentioned in the subsequent paragraph.
36660	58	11	58	16	Also relevant here is Krause et al. (2017): "Global consequences of afforestation and bioenergy cultivation on ecosystem service indicators," which considered impacts on evapotranspiration, albedo, BVOC emissions, runoff, nitrogen, and crop production. An interesting point is that since less land is needed for BECCS than afforestation for the same amount of CDR, they found smaller impacts on most ecosystem services in their BECCS scenario. https://www.biogeosciences.net/14/4829/2017/bg-14-4829-2017.pdf [Anna Harper, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The tradeoffs/impacts of individual CDR options are assessed in chapters 3.6.3, Box 3.2 and 4.3.7. More efficient cross-referencing to the respective sections, so that this (complementary) information is at hand, yet does not need to be repeated in the light of our space constraints in this chapter.
32670	58	14	58	16	What about a potential need for water and fertiliser for A/R? (I am not an expert on A/R, so wonder if it could be significant as well...) [Jasmin Kemper, United Kingdom (of Great Britain and Northern Ireland)]	Water needs are provided in Smith et al., no fertilizer needs. This is discussed further in Section 4.3.7.
1734	58	17	58	17	The potential negative impacts on GHG emissions should be indicated here, e.g. 'Some approaches like DACS can have high energy demand (potentially increasing GHG emissions) and water demand'. [Greece]	Rejected. Depends on energy mix.
63208	58	17	58	19	Add: " Some approaches like DACS can have high energy and water demand. Most of the CDR measures currently discussed could have significant impacts on either land, energy, water, or nutrients if deployed at scale (Smith et al., 2015). Yet all of the preceding negative impacts must be weighed against benefits to CO2 and climate impact reduction, which if unchecked have significant, negative environmnetal and societal consquences (Chapter ___)." [Greg Rau, United States of America]	Rejected. Broder trade-off analysis provided throughout the report.
13362	58	21	58	23	Issues of permanence of these NETs C/CO2 stores are compared and discussed in Scott et al 2015 Fossil Fuels in a trillion tonne world https://www.nature.com/articles/nclimate2578 [Scott Vivian, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Reference added.
13908	58	21	58	36	Paragraph descriibing geological carbon sequestration. No mention is made of the evidence that there can be induced seismicity here, which should also be mentioned. [Natalie MAHOWALD, United States of America]	Accepted. This has been added to the paragraph on sustainability concerns.
28074	58	21	58	26	Here, forests (woody vegetation) are only considered as C pools. What seems to be missing is the consideration of harvested wood products as additional pool and the impact of wood use as material instead of e.g. fossil fuel-intensive materials. Is this being accounted for in the model set-up? [Germany]	Accepted. This point was added to the discussion in Section 2.3.4.2.
54448	58	21	58	26	I did not find a more detailed discussion of the permanence of terrestrial carbon pools in Chapter 4. As of now this seems to be a missing element of both Chapters 2 and 4 and I suggest one of them cover it in detail given the very large sections on terrestrial CDR. Cross-chapter box 3.1 seems to be the only real mention and it is very light currently. [Christopher Weber, United States of America]	Taken into account. There is now a footnote on this in Chapter 4.3.7. A more elaborate discussion was not possible due to space constraints.
60128	58	21	58	36	While permanence is often discussed in terms of terrestrial carbon stocks, it should be noted that (1) the risk of future emissions due to anthropogenic causes is no different than the risk of future emissions from fossil fuel reservoirs; and (2) there is an atmospheric value to avoided emissions in any one year. Suggest adding a sentence after line 23 noting "The discussion of non-permanence due to anthropogenic causes in this context has parallels to questions of fossil fuel reservoirs remaining in the ground." [United States of America]	Accepted. Such a sentence was added.
55634	58	24	58	27	Concerns about permanance. Would be useful to note that permenance is itself related to climate change; as noted in chapter 3, risk of non-permance increases with temperaeture. (Perhaps useful to note that threshold in this regard are lijley to be >1.5, with some key ones (eg Amazon dieback) > 2C, perhaps ~4C). Thus there is potential for virtuous circle: rapid net GHG reductions, with Ecosystem-based approaches (mature CDR measure) playing a significant role, especially in early stages, limiting temperature increase, thereby increasing ecosystem resilience and permanence. (Contrast with viscous circle of weak mitigation, temp exceeding threhsolds, ecosystem breakdown contriuting to further (possibly runaway) climate change). [David Cooper, Canada]	Noted, a fair point, but was not included due to space constraints.
11838	58	26			Should also acknowledge forest pest and disease outbreaks as a potential source of CO2 being returned to the atmosphere – as well as the direct impacts of climate change. [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. This was added.
63210	58	26	58	26	Add: "There are similar concerns about outgassing of CO2 from ocean storage, unless it is transformed to a substance that does not easily exchange with the atmosphere, e.g.,ocean alkalinity or buried marine biomass." see chapter 4 additions [Greg Rau, United States of America]	Accepted. This was added.
13364	58	27	58	36	Quantification applying knowledge of geological trapping processes of potential leakage of geologically stored CO2 is investigated in detail in Alcade et al Quantifying geological CO2 storage security to deliver on climate mitigation (provisionally accepted) Nature Communications - preprint https://eartharxiv.org/x59qg/ . Previous studies have not as comprehensively incorporated geolocical understanding into estimates of possible CO2 leakage. [Scott Vivian, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Reference is now assessed in the Section.
44220	58	27	58	27	needs space between "Co2 release" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51764	58	27	58	27	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
37844	58	29	58	29	Use "full grown", or "mature" instead of "grown" [Michiel Schaeffer, Netherlands]	Accepted. Discussion of carbon storage limits on forest land was reworded.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
51254	58	29	58	32	In the statement "..... manage (e.g., risk evaluation, risk treatment, and monitoring and evaluation), evaluation seems to be repeated. [Muhammad Latif, Pakistan]	Take into account. Bracket was removed
5752	58	32	58	32	" but substantially lower than at 2°C". How much are we certain that the risks would be "substantially" lower? [Govindasamy Bala, India]	Comment does not seem to be on the indicated text. Not clear what is meant..
35814	58	32			More clarity is required on the certainty of the statement "but substantially lower than at 2°C". [India]	Comment does not seem to be on the indicated text. Not clear what is meant..
1736	58	33	58	34	The effectiveness of risk management in the case of all these cdr measures may need several decades to be properly assessed. Thus, the statement 'Successful risk management would prevent sustentative leakage from geological storage..' is arbitrary and not justified by the available literature. [Greece]	Accepted. Reworded.
19594	58	33	58	33	It would be more accurate to state that successful risk management SHOULD prevent substantive leakage as this is more a condition for risk management to have been successful rather than proven established practice. [Jennifer Morgan, Netherlands]	Accepted. Text was revised.
19598	58	33	58	33	sustentative' should perhaps be 'substantive'? [Jennifer Morgan, Netherlands]	Noted. We stayed with "sustentative"
19630	58	33	58	34	This statement, does not properly caractherize the risk of CO2 leakage from CCS operations It is a misleading statement, presenting the risks as manageable. There is potential risk of leakage during the injection phase, well blow outs, improper sealing of well casings and the potentially higher risk of leakage in former oil and gas fields (http://www.sciencedirect.com/science/article/pii/S1750583613000030), which are full of incompletely sealed and improperly sealed wells. Even very low leakage rates could completely negate the climate benefits of CCS. (Azar, C et al, 2006, Carbon Capture and Storage from Fossil Fuels and Biomass – Costs and Potential Role in Stabilizing the Atmosphere, Climactic Change vol. 74, 2006, pp. 47-79.) [Jennifer Morgan, Netherlands]	Accepted. The discussion has been reformulated including most recent literature on leakage risk.
28076	58	33	58	34	This assessment is trivial. The relevant aspect (and still open question) is, IF risk management can be adequately and successfully to prevent leakage? Please reformulate. [Germany]	Accepted. Text has been reformulated
1738	58	34	58	36	But the literature on the potential environmental impacts from the leakage of CO2 is yet inconclusive. This should be added here. [Greece]	Taken into account. Reworded.
44862	58	36	58	36	by (Jones et al., 2015b)--> by Jones et al.(2015b) [Hiroaki Kondo, Japan]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
7186	58	38	58	50	This paragraph is important but it is written in a rather tentative and perfunctory way. Be explicit about the challenges, with reference to the growing literature, and/or cross-reference Ch3, 4, and 5. Fig 2.18 shows a worrisome pattern - say so in the text! [Petra Tschakert, Australia]	Taken into account. The large land use changes and associated challenges are highlighted.
28078	58	41	58	44	This comparison with respect to land demand is somewhat misleading since a lot of other potential positive ecological effects of afforestation (e.g. on biodiversity or water balance) are ignored in this context. [Germany]	Taken into account. Discussion was revised.
49692	58	41	58	44	False conclusion. Clarify and check on terminology and calculations and revise: "In pathways that allow for large-scale afforestation in addition to BECCS, land demand for afforestation is larger than for BECCS. This is because the amount of carbon to be stored in soils and trees on a unit of land is limited, while BECCS is assumed to allow continuous sequestration of CO 2 from biomass year by year (Smith et al., 2015)." This comparative conclusion builds on the false assumption that after afforestation/ reforestation there is no use, incl. for BE, harwested wood products etc. with additional sequestration effects. BECCS from such comparative view would only be much less land demanding if there was really "continuous sequestration of CO2 from biomass year by year", i.e. BE was not usedor combined with CCS, which is often lacking political support and technical /economic feasibility. The (mutually exclusive) differentiation between afforestation and BECCS comparatively downsizes the actual use potential in restoration, afforestation or reforestation activites. Please consider additional literature for a broader understanding of what "afforestation" (or reforestation? or restoration?) may include, e.g. Agroforestry: Zomer, R. J., Neufeldt, H., Xu, J., Ahrends, A., Bossio, D., Trabucco, A., … Wang, M. (2016). Global Tree Cover and Biomass Carbon on Agricultural Land: The contribution of agroforestry to global and national carbon budgets. Scientific Reports, 6, No. 29987). [Sabine Reinecke, Germany]	Accepted. The discussion now highlights the possibility to harvest forests to allow for continued carbon uptake. The suggested reference on agroforestry was added.
28080	58	42	58	44	Again, forests appear to be seen only as pools for carbon, not as the "carbon pump" (from the atmosphere into products and bio-energy) if they can be properly managed. There is no real competition between forests and BECCS, as forests can provide wood fuel (directly and in the form of used wood-based products that are burnt at the end of their respective life span) for BECCS. [Germany]	Accepted. The discussion now highlights the possibility to harvest forests to allow for continued carbon uptake.
11840	58	44	58	46	This comparison to area of cropland should be made more prominent. Very significant. [United Kingdom (of Great Britain and Northern Ireland)]	Noted. We think the comparison as it is now is sufficient.
19602	58	44	58	50	In this paragraph, reference could also be usefully made to the recent review of Heck et al. (2018), which addresses the ways in which deployment of BECCS could have significant impacts on many Earth-sytem components (https://doi.org/10.1038/s41558-017-0064-y) [Jennifer Morgan, Netherlands]	Reference included.
37192	58	44	58	46	The information "The combined land demand for the two CDR measures can be very substantial by the end of the century, up to the magnitude of the current global cropland area." is useful but more interesting would be the lower limit in order to see what is "needed" in terms of BEECS& afforestation land in the cost effective scenarios. In addition, it would be helpful, if a summary of this very important point enters the executive summary on page 6. [Thomas Bruckner, Germany]	Taken into account. Fig. 2.18 includes the LED scenario with more limited land use change at the lower end of what is projected in 1.5°C pathways.
60130	58	44	58	50	This paragraph oversimplifies issues of land use related to bioenergy and afforestation/reforestation. Note that (1) bioenergy may not come from dedicated crops; (2) bioenergy feedstocks may come from forested land; (3) reforestation may occur on previously forested land, NOT at the expense of natural ecosystems; and (4) opportunities exist to use underutilized land for either bioenergy or afforestation (e.g., highway verges and medians). Suggest a caveat be added to line 44: "Without sustainable intensification or the better utilization of currently underused lands, the combined land demand ..." [United States of America]	Taken into account. The discussion now highlights that exploiting synergies between different land uses can mitigate the challenges.
60132	58	44	58	50	The paragraph does not recognize the co-benefits associated with the use of waste materials as bioenergy feedstocks, or of forest restoration. Suggest adding to line 48: "However, implementing such large-scale land use changes without proper consideration of other priorities could pose significant governance challenges, especially if co-benefits associated with forest restoration or utilization of waste materials for bioenergy feedstocks are not fully recognized." [United States of America]	Taken into account. The paragraph highlights the governance challenges and notes that synergies between different land uses can mitigate the challenges.
42448	58	46			modelled ===> modeled [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
50228	58	46	58	46	Explain the reason for conversion of pasture land. Is it lower meat / dairy consumption of intensification of animal husbandry? [Bert Metz, Netherlands]	Accepted. Reasons are explained..

Comment No	From Page	From Line	To Page	To Line	Comment	Response
11842	58	47			Potential impacts of CDR measures (land use change) on biodiversity go beyond expansion onto natural land; there are also likely to be impacts on populations at species level that result from such significant changes in land use. 'Governance' is mentioned, but this should be extended to cover the aspirations/objectives to those that own the land. [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Environmental challenges and the dimension of land tenure are now mentioned.
42450	58	47			natural ===> the natural [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42452	58	48			large scale ===> large-scale [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
37382	58	48	58	49	Allocating so much land to BECCS would not only pose substantial governance challenges, but would also have severe repercussions on food production, maintenance of C stocks in biota and soils (e.g. higher pressure on deforestation), etc. See e.g. Erb et al., 2016, Nature Communications, 7, 11382, Haberl, 2015. Ecological Economics, 119, 424-431. For example, allocating so much grassland to growing energy crops would have massive feedbacks on the ability to feed livestock. As the cited Erb et al. paper shows, in a no-deforestation world, cropland and grazing land scarcity severly constrains the option space for feeding the planet, especially if diets rich in animal protein (meat, milk, eggs) are considered. This would result in a strong additional driver for deforestation, further speed up the C cycle (see Erb et al., 2016, Nature GeoScience, 9, 674–678) and most likely intensify land-use with massive consequences for the global C balance of biota and soils, see Erb et al., 2018, nature, Haberl 2013, GCB Bioenergy, 5, 351f, etc., hence raising the question to what extent the full GHG implications of achieving such massive additional biomass harvests, and of using so much additional land, have been fully accounted for. If they have not been fully considered, the GHG benefits of bioenergy respectively BECCS are not correctly represented in the scenarios. It needs to be explicitly discussed to what extent such effects have been considered, and if they have not been fully considered, it is needed to introduce appropriate caveats to avoid mis-interpretation of the analysis. [Helmut Haberl, Austria]	Taken into account. The list of challenges was extended, and a discussion of how bioenergy and land use is represented in the scenarios was added to Section 2.3.4.1 (Box 3.1).
3224	58	49	58	50	Another key dynamics (which I think is mentioned in Popp et al (2017)) concerns future agricultural productivity (i.e. yields, pasture intensification). [Vassilis Daioglou, Netherlands]	Accepted. This is discussed in the paragraph.
34770	58	49	58	50	The paragraph should note at the end that 26 percent of the earth's terrestrial surface is used for livestock grazing, while one-third of the planet's arable land is occupied by livestock feed crop cultivation, according to the United Nations Food and Agriculture Organisation (FAO, see http://www.fao.org/3/a-ar591e.pdf). Thus, diet changes in the future have the potential to free up agricultural land for BECCS or afforestation (Kartha and Dooley, 2016). See: https://www.sei-international.org/mediamanager/documents/Publications/Climate/SEI-WP-2016-08-Negative-emissions.pdf [Helena Wright, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account. The importance of dietary changes was mentioned.
34772	58	49	58	50	The sentence which states 'These dynamics are heavily influenced by assumptions about future population levels, food crops and livestock demand (Popp et al., 2017)' should also include 'dietary preferences'. This is listed in the original source but missing here. [Helena Wright, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. This was added.
63212	58	49	58	50	Add: "These dynamics are heavily influenced by assumptions about future population levels, food crops and livestock demand (Popp et al., 2017). Greater use of marine-based CDR could reduce land governance issues, but likey create new management concerns." [Greg Rau, United States of America]	Noted. This was not added due to space constraints. Marine CDR is mentioned in the introductory part of Section 2.3.4.1.
57970	58	51	58	51	There is a missing word "to" in the phrase "compared preindustrial times (1850–1900)" to read "compared to preindustrial times (1850–1900)." [Siir KILKIS, Turkey]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
11844	58	52	58	54	And if BECCS is available, what substitutes for the absence of bioenergy to, for example, decarbonise fossil fuel liquids? Does BECCS just compensate for continued FF use in those sectors? Why is this preferred in the models? [United Kingdom (of Great Britain and Northern Ireland)]	There is 40-50% CO2 capture in biofuel production.
19624	58	52	58	55	It is concerning that pathway literature assumes large amounts of bioenergy replacing fossil fuel independent of BECCS. Much of bioenergy generally drives land demand, overuse of forests and biodiversity loss (exept a small share coming from biomass residues and waste) making it probably the most unsustainable form of renewable energy on average. [Jennifer Morgan, Netherlands]	Noted. See section 2.3.1.2 on the topic.
50226	58	52	58	53	This is a key finding that needs to be in the Exec Summary and the SPM, because there is a widespread misconception that biomass use is strictly driven by the amount of BECCS, which feeds the societal resistance against BECCS. [Bert Metz, Netherlands]	Taken into account. In the ES.
60134	58	52	59	33	These are informative findings developed from the analysis. [United States of America]	Noted. Text on CCS potential was moved to section 2.4.
18120	59				Fig 2.18 needs more explanatory background. What is the driver of reduced pasture and food crop area (diet? intensification? yield increase?). Or consider merging this section with the land section that begins on page 78. [Andrea TILCHE, Belgium]	Accepted. Discussion of Fig. 2.18 extended by a half sentence with explanation on drivers.
63214	59	1	59	3	In contrast, CCS deployment can be significantly increased if BECCS and, DACS are added as CDR measures compared to scenarios that only allow for CCS at fossil fuel installations. (Marcucci et al., 2017; Rogelj et al., 2017b). ----- Aside from benefitting the CCS lobby, why is increased reliance on expensive CCS with risky CO2 storage necessarily good thing? [Greg Rau, United States of America]	Noted. This is a misunderstanding, and the text was reworded to avoid the misunderstanding.
34200	59	3	59	6	Figure 2.18: Please explain what the category "other arable land" in the figure involves. The other categories, "food crops", "energy crops", "forest" and "pasture", are somewhat more clear, but the overall understanding of this figure would improve if also those categories were shortly defined. [Norway]	Accepted. Changed to "other natural land".

Comment No	From Page	From Line	To Page	To Line	Comment	Response
49610	59	4	59	4	Figure: such a change of pastures could entail massive sustainability challenges, and I wonder if they are reflected in the model at all. A reduction of pasture areas could severely affect food security at the global level. Erb et al.2016 doi10.1038/ncomms1138 show that the constraints from grassland availability are as frequent and important as cropland constraints for the feasibility of scenarios. The model assumptions with regard to this pasture reduction need to be openly discussed as they are key for the plausibility of the scenarios (and the 1.5° pathways altogether). Furthermore, a doubling of global cropland area, as claimed by some of the scenarios, will not occur only at the expense of grasslands/pastures only, and the likelyhood of deforestation is extremely high. Which form of governance could steer this cropland demand only to pastures, when pastures are used, not only for commercial production, but to a very large degree for subsistrence (and in the light of the pertinent SDGs). The deforestation signal will be so massive that it will anihilate the bioenergy signal. This is a grave condition and its implications need to be adquately reflected in the text, much beyond the text on pg 58ln38ff. [Karlheinz ERB, Austria]	Noted. The mechanisms and assumptions are discussed, carbon prices keep forests protected. We include a sentence that governance challenges of such large transitions are high and added a box on land use and bioenergy modelling in IAMs in which the crucial assumptions on good governance of land transitions are highlighted.
11846	59	5	59	5	Why does the amount of land for food decline in AIM ssp1? Fewer people? Healthier lifestyles? Given the importance of the sustainability implications of land CDR, I think the details of these scenarios need greater discussion. It's hard to properly contextualise without this. [United Kingdom (of Great Britain and Northern Ireland)]	Noted. Beyond the scope of this text but reference to section 2.3.1 with a discussion of SSPs has been provided.
45362	59	5	59	5	Figure 2.18 Reference year should be given here. Change from which year until 2050? Is 2100 change from 2050 or from some reference year? [Tuomo Kalliokoski, Finland]	Reference year is 2010 as stated in the label on the y-axis.
46626	59	5	59	7	Colourblind check for this figure. Please avoid using greens and reds together in figures as they are hard to distinguish between. [Sarah Connors, France]	Accepted. Colours adjusted
51766	59	7	59	9	Once again, the framing should be imperative rather than descriptive. It confuses the issue if the implication is that will be mitigated. The must be doesn't mean that they will be. [Jason Donev, Canada]	Taken into account. Discussion was revised to highlight this point.
13366	59	8	59	33	Key here is that the quality of knowlegde (confidence) in CO2 storage estimates varys widely across regions - from very high to extremely low. As a result, there are fifferent development timelines whereby some regions could radidly develop large scale geological co2 storage, while others would need to undertake decade(s) of more detailed assessment and investigation. Some discussion and data in (including in suppplementary information) Haszeldine et al (accepted) Phil Trans R Soc - Negative emissions technologies and carbon capture and storage to achieve the Paris Agreement commitments. [Scott Vivian, United Kingdom (of Great Britain and Northern Ireland)]	Taken Into Account. A separate section on CCS is given in 2.4.2.3 and includes a short discussion of pace.
50230	59	8	59	33	It is important to draw clear conclusions that the available storage space for CO2 is significantly larger than what any 1.5C scenario would require. This is also important for the SPM. [Bert Metz, Netherlands]	Taken Into Account. A separate section on CCS is given in 2.4.2.3 and includes a clear statement about the size of storage estimates being larger than storage in pathways.
14074	59	9	59	10	It would make more sense to also include CCS for the industrial sector. I suggest changing to "...which is similar to what is found in 2°C pathways (including CCS at industrial plants and fossil fuel and bioenergy installations" [Aage Stangeland, Norway]	taken into account: storage capacity is assessed in this section, and CCS is included in most 1.5 pathways across the report
11848	59	11	59	12	Why less ccs, what is driving this? [United Kingdom (of Great Britain and Northern Ireland)]	taken into account: it is noted in the figure caption that fossil carbon includes eg cement
28082	59	13	59	16	This assessment is one-sided as it only considers technical and natural aspects. It is still an open question if this technical potential can be realized because of limit of acceptance by society. Please add this constraint. [Germany]	Taken Into Account. A separate section on CCS is given in 2.4.2.3 and highlights the wide range of CCS inclusion across pathways. Addressing constraints that limit the pace of mitigation is a central topic for Chapter 4.
45364	59	13	59	13	Why referred to this old IPCC work? Does not look convincing if the technical potential estimate is 15 years old. [Tuomo Kalliokoski, Finland]	noted: text starts with what the IPCC assessed in SRCCS and then updates this with new studies
46536	59	14	59	14	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
42454	59	16			Furthermore ===> Furthermore, [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
37224	59	20	59	25	An important reference to add to this list is the DOE Geological Storage Atlas of North America (primarily US). This is the most advanced national storage characterisation study (in terms of subsurface data, knowledge, actual injection tests and anlaysis). The conclusion for the study only for saline formations was a low confidence of 2,379 billion metric tons to 21,978 billion metric tons of CO2 (DOE, 2015). Much greater than all the required geological storage from all scenarios [John Scowcroft, Belgium]	taken into account: this discussion is moved to 2.4.2 where CCS is discussed more broadly
42456	59	27	59	28	(Bachu, 2015) . ===> (Bachu, 2015). [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
18118	59	35	59	36	The TOD should consider not only the relationship "between bioenergy and BECCS" (which is odd, as BECCS is bioenergy), but, more importantly, should revisit and clarify the relationship between land use and bioenergy (with or without CCS). Essential sources: Haberl et al. 2012. Correcting a fundamental error in greenhouse gas accounting related to bioenergy. Energy policy, Vol: 45-222, Issue: 5, Page: 18-23 Haberl, Helmut, 2013. Net land-atmosphere flows of biogenic carbon related to bioenergy: towards an understanding of systemic feedbacks. Global Change Biology Bioenergy, 5, 351-357 Haberl, Helmut, Karl-Heinz Erb, Fridolin Krausmann, Steve Running, Timothy D. Searchinger, W. Kolby Smith, 2013 Bioenergy: how much can we expect for 2050? Environmental Research Letters, 8, 031004 Shows that land management effects beyond deforestation are almost never taken into account when assessing the C effects of land-use changes, even more so in coarse models such as IAMs [Andrea TILCHE, Belgium]	Taken into account. A discussion of bioenergy and land use, and how they are represented in IAMs, has been added in a new box in Section 2.3.4.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
42772	59	35	59	36	Whether BECCS is effective will depend a great deal on the type of bioenergy being used. Using biomass for energy (BE) from wood is considerably worse than coal in the near-term. See, e.g., Duncan Brack, Wood Is Not a Carbon-Neutral Energy Source (1 March 2017). Using switchgrass could lead to net carbon removal. See Danielle Venton, Core Concept: Can bioenergy with carbon capture and storage make an impact?, PNAS (2016). [Kristin Campbell, United States of America]	Taken into account - A discussion of bioenergy feedstocks considered in IAM-based mitigation pathways is added in a box in Section 2.3.4 and to the description of IAMs in the Annex. Feedstocks are also part of the assessment of bioenergy in Section 4.3.2. A cross-reference has been added here to make the link to this complementary information.
43000	59	35	59	36	Whether BECCS is effective will depend a great deal on the type of bioenergy being used. Using biomass for energy (BE) from wood is considerably worse than coal in the near-term. See, e.g.,. Sterman J. D., et al. (2018) Does replacing coal with wood lower CO2 emissions? Dynamic lifecycle analysis of wood bioenergy, ENVTL. RESEARCH LETTERS 13(015007):1–10, 1 ("We simulate substitution of wood for coal in power generation, estimating the parameters governing NPP and other fluxes using data for forests in the eastern US and using published estimates for supply chain emissions. Because combustion and processing efficiencies for wood are less than coal, the immediate impact of substituting wood for coal is an increase in atmospheric CO2 relative to coal. The payback time for this carbon debt ranges from 44–104 years after clearcut, depending on forest type—assuming the land remains forest. Surprisingly, replanting hardwood forests with fast-growing pine plantations raises the CO2 impact of wood because the equilibrium carbon density of plantations is lower than natural forests. Further, projected growth in wood harvest for bioenergy would increase atmospheric CO2 for at least a century because new carbon debt continuously exceeds NPP. Assuming biofuels are carbon neutral may worsen irreversible impacts of climate change before benefits accrue. Instead, explicit dynamic models should be used to assess the climate impacts of biofuels."); and Booth M. S. (2018) "Not carbon neutral: Assessing the net emissions impact of residues burned for bioenergy", Envtl. Research Letters. [Durwood Zaelke, United States of America]	Taken into account - A discussion of bioenergy feedstocks considered in IAM-based mitigation pathways is added in a box in Section 2.3.4 and to the description of IAMs in the Annex. Feedstocks are also part of the assessment of bioenergy in Section 4.3.2. A cross-reference has been added here to make the link to this complementary information.
56036	59	35	59	36	Good that the TOR will have consideration of this issue. Setting aside various perspectives on the benefits of bioenergy, there are limits to biomass production (both biophysically and socially considering competing demands for land) and there are trade-offs between BECCS and biofuels for hard to decarbonize sectors. With limit land, what is the best use of land for meeting the Paris Agreement's goals in the context of sustainable development? [Kelly Stone, United States of America]	Noted. A box on bioenergy and BECCS use in 1.5°C pathways and underlying assumptions and enabling factors has been added to Section 2.3.4.
53234	59	35	59	36	This section states, "[Note on the SOD: The discussion of the relationship between bioenergy and BECCS will be further updated in the TOR]" We recommend that the report include one long detailed section highlighting all issues and problems with BECCS and bioenergy (We also made this recommendation in our comments on the FOD). We hope the above placeholder serves as notice that this overview will be included. We suggest the following outline as a guide to what information the bioenergy/BECCS section should include. Outline 1. What bioenergy is: burning wood, crops, residues, waste, biogenic gases for heat and power, and using materials to manufacture biofuels 2. The role that bioenergy plays (with, and without CCS) in various modeling scenarios a. Competing demands for biomass – for use as fuel in power plants, and feedstock for liquid biofuels 3. Bioenergy carbon impacts: Carbon emissions from bioenergy: that biomass has about the same energy content per kg carbon content as coal, so that on a heat input basis, CO2 emissions per unit energy input are similar between biomass and coal. But since biomass has high moisture content, this degrades efficiency at power plants, thus actual CO2 emissions on a heat output basis tend to be higher per unit energy for biomass than for coal. a. Bioenergy is not instantaneously carbon neutral/bioenergy carbon impacts 4. Why bioenergy is considered by models to mitigate CO2; why climate models tend to treat some types of bioenergy as having zero carbon emissions. 5. Modeling assumptions about bioenergy that undercount emissions impacts a. some models do not take emissions from direct and indirect land use change into account b. for the models that do examine emissions from land-use change, absent a change in land-use, models tend to treat biomass consumption as if it has zero carbon emissions c. models appear to treat residues as having zero net emissions 6. What BECCS is 7. BECCS role in providing negative emissions – how necessary is BECCS? 8. Issues that could prevent BECCS from delivering negative emissions a. Technical issues: the assumption that gasification is available and the need for dried fuels b. Scaling issues c. Environmental issues, including water demand d. Cost e. Impossibility of capturing most emissions from biomass converted to liquid biofuels f. Impossibility of capturing lifecycle emissions from biomass processing and transport 9. Plausibility that BECCS can actually be deployed for CDR, versus afforestation 10. Scenarios under models that don't include BECCS as mitigation Some of the comments below include the headings from the outline above with asterisks (**) to to indicate how the report's current mode of discussing bioenergy and BECCS can be improved to provide more information and transparency. [Mary Booth, United States of America]	Noted - Given space constraints, it is not possible to include a long additional section, but clarity on the most salient of these issues has been enhanced in the following ways: (1) Section 2.3.4 now includes a box on the land use and bioenergy dynamics in 1.5°C pathways and the underlying assumptions and determining factors. (2) On the bottom-up assessment of BECCS/bioenergy, the individual options are assessed in Chapter 4.3.2 and 4.3.7, with impacts also assessed in chapter 3.6.3 and a cross-chapter box on land-based CDR. The cross-referencing to the respective sections has been extended, so that this (complementary) information is at hand, without being repeated in Chapter 2..
42458	60	1			near term ===> near-term [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
51026	60	1	60	44	Include discussion of Holz et al. in this section. [Doreen Stabinsky, United States of America]	Accepted. Holz et al. is now cited in the section.
13910	60	5	60	5	This is a direct consequence of the quasi-linear relationship between the total cumulative 5 amount of CO2 emitted into the atmosphere and global mean temperature rise (Collins et al., 2013). is this the right citation? Maybe Zickfield et al., 2009 is better or use the ones consistent with chapter 1? [Natalie MAHOWALD, United States of America]	Accepted. Reference to Zickfeld has been added.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
35816	60	7	60	7	The issue of technology lock-in is introduced here. It needs to be clarified that this is not a 'natural' process but an institutional one reinforced by political, market, and social factors. These tend to affect long-term lock-out of advanced technologies and can potentially be anticipated and addressed by policymakers and investors. Similarly, even as advanced technologies like solar are deployed, there are particular configurations and technologies that may be favored and quickly deployed at the expense of others, creating other conditions of lock-in and lock-out. See, for instance, Erickson, Peter, Sivan Kartha, Michael Lazarus, and Kevin Tempest. "Assessing carbon lock-in." Environmental Research Letters 10, no. 8 (2015): 084023. [India]	Accepted. We now say "Institutional and economic" lock-in
29636	60	9	60	9	Please insert after "once deployed": (Michaelowa et al. 2018) Reference: Michaelowa, Axel; Allen, Myles; Fu Sha (2018): Policy instruments for limiting global temperature rise to 1.5°C – can humanity rise to the challenge?, in: Climate Policy, 18, p. 275-286 [Mareike Blum, Germany]	Accepted. Reference has been added together with other references on carbon lock-in.
11850	60	13	60	15	So models do have the scope to avoid "committed" emissions. This undermines the use of comitted emissions earlier in the chapter (page 28, lines 50-52). [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Will be reflected in the discussion on committed emissions.
1740	60	14	60	15	Studies show that to still meet stringent climate targets despite near-term delays in emissions reductions, models need to prematurely retire carbon intensive infrastructure, in particular coal without CCS': this may be true from the point of view of GHG emissions, but it may be unrealistic from an economic point of view considering the long lifetime of coal power plants. This point should be added here as a critisism of these studies. [Greece]	This is already mentioned in the preceding sentence: "the continued investment in and use of carbon-intensive technologies that are difficult or costly to phase out once deployed"
42460	60	15			in particular ===> in particular, [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
14036	60	18	60	18	No need to define "renewables" every time used. Surely everyone knows the term nowadays. Constraints of integrating variable renewables whilst still maintaining grid stabilility need to be mentioned. IPCC SRREN (2011) Ch 8 covered it in detail that mainly still holds true. [Ralph Sims, New Zealand]	Renewables not used in the sentence. Comment is likely misplaced.
58434	60	19	60	19	Another useful reference here, including a delayed scenario: IEA/IRENA (2017) [Andrew Prag, France]	Accepted. Reference added
42462	60	24			limited with ===> limited to [Egypt]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
61768	60	31	60	44	You may also want to quote other studies evaluating the uncertainty associated with the emissions implied by NDCs such as Benveniste et al, ERL, 2018 (http://iopscience.iop.org/article/10.1088/1748-9326/aaa0b9/meta). [Valérie Masson-Delmotte, France]	Accepted. Reference added
58446	60	32	60	34	suggest to cite: WEO-2017; as (IEA, 2017X) [Andrew Prag, France]	Rejected. We cite studies assessing the NDCs across all sectors and Kyoto gases.
51768	60	33	60	33	The acronym NDC has been used for dozens of pages, why is it getting defined here? [Jason Donev, Canada]	True, but it was not mentioned in previous subsections (2.3.3 and 2.3.4) so we felt it is useful to recall it here.
54580	60	33	60	33	Nationally Determined Contributions (NDCs)'…this has been defined earlier on Page 5, line 16 [Qudsia Zafar, Pakistan]	We opt for re-introducing the acronym in this subsection to make it self contained.
19122	60	34	60	38	Our study (Benveniste, H., O. Boucher, C. Guivarch, H. Le Treut, and P. Criqui, Impacts of nationally determined contributions on 2030 global greenhouse gas emissions: uncertainty analysis and distribution of emissions, Environmental Research Letters, 13, 1, doi:10.1088/1748-9326/aaa0b9, 2018) actually questions the range of 49-58 GtCO2eq [note that the exec summary and the FAQ say 56 rather than 58 for the upper bound]. None of the studies cited here provide a level of details and disaggregation (at the country level) that make the estimate truly transparent and trustworthy. The text should reflect the possibility of a significantly larger range for 2030 GHG emissions depending on GDP growth scenarios. [Olivier Boucher, France]	Noted. Benveniste et al. do not account for sector targets (both energy sector and afforestation targets) that can also result in emissions reductions. Some of the cited studies conduct country level analysis and therefore have the necessary detail. We added reference to Benveniste et al. Rogelj et al., 2017, also looked at GDP uncertainty.
7400	60	36	60	38	Fawcett et al. is an old study, and is replaced by Iyer et al. 2015b, which is analysed in one of the ten studies of Rogelj et al. 2016a. I no do not understand why you group this study as a recent study. I would delete Fawcett et al. 2015; Iyer et al. 2015b; and Vandyck et al., 2016, as these studies are all assessed in Rogelj at al. 2016a. [Michel den Elzen, Netherlands]	Accepted. References removed.
7402	60	37	60	37	Rogelj et al. 2016 was cited before, and not needed here [Michel den Elzen, Netherlands]	Accepted. Reference removed.
7404	60	37	60	37	Sanderson et al. does not present any calculations for the NDC. It als does not give any insights of national and counries' results. I think it should not be cited here. It will also not be included in the NDC analysis of the UNEP Gap assessment. [Michel den Elzen, Netherlands]	Accepted. Reference removed.
39144	60	38	60	44	It is important that this critical point is highlighted for policy makers to understand that GHG emissions must decline before 2030 for a chance at 1.5C temperature limit. This is a clear message, if I have understood it correctly as a reader. Please ensure it stands out. [Lindsey Cook, Germany]	Accepted. We have strengthened the discussion of the importance of near term emissions reduction for limiting warming to 1.5°C.
7406	60	39	60	39	you could make a cross reference to Box 4.2 [Michel den Elzen, Netherlands]	Accepted. Cross-reference included.
30946	60	39	60	39	cites an interquartile range of 25-41 GtCO2e, however page 5 line 20 gives the interquartile range of 14-48. Table 2.9 p61 appears to say 25-39 GtCO2e. Not clear why these figures are different. The middle one (14-48) appears to concur with the figures in Table 2.7 [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Figures are harmonized.
39146	60	41	60	43	It is of concern that the IPCC expresses cynicism for the potential in global cooperation and sustainable development to meet mitigation needs. This is a crisis - much can be achieved to face a crisis. The IPCC must state clearly the essential needs within these two categories and let States decide either to act or ignore. At least the IPCC will be doing the morally correct action. [Lindsey Cook, Germany]	The sentence has been removed.
46586	60	44	60	44	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Taken into account. The third order draft of the chapter was checked for grammar, spelling, referencing and layout before submission.
15752	61				re "switching from fossill fuels to electricity" presumably means switching from liquid fossil fuels to low-carbon electricity? Otherwise it makes no sense as a mitigation measure. [Australia]	noted: fossil fuels used as energy carriers can be any phase
18122	61				Table 2.9: This table is very useful and should be placed at the start of the chapter. It is not logical to place it in the middle of the chapter, referencing material that comes both earlier and later. [Andrea TILCHE, Belgium]	noted: this table is placed closest to the sections where pathways are explored
10512	61	1	85	5	So far the chapter presents results for the entire 21th century. However in this subsection, figures have been prepared up to 2050. It should be explained why analyses have not been done for 2050-2100. [Hong Yang, Switzerland]	Taken into account - Please note that carbon pricing figures were updated based on data provided by modelling teams and accepted literature. Now, updated figures are presented for the period 2030-2100 (undiscounted) and average discounted figures (5% rate, for comparison with AR5) for the same period.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
21462	61	1	83	10	Section 2.4 is at present the weakest in Chapter 2 as the figures and insights are less clear than in the remaining sections. I would suggest the following changes to improve the messaging as well as the intergation with the remaining chapter. The choice of scenarios in Section 2.4 is not well motivated and would benefit from adopting the sme concept of "example scenarios" used in Section 2.3. If the same scenarios as in 2.3 are not suitable, this concept could also be used with changing example scenarios per section/sector but would then need to be anchored into the narrative of Chapter 2. [Volker Krey, Austria]	Accepted - The revised Section 2.4, and Chapter 2 as a whole now uses the same set of illustrative archetype pathways, introduced in Section 2.1 and 2.3.
37846	61	5	61	6	Language is awkward and verbose in this first paragraph. "The transition fromtoday to mid-century plays the central role in 1.5°C pathways." [Michiel Schaeffer, Netherlands]	Accepted - The intro to this section has been revised for clarity.
37848	61	6	61	8	Language is awkward and verbose in this first paragraph. " ... underlining the steep declines ..." End sentence after the reference to Section 2.3.1 [Michiel Schaeffer, Netherlands]	Accepted - The intro to this section has been revised for clarity.
11852	61	9	61	10	Is there really a wide variety? This wasn't particularly well justified earlier [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - this has now been explicitly discussed in Section 2.3
37850	61	9	61	11	Language is awkward and verbose in this first paragraph. Strike "stringent". Replace "phase-out" with "reduction". End sentence after the parenthetical reference to to Section 2.3 (it's repetitive of "1.5°C carbon budget" [Michiel Schaeffer, Netherlands]	Accepted - The intro to this section has been revised for clarity.
42464	61	11			preindustrial ===> pre-industrial [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
806	61	12	61	12	Table 2.9' should be 'Figure 2.9' [Robert Shapiro, United States of America]	Noted and corrected
11854	61	14	61	14	The numbers in this table for 2030 GtC yr (18-28) differ from the full range in table 2.7 (page 34) which has a median for 50% no overshoot of 14.5. [United Kingdom (of Great Britain and Northern Ireland)]	Noted. Numbers have been checked for internal consistency throughout the chapter. The numbers in this table are also for GtCO2 yr-1 not GtC yr, which is not a unit of annual emissions.
11856	61	14	61	14	Net annual CO2 emissions are reduced to 18–28 GtCO2 yr-1 by 2030 and to –1 to 3 GtCO2 yr–1 in 2050, reaching carbon neutrality by mid-century or shortly thereafter in scenarios limiting warming to 1.5°C in 2100 with greater than 66% probability - if you reach carbon neutrality in mid century aren't you more likely in a non-overshoot scenario? In which case there aren't any 66% likelihood scenarios. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - this statement has been updated and formulated so that it now refers to the pathway classes introduced in section 2.1. The confusion with the probabilities should therewith hopefully be limited.
14076	61	14	61	15	Row 4 in this table is about switching from fossil fuel to electricity in end use sectors. I suggest changing this to switching from fossil fuels to electricity or hydrogen in end use sectors. This means that sections 2.4.3.2 and 2.4.3.3 also needs to be updated with Hydrogen [Aage Stangeland, Norway]	Taken into account - While it is correct that hydrogen can also play a role for fuel switching, this table intends to highlight the most robust features of scenarios. Due to length limits for the chapter and the relatively technical literature on hydrogen, this aspect was not covered in depth in this special report.
21464	61	14	61	16	Table 2.9 should be turned into a (text-)guide to Section 2.4 and could actually be shortened by doing so. [Volker Krey, Austria]	Noted. However, the table has been maintained because tables did not count towards chapter word count, but paragraphs do.
30948	61	14	61	14	the text in the box for “comprehensive emissions reductions are implemented in the coming decade” is critical, and should be pulled out in the ES. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - ES messages have been based on the most robust insights from the chapter's assessment
30950	61	14	61	14	it would be good to set out somewhere the % reduction implications for each non-CO2 forcer [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - Section 2.3.3. provides an overview of reductions for a set of non-CO2 forcers.
37384	61	14	61	14	In my view it is not appropriate to list demand-side options as just one among many options. I think it is essential to communicate that without reducing energy demand and altering many other resource-intensive demand categories, supply-side measures are not up to the taks of achieving 1.5°. The way this table is presented does not communicate that point well, also as demand-side measures are underrepresented (as also on p.41ff) [Helmut Haberl, Austria]	Taken into account - We agree with the reviewer's assessment of the importance of demand-side options. This table provides an overview, while other sections, including the ES, make clear that demand-side options are critical.
37852	61	14	61	15	Table, fifth row ("Comprehensive..."), last sentence. "Many models find no feasible solutions to achieve 1.5°C targets if emissions in 2030 have not been reduced sufficiently" [Michiel Schaeffer, Netherlands]	Noted. To keep the size of the table manageable, the text in the cells had to be limited.
39148	61	14	61	14	The AR5 states economic growth and population growth as main CO2 drivers, yet these are not addressed here. Nor is the mitigation reduction potential of food waste and diet (non meat to vegan), nor the full potential of natural cliamte solutions (http://www.pnas.org/content/114/44/11645) and ending of forest degredation. Why missing? [Lindsey Cook, Germany]	Taken into account - These aspects were considered and their presence and importance in the integrated pathway literature was assessed. Natural climate solutions are indeed mentioned in one publication (which is refereed to in Section 2.4.4.). However, an in-depth assessment of these measures rather falls in the scope of either the AR6 or the Special Report on Land.
42466	61	14			rapid deployment ===> the rapid deployment [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51770	61	14	61	15	In one of the boxes it claims that aerosols are reduced. This seems a little unlikely since aerosols are supressing climate change. [Jason Donev, Canada]	Taken into account - As data in Section 2.3.3 shows, due to the transformation of the energy system and combustion sources therein, aerosols are indeed reduced in 1.5°C consistent pathways.
49626	61	14	61	15	Table: note that the issue of sustainability, as often defined in e.g. forestry, is that harvest must be lower than increment. This "rule" is irrelevant when it comes to keeping ecosytems carbon rich or warranting depleted ecosystems to return to high carbon state. In largely depleted systems (e.g. due to heavy past land use impacts such as those in the agrarian society of Austria; Gingrich et al. 2012 10.1007/s10113-007-0024-6, Erb et al. 2016 10.1038/nclimate2004) harvest below increment will just result in a significant lower steady-state equilibrium of biomass (and soil) stocks or slower returns - thus the carbon depths are kept large. This should be explicitly discusseed in the text. [Karlheinz ERB, Austria]	Taken into account - Section 2.4.4. discusses land-use related issues of 1.5°C mitigation pathways. However, detailed discussions and assessment of land-use related issues are covered in the dedicated IPCC Special Report on Land.
62104	61	14	61	15	2030 is rather late a date for the "successful 1.5" mentioned in this chapter, maybe mention "as early as 2020 or 2025"? Maybe mention the rapide phase out of internal combustion engine announced by several major car manufacturers (before 2030) and by cities (which intend to ban their use). [Antoine Bonduelle, France]	Noted. However, it is unclear which precise statement the reviewer is referring to.
32672	61	15	61	15	Table 2.9 , last row: BECCS deployment of 2.5-7.5 GtCO2/yr is mentoined here, this should be mentioned in the Executice Summary of this chapter (see comment no. 4). [Jasmin Kemper, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - ES messages have been based on the most robust insights from the chapter's assessment

Comment No	From Page	From Line	To Page	To Line	Comment	Response
39400	61	15	61	15	In the table 2.9, box: Considerable shifts in investment patterns, in the supporting information. Between 2010USD yr–1globally there must be a free space: 2010USD yr–1 globally [Olga Alcaraz, Spain]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51772	61	16	61	16	Label for table goes at the top. [Jason Donev, Canada]	Accepted.
3344	61	40	61	40	on Investment patterns, add Public transport and urban design [Kamel Bennaceur, United Arab Emirates]	Noted. However, key insights can only be added based on available evidence. The reviewer does not provide such evidence.
37858	62		63		An overriding question in discussing the IAM scenario results is to know if these use updated cost data and trends (learning curves or similar, for example), especially for renewables and storage technology options. If some scenarios or results do not use the most recent and relevant input information, they should be labeled as such. [Michiel Schaeffer, Netherlands]	noted: discussion of IAMs is elsewhere in the chapter
18124	62	1			2.4.2 Why do we again have a discussion of energy supply which was done is section 2.3.3.2. ? Plus the scenarios are different than those defined in Table 2.1. Therefore we suggest combining insights from these sections. [Andrea TILCHE, Belgium]	accepted: sections have been merged
40038	62	1	66	10	I think it would be useful to pay separate attention to the power sector, as the transition pathways may be different than for the rest of the energy sector. [Kornelis Blok, Netherlands]	accepted: a section is added on electricity
56464	62	1		36	All pathways to look into the future seem to be based om models, Models may be the best we have, but they are not reality. I miss a consumer market approach. Mass consumer products that allow power consumers, and SME too, to generate their own power, and have it at cost price, being lower than commercial fossil power market price, even without CCS and CCS2 or CCU. Renewable power generation, with wind turbines and solar panels work automatically, so power consumers can just buy their own power generation. This requires the government regulation that the public grid really is a public road for power, so net-metering is allowed and possible. The Netherlands has this condition, but the ministry of economics, blocks this cheap transition pathway, because of business lobby, that want consumers to pay for their renewable subsidies. A german auction of 1 GW of wind power, for consumers, resulted in a power price of 4,2 cents per kWh, 2017. Dutch reneweable subsidy policy papers, show a self generated power price for on land wind farms, of 3,6 cents is a realistic estimate, so well below Dutch commercial power price. All this means that there is a path way for many parts of the world, where power consumers can generate their own power, and push most fossil generation off the market. Converting power plants more and more to backup ans storage facilities. Because European grid regulations give renewable power preference on the grid, forcing fossil power plants to give way to power from self generating consumers. When fossil power has to give way to renewable power, they save on fuel, so storage, This is used when wind output reduces and the power users need fossil power. Because power plants will be necessary, for decades, they have to be made climate neutral, mandatory. [Henk Daalder, Netherlands]	noted: policy to reduce emissions is covered in chapter 4
3346	62	3	62	4	2050 shares Fossil should have a range [Kamel Bennaceur, United Arab Emirates]	Accepted - Ranges are now provided.
55540	62	3	62	10	Thw following reference supports the ideas of all this paragraph. Giannakidis G., K. Karlsson, M. Labriet, B. Ó Gallachóir (eds.), 2018. Limiting Global Warming to Well Below 2°C: Energy System Modelling and Policy Development. Springer, Lecture Notes in Energy, in press. [Maryse Labriet, Spain]	not applicable: text removed
92	62	5	62	5	“Compared with to limiting warming to 2°C” Remove first “to”. [Levihn Fabian, Sweden]	Accepted.
808	62	5	62	5	Compared with to limiting' either 'with' or 'to', not both!! [Robert Shapiro, United States of America]	Accepted.
4894	62	5	62	5	Delete the "to" as extraneous [Michael MacCracken, United States of America]	Accepted.
51028	62	7	62	9	Two caracteristics are typical in SOME 1.5C pathways. Be explicit. BECCS is common in pathways because it is one of only two CDR options that you put into the IAMs.This is a massively misleading sentence. [Doreen Stabinsky, United States of America]	taken into account: text revised to indicate robust findings in existing pathways
54630	62	9	62	9	carbon dioxide removal' should be removed as it has been defined previously in the text [Qudsia Zafar, Pakistan]	accepted
1620	62	12	66	5	I could not understand why only the reuslts of end-use sectors from IEA ETP-B2DS are presented and compared with IAMs. It would be better to also compare the differences of energy supply between IEA ETP-B2DS and IAMs to let readers to better understand the results/implications. [Wenying Chen, China]	noted: figure including this comparison has been moved from 2.3.3
1750	62	12	65	11	In these sections analysis is devoted to coal, natural gas, nuclear and CCS, while not equal attention is paid on renewables in energy supply. This imbalance should be corrected, given the importance of the contribution of renewables to all mitigation scenarios and the challenges faced for an acceleration of their deployment. [Greece]	noted: both fossil and non-fossil are included
45410	62	12	66		In discussing Primary Energy, it is of utmost importance to clarify the PE accounting system. To my knowledge, the IPCC uses "direct equivalent accounting". This approach tends to understate the contribution of non-combustible renewables and nuclear. If the "substitution method" was applied, the results would look much different. Annex A.II.4 to the IPCC SRREN does a good job of conveying this issue - it would be useful to do something similar for SR1.5 [Gunnar Luderer, Germany]	Taken into account - We now clarify that "Note that this section reports primary energy using the direct equivalent method on a lower heating values basis (Bruckner et al., 2014)."
58450	62	12	63	15	this section (2.4.2.1) could benefit from a comparison of IAMs to IEA's supply-side projections in the World Energy Outlook 2017 (Sustainable Development Scenario and Faster Transition Scenario) [Andrew Prag, France]	not applicable: text removed
42468	62	13			for large potential ===> for the large potential [Egypt]	Accepted.
11858	62	14	62	15	Continued decreases from zero? Do you mean the energy supply sector is a source of negative emissions? [United Kingdom (of Great Britain and Northern Ireland)]	not applicable: text removed
18126	62	14	62	15	The sentence "CO2 emissions from energy supply would need to decline to zero sometime between 2030 and 2060, with continued large decreases thereafter" is difficult to understand. How can it decline if it is already zero. Do you mean that after 2030-2060 there should be negative emissions? Please clarify. [Andrea TILCHE, Belgium]	Accepted. This sentence repeated insights from earlier in the chapter an has been removed.
45366	62	15	62	16	I don't like this wording. How model performs something depends on assumptions, paramterization and so on. Model does not reach anything but just gives a estimate on basis of your system description and assumptions. [Tuomo Kalliokoski, Finland]	not applicable: text removed

Comment No	From Page	From Line	To Page	To Line	Comment	Response
4896	62	18	62	24	The point needs to be made early on that the analyses done here are for gross production of energy and do not include consideration of issues such as ensuring adequate energy at all times of day through all weather situations, dealing with water shortages for cooling, etc. Basically all the IAMs consider rather large regions and time steps that do not allow consideration of climate extremes like drought, etc. So, as a result, the insights provided are necessarily quite general and the actual optimal and most cost-efficient strategy is likely to be somewhat different. [Michael MacCracken, United States of America]	noted: descriptions given here do not go into all of the detail in modeling renewables
35496	62	18	62	22	The role / rate of growth of bioenergy is a bit confusing. If wind-solar grow fastest in 2020-2050 and bioenergy provides as much energy as wind+solar in 2050, then bioenergy must outstrip wind+solar significantly by 2020. Considering that today, wind+solar has much greater contribution than bioenergy, it seems highly unlikely that this will happen by 2020. Am I missing something or is something inconsistent here? [Ashok Sreenivas, India]	not applicable: text removed
36704	62	18	62	24	It should be acknowledged somewhere in this section that the contribution of different energy sources from the different models will vary based on future cost and performance assumptions, which are highly uncertain, especially for technologies like nuclear and CCS that have had limited deployment in recent years. [Steve Clemmer, United States of America]	noted: this is noted in other sections where pathways are introduced, and later where CCS is discussed and in chapter 4
62106	62	18	62	20	Several leading scenarios including the ETP series, as early as 2014, have mentioned solar as "dominant" or "first" at this horizon, this makes biomass as one among other Res, not "the largest portion". [Antoine Bonduelle, France]	not applicable: text removed
810	62	19	62	19	Table 2.10' should be 'Figure 2.10' [Robert Shapiro, United States of America]	noted: this is referring to a table
11864	62	19	62	20	That bioenergy is the largest form of renewables (in 2050) is a pretty significant point and should be articulated and presented much more clearly. It's buried in the text here but needs to be made much more prominent. Major policy relevance. [United Kingdom (of Great Britain and Northern Ireland)]	not applicable: text removed
37854	62	20			Statement "largest portion from bioenergy" not backed up by the plots in Fig. 2.19, p. 63 (or with most scenarios in Fig. 2.13) in which Non-biomass renewables have, on average and in the maximum of the range, higher contributions than biomass [Michiel Schaeffer, Netherlands]	not applicable: text removed
60136	62	20	62	22	Add that recent studies show integrating these high share of variable renewables as technically feasbile. References include NREL ERGIS, WWSIS, Integrating Renewables Best Practice (21st century power partnership), Hirsh et al, ADVANCE program papers (Energy economics special issue), Clack et al, O'malley et al, Bloom et al. [United States of America]	noted: these references would be out of place here
51774	62	22	62	24	There is a consistency problem here. On page 49 the document talks about the reduction of nuclear power, this sentence talks about the need to increase nuclear power. I for one believe that nuclear power must be increased, but this inconsistency is troubling. [Jason Donev, Canada]	taken into account: these sections are now merged and consistent
62108	62	22	62	24	These sentences give not much information. "Average of these scenarios" is an odd metrics. Maybe mention that no scenario envisions a large scale growht of the nuclear share. [Antoine Bonduelle, France]	taken into account: the table now gives median and range and not average
11860	62	26	62	35	I'm unsure what the point of this paragraph is. The purpose of the report isn't to say that other stuff exists and you can go and check them out, here is the reference. If these alternate analyses exist you need to describe them, discuss their implications, contrast against IAMs etc etc. [United Kingdom (of Great Britain and Northern Ireland)]	taken into account: : literature now put in the context of the range of the database.
36702	62	26	62	30	Other studies evaluating deep decarbonization scenarios in the United States that could be added to this section that show a large contribution from wind and solar. These include: 1) Steinberg, D., et. al. 2017. Electrification and Decarbonization: Exploring U.S. Energy and Greenhouse Gas Emissions in Scenarios with Widespread Electrification and Power Sector Decarbonization. National Renewable Energy Laboratory. NREL/TP-6A20-68214. 2) Cleetus, R., A. Bailie, and S. Clemmer. 2016. The U.S. Power Sector in a Net Zero World: Analyzing Pathways for Deep Carbon Reductions. Union of Concerned Scientists. 3) United States Mid-Century Strategy for Deep Decarbonization. 2016. [Steve Clemmer, United States of America]	note: literature referenced in report tend to not be specific to one country
1582	62	28	62	29	For example, there are analyses of transition to 100% renewable energy… Please cite the following additional global studies: (1) Jacobson, M.Z., and M.A. Delucchi, A path to sustainable energy by 2030, Scientific American, November 2009; (2) Jacobson, M.Z., and M.A. Delucchi, Providing all Global Energy with Wind, Water, and Solar Power, Part I: Technologies, Energy Resources, Quantities and Areas of Infrastructure, and Materials, Energy Policy, 39, 1154-1169, doi:10.1016/j.enpol.2010.11.040, 2011; (3) Delucchi, M.Z., and M.Z. Jacobson, Providing all global energy with wind, water, and solar power, Part II: Reliability, System and Transmission Costs, and Policies, Energy Policy, 39, 1170-1190, doi:10.1016/j.enpol.2010.11.045, 2011; (4) Jacobson, M.Z., M.A. Delucchi, M.A. Cameron, and B.V, Mathiesen, Matching demand with supply at low cost among 139 countries within 20 world regions with 100% intermittent wind, water, and sunlight (WWS) for all purposes, Renewable Energy, https://doi.org/10.1016/j.renene.2018.02.009, 2018 [Mark Jacobson, United States of America]	taken into account: references focus on recent literature
57204	62	28	62	30	sector scenarios: the two following literature pieces should be added documenting a full decarbonisation of electricity supply, mainly based on solar energy: DOI: 10.1002/pip.2950 and Ram et al. (2017) (ISBN: 978-952-335-171-4) link: https://www.researchgate.net/publication/320934766_Global_Energy_System_based_on_100_Renewable_Energy_-_Power_Sector - in Ram et al., a detailed GHG emission decline to zero in the global power sector till 2050 is shown with already very low values for 2040 - all as part of a least cost pathway [Christian Breyer, Finland]	noted: using only peer-reviewed literature since it is available
60138	62	28	62	30	The references cited here (Clack et. al. 2017 and Jacobson 2017) are not in agreement about whether reaching 100% renewable power is feasible. The text should more accurately reflect that the literature cited is divided on this point. In particular, Clack et al. (2017) dispute the Jacobson paper and say that nuclear/CCS/BECCS is necessary to remove carbon emissions in the energy sector, and that getting to 100% with solar/wind/hydro is not feasible. [United States of America]	taken into account: text revised to note difference
1584	62	29	62	30	Jacobson (2017) should be Jacobson et al. (2017) [Mark Jacobson, United States of America]	accepted
1742	62	30	62	35	The results of sectoral studies mentioned here on nuclear energy are not consistent with the findings of all IAMs - see what is written in page 49, lines 17-20. [Greece]	taken into account: now mentioned that these cases could expand the range of pathways
51256	62	30	62	32	The statement "There are also studies show the role of nuclear energy in mitigation of GHGs in the whole energy system could be large.." may be modified with "There are also studies that show large role of nuclear energy in mitigation of GHGs in the whole energy system." [Muhammad Latif, Pakistan]	taken into account: text modified

Comment No	From Page	From Line	To Page	To Line	Comment	Response
57206	62	30	62	33	role of nuclear energy: the two following literature pieces should be added documenting that a full decarbonisation of electricity supply, mainly based on solar energy is doable - WITHOUT any need of new nuclear as part of a least cost scenario: DOI: 10.1002/pip.2950 and Ram et al. (2017) (ISBN: 978-952-335-171-4) link: https://www.researchgate.net/publication/320934766_Global_Energy_System_based_on_100_Renewable_Energy_-_Power_Sector - in Ram et al. [Christian Breyer, Finland]	noted: using only peer-reviewed literature since it is available
22600	62	31			Replace "show" by "showing" [LUIS VALDES, Spain]	Taken into account - sentence has been edited.
58448	62	31	62	32	we find that the IEA reference here is not very appropriate; please remove or change the word "large" [Andrew Prag, France]	accepted
242	62	32	62	33	Add a reference to 10.1504/IJGEI.2017.10007761 [Herve Nifenecker, France]	accepted
42774	62	33	62	34	Also challenged by the ability to guarantee that it is actually carbon neutral. See, e.g., the problems with using wood for biomass in Duncan Brack, Wood Is Not a Carbon-Neutral Energy Source (1 March 2017). See Sterman et al. Additional barriers to BECCS implementation include a need for internationally agreed upon carbon accounting for instances where the bioenergy is harvested in one country, used in another, and then stored in a third (Peters and Geden 2017, Catalysing a political shift from low to negative carbon). [Kristin Campbell, United States of America]	taken into account: text now refers to section 2.3.4.2 which has a fuller discussion
43002	62	33	62	34	Bioenergy is not carbon neutral, especially in the 10–15 year window before positive feedbacks risk locking in dangerous warming, and CCS is not yet technologically mature, nor socially acceptable. Additional barriers to BECCS implementation include a need for internationally agreed upon carbon accounting for instances where the bioenergy is harvested in one country, used in another, and then stored in a third (Peters and Geden 2017, Catalysing a political shift from low to negative carbon). See Booth M. S. (2018) “Not carbon neutral: Assessing the net emissions impact of residues burned for bioenergy”, Envtl. Research Letters; and Sterman et al (2018) “Does replacing coal with wood lower CO2 emissions? Dynamic lifecycle analysis of wood bioenergy”, Envtl. Research Letters. [Durwood Zaelke, United States of America]	taken into account: text now refers to section 2.3.4.2 which has a fuller discussion
11862	62	34	62	35	What does it mean that they are consistent? They have the same decarbonisation rates? That the IAMs think that they are possible (e.g. do any IAMs produce a 100% renewable future?)? [United Kingdom (of Great Britain and Northern Ireland)]	taken into account: text now mentions that these could expand the range of pathways if assumptions are plausible
37856	62	34	62	35	Last sentence is not clear - what does it mean, "results of IAMs were consistent with sectoral analyses"? Prior to this sentence scenarios with 100% renewable energy are mentioned. No IAM shows that result, and therefore there is certainly not a blanket statement of consistency. [Michiel Schaeffer, Netherlands]	taken into account: text now mentions that these could expand the range of pathways if assumptions are plausible
40040	62	34	62	35	I am not certain whether this is true. At least the simple reference to AR5 is not convincing enough! There are, for example, scenarios that describe a much more rapid decarbonization of the power sector, see e.g. the report Global Energy System Based on 100% Renewable Enregy - Power Sector, Lappanreenta University of Technology and EnergyWatchGroup, 2017 (not peer reviewed, but Appendix of report contains long list of underlying peer-reviewed articles). [Kornelis Blok, Netherlands]	taken into account: text now mentions that these could expand the range of pathways if assumptions are plausible
35820	63				Text inside the Figure 2.19 is not visible clearly. Enlargement of font size of text would be useful [India]	not applicable: text has been removed
54634	63		66		Figure 2.19-2.22. Legends and axis labels are not readable [Qudsia Zafar, Pakistan]	not applicable: figure has been removed
65	63	1	63	1	Figure 2.19 needs a notable amount of improvement, as it is very difficult to read. Put one legend for the whole figure. Remove the boxes. Consider using shading instead of dashes for the range in each figure. [Tommi Ekholm, Finland]	Accepted. Figures and figure captions have been revised for clarity and completeness.
1610	63	1	65	1	The data shown in Figure 2.21 for BECCS should be smaller than the total biomass consumption shown in Figure 2.19. [Wenying Chen, China]	not applicable: figure has been removed
3226	63	1	63	1	These graphs are very difficult to read and the show some strange behaviour (particularily the red dashed line in panel "e" [Vassilis Daioglou, Netherlands]	Accepted. Figures and figure captions have been revised for clarity and completeness.
21466	63	1	63	2	Figure 2.19: Consider using example scenarios of Section 2.3. [Volker Krey, Austria]	accepted
37386	63	1	63	3	Figure: Raising biomass supply to 300 EJ/y in 2050 and over 500 EJ/y in 2100 is considered by many analysts as being completely unfeasible. See e.g. IPCC AR5, WGIII, ch11, Creutzig et al., 2016, GCB Bioenergy, Running, 2012. Science 337, 1458–1459; Haberl et al. 2013. Environ. Res. Lett. 8, 031004; Smith et al. 2012. BioScience 62, 911–922; Searle, Malins, 2015. GCB Bioenergy 7, 328–336. Searle, Malins, 2014. Biomass and Bioenergy doi: 10.1016/j.biombioe.2014.01.001. Please consider the following three options toward a more balanced report: (1) introduce stronger caveats in the text related to the fact that these high values are controversial and cite some of the authors who are skeptical that achieving such high potentials were feasible, (2) give detail on how much of that biomass is expected from main sources, e.g. dedicated energy crops, residues/byproducts/wastes, forest biomass, etc. and (2) be explicit about the land area required and at least the globally average yearly energy crop yield assumed behind such high numbers. This would facilitate cross-checking these numbers with other studies which are perhaps less optimistic about the possibility of reaching very high energy crop yields (that are probably required to achieve such high values), and checking the feasibility as well as the full C cycle effects of sourcing so much biomass through independent databases and models. [Helmut Haberl, Austria]	not applicable: figure has been removed
44864	63	1	63	1	It seems that Figure 2.19 is not referred in the text. [Hiroaki Kondo, Japan]	not applicable: figure has been removed
46628	63	1	63	2	Colourblind check for this figure. Please avoid using greens and reds together in figures as they are hard to distinguish between. [Sarah Connors, France]	Editorial
49350	63	1	63	1	the Figures are too small [Spyros Schismenos, China]	Accepted. Figures and figure captions have been revised for clarity and completeness.
51776	63	1	63	1	Text in picture is impossible to read, please resize. [Jason Donev, Canada]	Accepted. Figures and figure captions have been revised for clarity and completeness.
61770	63	1	63	2	This set of figures does not have the quality standards for an IPCC report. Captions cannot be read. [Valérie Masson-Delmotte, France]	Accepted. Figures and figure captions have been revised for clarity and completeness.
243	63	2	63	2	Add data from DOI: 10.1504/IJGEI.2017.10007761 Table 1 Nuclear 605 EJ or doi: 10.150/IJGEI.2017.080766 Fig.5 to Fig 2.19 (f) [Herve Nifenecker, France]	not applicable: figure has been removed
11866	63	2	63	2	Figure too small, hard to read. Same comment applies to all similar figures. [United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Figures and figure captions have been revised for clarity and completeness.
11868	63	2	63	2	What is the hydro spike in max2? [United Kingdom (of Great Britain and Northern Ireland)]	not applicable: figure has been removed
13912	63	2	63	2	Figure 2.19. Please expand the figure caption so that this figure is stand alone. Are these means or representative? What the ae the citations for these? How did you chose them? They are likely 50% <1.5 degree, right? Please specify all these details as this figure will be important and widely shown. [Natalie MAHOWALD, United States of America]	not applicable: figure has been removed

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51778	63	2	63	2	We need more of an explanation in this figure caption about this figure. Figure captions are important from the standpoint of explaining the overarching story. Even if people are reading this whole document (and many won't, they'll look at pictures), the figure caption provides a centring refresh to re-engage the reader. [Jason Donev, Canada]	Accepted. Figures and figure captions have been revised for clarity and completeness.
53286	63	2	62	2	This figure caption – and many others – needs more detail. Eg this particular caption should explain what the lines are – are they averages of modeling scenarios? [Mary Booth, United States of America]	Accepted. Figures and figure captions have been revised for clarity and completeness.
60140	63	2	63	2	Figure legends are not readable. [United States of America]	Accepted. Figures and figure captions have been revised for clarity and completeness.
37860	63	4			strike "to provide energy" [Michiel Schaeffer, Netherlands]	Accepted. The sentence has been edited for clarity.
11870	63	6	63	8	Coal with ccs or unabated? [United Kingdom (of Great Britain and Northern Ireland)]	not applicable: text removed
35818	63	6	63	8	It is mentioned that Coal's share of energy decreases from slightly more than one quarter of global supply in 2020 to just under 7% in 2050. Various pathways need to quote the limits/ figures on a more realistic and pragmatic basis keeping in view the projection of coal demand made by developing countries. [India]	not applicable: text removed
42470	63	6			as whole ===> as a whole [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
1744	63	9	63	9	Some PATHWAYS/SCENARIOS show rapid decreases..' [Greece]	Noted. The chapter now consistently uses the terms pathways in line with their introduction in Chapter 1.
44866	63	10	63	10	Figure 2.14 should be Figure 2.20. [Hiroaki Kondo, Japan]	Accepted. Figures and figure captions have been revised for clarity and completeness.
39150	63	11	63	11	CCS may never be developed to a place of a viable and sufficient technology. The IPCC wording here appears to promise what is not yet delivered and this is misleading to policy makers. We are already seeing reduced mitigation efforts in the name of deploying an as yet undeveloped technology (UK Clean Growth Strategy). This is dangerous - as policy makers are taking on unsubstantiated assumptions. Nor do I yet see in the SR, research on environmental damage of CCS when pumped into the earth. Further information -- http://science.sciencemag.org/content/354/6309/182 [Lindsey Cook, Germany]	Noted.
11872	63	12	63	15	This is true, but why mention it here? It should be covered in the relevant chapter, not lenghtening the text here [United Kingdom (of Great Britain and Northern Ireland)]	accepted: text removed
37862	63	15			cited reference missing [Michiel Schaeffer, Netherlands]	Accepted. References have been updated.
47894	63	15	63	15	Please check the citation: Shi, 2017……not available in reference section [Sarah Connors, France]	Accepted. References have been updated.
18130	64				Table 2.10: the extent of abatement (i.e. CCS use accompanying the biomass and fossil fuels) should be stated. The title needs to state clearly that the table refers to 1.5°C scenarios. Also, p65: BECCS accounting for 59% of biomass demand by 2050. Definition of "biomass" here needs to be clarified. [Andrea TILCHE, Belgium]	noted: CCS applied to biomass covered in section on 2.3
19560	64		64		Table 2.20 Overview of energy supply system transformation characteristic. In this table and in other parts of the draft significant annual growth is assumed in nuclear energy (3.9% hardly lower than for renewables 4.7%) while much less countries have nuclear power today and only a few mentions nuclear at all in their INDCs. As this has been analysed in Schneider et all (2017) - source already refered to in the SOD Chapter 4. Quote: "Within the actual INDCs only eleven countries mentioned that they were operating or considering to operate nuclear power as part of their mitigation strategy and even fewer (five) actually state that they were proposing to expand its use (Belarus, India, Japan, Turkey, and UAE). This compares with 144 that mention the use of renewable energy and 111 that explicitly mention targets or plans for expanding its use." https://www.worldnuclearreport.org/IMG/pdf/20170912wnisr2017-en-lr.pdf [Jennifer Morgan, Netherlands]	taken into account: a table has been added to focus on the changes in power generation across pathways and shows nuclear with slower growth than renewables.
35822	64				Text inside the Figure 2.20 is not visible clearly. Enlargement of font size of text would be useful. [India]	not applicable: figure has been removed
66	64	1	64	1	Figure 2.20 needs a notable amount of improvement, as it is very difficult to read. Put one legend for the whole figure. Remove the boxes. Consider using shading instead of dashes for the range in each figure. [Tommi Ekholm, Finland]	not applicable: figure has been removed
21468	64	1	64	2	Figure 2.20: Consider using example scenarios of Section 2.3 [Volker Krey, Austria]	accepted: archetypical pathways shown as well as distribution of all pathways
46630	64	1	64	2	Colourblind check for this figure. Please avoid using greens and reds together in figures as they are hard to distinguish between. [Sarah Connors, France]	Editorial
51780	64	1	64	1	Text in picture is impossible to read, please resize. [Jason Donev, Canada]	not applicable: figure has been removed
1746	64	2	64	8	What is the consistency/relationship between Table 2.10 and Figure 2.13 in page 50? [Greece]	taken into account: these are both from the same scenarios database as is made clear in the new figures and tables
51782	64	2	64	2	Could the colours be explained in the figure caption to give us more room to see the details in the figures? [Jason Donev, Canada]	not applicable: figure has been removed
51784	64	2	64	2	Explain the graphs in the figure captions, it will help. [Jason Donev, Canada]	not applicable: figure has been removed
60142	64	2	64	2	Figure legends are not readable. [United States of America]	not applicable: figure has been removed
34202	64	3	64	8	It is not currently clear if this Table includes all scenario classes or if it is for only one class. Please consider making two or more similar tables to better show differences between these scenario classes. This could also help to narrow the ranges within each energy supply system. Also consider including numbers for 2030 to better illustrate issues relevant for current policy. [Norway]	taken into account: data in the table is limited to 1.5 pathways. Additional information is available in the figures in this section
35500	64	3	64	7	The table is confusing. Does "Renewables" include the two rows afterwards or three? The numbers suggest that it is the next three rows - in which case it should not be called "Renewables" but only "Non-fossil" since nuclear cannot be classified as a renewable source. [Ashok Sreenivas, India]	accepted: the renewable contributors are now indented in the table under renewables, nuclear is not
35502	64	3	64	7	The biomass energy / share numbers seem rather high. Wouldn't 55 EJ of biomass be equivalent to about 3.7 billion tons of biomass? That appears excessively high for use as an (commercial) energy source, since even the non-commercial biomass use in India - presumably one of the highest biomass using countries albeit non-commercially - is only about 370-380 million tons. [Ashok Sreenivas, India]	noted: there is a wide range of change in biomass in 1.5 pathways
45408	64	3		7	The caption says "supply", wheras the column head is "demand". This might confuse many readers. [Gunnar Luderer, Germany]	not applicable: figure has been removed
49628	64	3	64	4	Nuclear is not renewable [Karlheinz ERB, Austria]	accepted: the renewable contributors are now indented in the table under renewables, nuclear is not
51258	64	3	64	8	The "%" may be removed in last row of columns 3 and 6. [Muhammad Latif, Pakistan]	Accepted

Comment No	From Page	From Line	To Page	To Line	Comment	Response
51786	64	3	64	3	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	not applicable: figure has been removed
51788	64	3	64	3	Listing 'renewables' and then 'wind and solar' is confusing. What are meant by these? Adding wind, solar and biomass doesn't sum to renewables. Also renewables + nuclear + fossil fuels doesn't add to 100? [Jason Donev, Canada]	noted: summing medians or extreme values of each category should not necessarily add to the total. Wind, solar, and biomass are each important contributors to renewables are not the only contributors
51790	64	3	64	3	Why is 'gas' the only one with a percentage? [Jason Donev, Canada]	Accepted
57208	64	3	64	5	share of renewables in the power sector: the two following literature pieces should be added documenting that a 100% renewables scenario till 2050 is possible as part of a least cost scenario: DOI: 10.1002/pip.2950 and Ram et al. (2017) (ISBN: 978-952-335-171-4) link: https://www.researchgate.net/publication/320934766_Global_Energy_System_based_on_100_Renewable_Energy_-_Power_Sector [Christian Breyer, Finland]	noted: not peer reviewed
19564	64	4	64	15	And Figure 2.20, this assumes only 1.1% annual decrease for natural gas and 2.8% for oil. See comments concerning Chapter 2, page 7 lines 33-35 above [Jennifer Morgan, Netherlands]	taken into account: table and figure have been revised and summarize 1.5 pathways in the database; archetypical pathway LED illustrated a no-fossil case
3228	64	5	64	7	Caption hsould make clear what class of scenarios these values are for (1.5 or 2 degree targets? With or without overshoot?) [Vassilis Daioglou, Netherlands]	accepted: caption strengthened
14078	64	5	64	7	It should be clearly stated that the data is the global energy supply. The word global is missing. It should also be stated if the data is according to the 1.5C or 2C scenario, or if it is a business as usual scenario. [Aage Stangeland, Norway]	Accepted: global added; this is for 1.5
28084	64	5	64	7	Table 2.10 Caption: Please clarify what is shown in the table: Shares of Primary Energy or Final Energy, and which conversion method is used for Renewable Energy Sources? It seems kind of surprising to see a 40% fossil share in the energy system in 2050 - given that the energy system is supposed to be carbon-neutral by 2050 (cf. table 2.9), a large part of this would be fossil with CCS. Can this be made explicit? [Germany]	taken into account: table indicates it is for primary energy; this subsection section's first paragraph includes the statement that energy is given using the direct equivalent method
58206	64	5	64	5	Biomass energy potential by 2050 in Table 2.10 is also consistent with the model proposed by Strapasson et al. (2017), DOI: 10.1111/gcbb.12456. This paper may be useful to complement some discussion on land use in other parts of Chapter 2 as well. [Alexandre Strapasson, Brazil]	noted: the table is an exposition of the pathway database and not a broader literature.
51792	64	6	64	6	Label for table goes at the top. [Jason Donev, Canada]	accepted
1586	64	9	64	20	Please clarify that, although CCS is assumed in those scenarios, it is NOT necessary for achieving 1.5 C, as found in Jacobson (2017), who state in Section S10.2 that a 80% emission reduction by 2030 and 100% by 2050 result in "an additional cumulative 419 Gt-C emitted to the atmosphere, in the range of the maximum allowable to keep warming under 1.5oC." [Mark Jacobson, United States of America]	taken into account: this section includes an archetypical 1.5 pathway that does not include CCS
18128	64	9			2.4.2.2 The discussion on CCS has already been done under 2.3.4. Insights from these sections should be merged. [Andrea TILCHE, Belgium]	taken into account: some of 2.3.4 has been moved to 2.4.2.3
11874	64	10	64	20	On page 48 (line 41) to page 49 (line 1-2), it is stated that CCS remains limited in many pathways as <99% efficiency is penalised by carbon price. Yet this section seems to suggest that it's fairly widespread. Could this be clarified and more detail on the scale/role of CCS provided if necessary for clarification. [United Kingdom (of Great Britain and Northern Ireland)]	noted: the greater discussion of the range of CCS across pathways is given
45412	64	10	65	11	New work on intergrating IAM and LCA shows that fossil CCS comes with substantial upstream and indirect GHG emissions, making it much less effective as a low-carbon electricity supply option than wind, solar or nuclear. This should be mentioned here. Reference: Pehl, Michaja, Anders Arvesen et al.. “Embodied Energy Use and Lifecycle Greenhouse Gas Emissions of Future Electricity Supply Systems.” Nature Energy 2, no. 11 (December 8, 2017). https://doi.org/10.1038/s41560-017-0032-9. [Gunnar Luderer, Germany]	taken into account: reference given and lifecycle emissions discussed
5976	64	11			CCS should have a large role starting from 2020. However 2020 is now in 2 years time, and few large scale plants are currently operating. This should be reflected in the outcomes of the models [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	not applicable: text removed
42472	64	14			pathways ===> pathways, [Egypt]	not applicable: text has been removed
42474	64	18			higher ===> a higher [Egypt]	not applicable: text has been removed
42476	64	19			more ===> a more [Egypt]	not applicable: text has been removed
44868	64	31	64	31	I don't think the suitable figure here is Figure 2.14. [Hiroaki Kondo, Japan]	not applicable: text removed
15756	65				Figure 2.21 and similar: please use a different line style that shows more detail. [Australia]	not applicable: figure has been removed
35824	65				Text inside the Figure 2.21 is not visible clearly. Enlargement of font size of text would be useful. [India]	not applicable: figure replaced
67	65	1	65	1	Figure 2.21 needs a notable amount of improvement, as it is very difficult to read. Put one legend for the whole figure. Remove the boxes. Consider using shading instead of dashes for the range in each figure. [Tommi Ekholm, Finland]	not applicable: figure has been removed
21470	65	1	65	2	Figure 2.21: Consider using example scenarios of Section 2.3 [Volker Krey, Austria]	accepted: archetypical pathways shown as well as distribution of all pathways
24118	65	1	65	2	Showing CCS penetration for these three fuels only and showing it in energy terms is risky in terms of miscommunication of where CCS is needed. CCS is important in industrial applications, such as steel, chemicals and cement, where the CO2 originates from oil and liestone, as well as coal, gas and biomass. I think it would be good to cross-reference the CCS section in the end-use discussion and explain that CCS deployment for energy supply and end-use (including limestone use) are closely intertwined in terms of infrastructure and costs. It is unclear whether the EJ in these charts refer to the total fuel input to CCS-equipped plants (and the auxiliary fuel needs of the CCS value chain) or an amount that is adjusted to account for capture rate. I would think that a more useful graphic would show the CO2 permanently stored and its % of total CO2 produced in the sector. [Simon Bennett, France]	noted: this section focuses on the range of CCS across the 1.5 pathway database. The attribution of CCS to different end use sectors across pathways is currently too limited to assess.
46632	65	1	65	2	Colourblind check for this figure. Please avoid using greens and reds together in figures as they are hard to distinguish between. [Sarah Connors, France]	Editorial
51794	65	1	65	1	Text in picture is impossible to read, please resize. [Jason Donev, Canada]	not applicable: figure has been removed
51796	65	2	65	2	Is this CCS or fuels? The labels on the graphs are unclear. [Jason Donev, Canada]	not applicable: figure has been removed
58126	65	2			Figure 2.21(a): I do no tknow of any scenarios that deployed 800EJ/yr biomass with CCS. There must be something wrong. [Nico Bauer, Germany]	not applicable: figure replaced
60144	65	2	65	2	Figure legends are not readable. [United States of America]	not applicable: figure has been removed

Comment No	From Page	From Line	To Page	To Line	Comment	Response
2466	65	4	65	11	This section would be improved by discussing what the models reported on assume about the adoption of CCS in terms of its timeline for commercial viability, its cost relative to alternatives, and the degree of uncertainty around these assumptions. [Jared Woollacott, United States of America]	noted: there some limited discussion about model assumptions regarding CCS, but space limits assessment of this topic and the literature does not provide comprehensive comparisons of assumptions
19568	65	4	65	7	There is uncertainty in the future deployment of CCS given the limited pace of current deployment. The current lack of incentives for large-scale implementation of CCS is associated with the current slow pace of CCS deployment. In the pathways considered in this section, there is rapid deployment soon after 2020. There is no justification why a very rapid deployment for CCS is realistic after 2020. [Jennifer Morgan, Netherlands]	taken into account: as can be seen in the replaced figure, CCS ramps up in many scenarios in the decades following 2020; rapid soon after has been removed
24120	65	4	65	4	There is uncertainty in the future deployment of CCS given the limited pace of current deployment. This is a very partial statement. There is uncertainty in the future deployment of CCS because there is uncertainty in the speed and conviction with which society will tackle climate chance and there is uncertainty in the costs of competing technologies and the economic structures that would facilitate two massive new interdependent industries: one for CO2 storage and one for CO2 capture. This paragraph would benefit from some re-phrasing to get at the real issue: CCS has not received much investment or interest over the last decade because it has no economic basis in today's high-carbon marketplace and it has no effective political supporters that want to get a CCS industry operating efficiently at large scale. At the same time, its potential scale and date of market entry has been delayed by falling costs of alternatives. Because each CCS project has a high unit cost, there is a significant first-mover risk and difficiulty to capitalise on the knowledge gained from early investments. The challenge, therefore, is to create a policy bridge that encourages a committed CCS industry to develop in the near-term while a large-scale market remains underdeveloped and uncertain. This is non-trivial and a much bigger challenge than " a need to further develop the technology in short term". [Simon Bennett, France]	taken into account: the sentence is modified to raise some of the issues in the comment, but the focus on accelerating mitigation is in Chapter 4.
37864	65	4	65	11	Reword the paragraph (partially grammar, partially to avoid repetition, partially to not be prescriptive). First sentence okay, then "Currently there is a lack of incentive for large-scale implementation of CCS" Strike rest of (repetitive) sentence. Next sentence, "In the pathways ..." okay [Michiel Schaeffer, Netherlands]	noted: paragraph reworded
13368	65	6	65	9	CCS progress to date, and the lead time (10yr+) for geological investigation and testing and infrastructure establishment is such that it is extremely implausible that "rapid" and regionally widespread deployment could occur in the coming decade even with a reversal of present policy failure to very strong policy support. Only North America presently has an existing large-scale CO2 transport and storage network (for EOR) that might be quite rapidly expanded. [Scott Vivian, United Kingdom (of Great Britain and Northern Ireland)]	noted: the paragraph has been reworded and the term rapid removed
24122	65	6	65	11	In the pathways considered in this section, there is rapid deployment soon after 2020… Given the importance of CCS in mitigation pathways... there is a need... enable large scale deployment of CCS as an option. The first part of this paragraph gives the impression that current state-of-the-art knowledge thinks CCS is absolutely necessary, and soon! Therefore it seems very strange to conclude that is needs to be developed as an option, which gives the impression that it might just be a handy backup insurance. What are the other options for industrial emissions and CO2 removal technologies? [Simon Bennett, France]	noted: the term rapid…soon after 2020 is removed.
37866	65	7	65	8	Cont'd from previous - Sentence not clear: "It also is noted ... challenges and risks of CCS" Do citations refer only to this comment? Sentence is very vague. [Michiel Schaeffer, Netherlands]	noted: sentence has been reworded
1748	65	9	65	11	This sentence as it stands is policy-prescriptive. I suggest to rephrase it as follows: "Given the importance of CCS in mitigation pathways and its current slow pace of improvement, the large scale deployment of CCS as an option depends on the further development of the technology in short term". [Greece]	accepted: sentence replaced with suggestion
36706	65	9	65	11	This sentence should be reworded. The main reason CCS deployment has been slower than expected is because of costs have been much higher than expected and some technical challenges. For CCS to achieve large scale deployment, costs will need to come down significantly. It's a similar situation for nuclear. If this doesn't happen as assumed in many assessment models, wind, solar and other renewables could play an even large role than show in Figure 2.19. (The report does make this point on p. 92, lines 33-37, but it should also be included somewhere in this section of the report). [Steve Clemmer, United States of America]	noted: this section is not focused on past deployment of CCS or the attribution of why that deployment did or did not occur. The text referred to in section 2.5 focuses on limitations of analyses.
37868	65	9	65	11	Cont'd from previous "Given the current slow pace of deployment of CCS, if the technology is to play a large-scale role in mitigation there will have to be significant further development, which is discussed in Chapter 4" [Michiel Schaeffer, Netherlands]	noted: sentence has been reworded
42478	65	10			short term ===> short-term [Egypt]	taken into account: text has been reworded
42480	65	10	65	11	large scale ===> large-scale [Egypt]	accepted
58034	65	10	65	10	The word usage in the phrase "make enable large" has redundancy so that only "enable" may be used. [Siir KILKIS, Turkey]	taken into account: text has been reworded
1754	65	14	66	10	The scope of section 2.4.2.3 is not clear. As it stands, this text should be merged with previous sections. [Greece]	not applicable: text removed
3230	65	14	66	10	This entire section has very poor english, which makes the message very unclear. [Vassilis Daioglou, Netherlands]	not applicable: text has been removed
14038	65	14	64	25	This section needs heavy editing [Ralph Sims, New Zealand]	not applicable: text has been removed
18132	65	14			Again a description of BECCS and CCS which has already been done. Therefore either merge or delete [Andrea TILCHE, Belgium]	accepted: sections have been merged
58128	65	14			In Bauer et al (2017) the EMF33 scenarios included the senstivitiy of having BECCS available only by 2050. Such a delay showed a considerable increase in required CO2 prices for the 1.5°C target and it was much larger than the doubling of investment costs. [Nico Bauer, Germany]	not applicable: text removed
58460	65	14	66	9	Section 2.4.2.3 could also benefit from a comparison with IEA supply-side projections in World Energy Outlook 2017 [Andrew Prag, France]	not applicable: text removed
812	65	15	65	15	sector is most important' should be " 'sector is the most important' [Robert Shapiro, United States of America]	not applicable: text removed
814	65	15	65	16	need to make change in a rapid rate.' should be 'needs to change rapidly.' [Robert Shapiro, United States of America]	not applicable: text removed
1752	65	15	65	15	Power generation sector is THE most important sector in the transition, and needS to make…' [Greece]	not applicable: text has been removed
2468	65	15	65	20	This paragraph needs to be rewritten to improve the English grammar. [Jared Woollacott, United States of America]	not applicable: text has been removed
4898	65	15	65	20	There are quite a number of places in the chapter where the English needs to be smoothed--this paragraph is an example. [Michael MacCracken, United States of America]	not applicable: text has been removed
5872	65	15	65	20	Passage is very confusing and would benefit from a substantive redraft for readability. [Peter Thorne, Ireland]	not applicable: text has been removed
11876	65	15	65	16	Which sector is most important is an opinion not really science [United Kingdom (of Great Britain and Northern Ireland)]	not applicable: text removed

Comment No	From Page	From Line	To Page	To Line	Comment	Response
11878	65	15	65	20	Sorry, but wording needs to be improved. This is a general comment about all of it, but in particular it's not clear what you are trying to say about nuclear. [United Kingdom (of Great Britain and Northern Ireland)]	not applicable: text has been removed
37870	65	15	65	16	Rapid changes will be needed in the power sector to achieve 1.5°C targets [Michiel Schaeffer, Netherlands]	not applicable: text has been removed
42482	65	15			most ===> the most [Egypt]	not applicable: text has been removed
42484	65	15			change ===> the change [Egypt]	not applicable: text has been removed
47066	65	15	65	22	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	not applicable: text has been removed
53288	65	15	65	20	This whole paragraph really needs a good edit. [Mary Booth, United States of America]	not applicable: text has been removed
58036	65	15	65	16	The statement "Power generation sector is most important sector in the transition, and need to make change in a rapid rate... All low carbon power generation need" may read "The power generation sector is the most important sector in the transition, and needs to make change in a rapid rate... All low carbon power generation needs" with the plural use of "needs" and the article use "the" prior to certain words. [Siir KILKIS, Turkey]	not applicable: text has been removed
60146	65	15	65	16	Use of "need" is odd in IPCC. Language here needs improving. [United States of America]	not applicable: text removed
37872	65	16			Figure 2.22 ... - this only represents to possible scenarios. Here it is stated as if it were the only possible result [Michiel Schaeffer, Netherlands]	not applicable: text removed
37874	65	16	65	19	All low carbon power ... This sentence is too broadly stated, as is the following one. In spite of what is stated here, nuclear power plays only a minimal, and not strongly increasing role in either of the results presented in Fig. 2.22 [Michiel Schaeffer, Netherlands]	not applicable: text removed
816	65	17	65	17	much beyond than today's development' delete 'than' [Robert Shapiro, United States of America]	not applicable: text has been removed
818	65	17	65	17	From the figure, there is not big increase' 'not' should be 'no' [Robert Shapiro, United States of America]	not applicable: text has been removed
32774	65	17			From the figure, there is not big increase for ... "there is no big increase" is better? [Manfred Treber, Germany]	not applicable: text has been removed
37876	65	17	65	19	misleading statements, or at least ones that cannot be substantiated. Results for growth rates are not explicitly given here, so to say that they are not large is un-confirmed. Starting from a small base, the growth rate could be large and thus lead naturally to significantly larger shares later. More fundamentally, why these two scenarios, and what are the underlying assumptions about costs of technologies, etc. [Michiel Schaeffer, Netherlands]	not applicable: text removed
40042	65	17	65	18	Surprising that there is no big increase in wind and solar from 2020 to 2030. Is this just one example or representative for IAMs? If the latter is the case, the critical analysis by Creutzig et al. 2017 about the underestimation of solar PV in IAMs should be mentioned here. [Kornelis Blok, Netherlands]	not applicable: text removed
42486	65	17			not ===> no [Egypt]	not applicable: text has been removed
60148	65	17	65	19	Syntax "nuclear power need"? [United States of America]	not applicable: text removed
820	65	18	65	19	but nuclear power need to departure in near future' This must be rewritten. What was intended? For instance: 'but nuclear power needs to be eliminated' ?? Why? [Robert Shapiro, United States of America]	not applicable: text removed
15754	65	18	65	19	Change 'need to departure' to 'needs to be scaled down in the near future' [Australia]	not applicable: text has been removed
37122	65	18	65	19	... but nuclear power need to departure in near future. The word "departure" is ambiguous and mislleading because it could be understood as "phasing out". To be consistent with figure 2.22b and with the message that, unlike solar and wind, nuclear development should be anticipated well in advance because of it long decisional time scales, I am proposing to replace the sentence between brackets by: "... but the pace of development of nuclear power must be accelerated in near future" [Jean-Luc SALANAVE, France]	not applicable: text has been removed
40044	65	18	65	19	What does that mean: "nuclear energy need to departure"? [Kornelis Blok, Netherlands]	not applicable: text has been removed
42488	65	18			need ===> needs [Egypt]	not applicable: text has been removed
51798	65	18	65	20	There is a consistency problem here. On page 49 the document talks about the reduction of nuclear power, this sentence talks about the need to increase nuclear power. I for one believe that nuclear power must be increased, but this inconsistency is troubling. I agree, the pace must change, and it would be a very good idea to talk about the need to slow the decommissioning of nuclear power plants, but that isn't addressed here. [Jason Donev, Canada]	not applicable: text removed
62110	65	18	65	20	nuclear power need to departure in near future is policy prescriptive in this form. It is also not very realistic with the very long time lag of this industry (in decades) compared to other energy supply options such as solar or wind. [Antoine Bonduelle, France]	not applicable: text removed
822	65	19	65	20	power need to go much beyond than today's pace.' should be 'needs to proceed much faster than today's pace.' [Robert Shapiro, United States of America]	not applicable: text removed
42490	65	19			need ===> needs [Egypt]	not applicable: text has been removed
9700	65	22	65	32	text related to figure 2.22 seems inconsistent with the figure and its caption. [Mustafa BABIKER, Sudan]	not applicable: figure has been removed
11882	65	22	65	31	This is all very interesting but I don't think it's in the right section. It's not the place a reader would go to to find this level of helpful detail on BECCS. Surely it should be in the earlier CDR section [United Kingdom (of Great Britain and Northern Ireland)]	not applicable: text removed
13370	65	22	65	22	BECCS "is" needed [Scott Vivian, United Kingdom (of Great Britain and Northern Ireland)]	not applicable: text has been removed
28086	65	22	65	24	This seems to contradict 2.3.1 where it gives the impression that a few scenarios include CDR, but not BECCS (particularly Figure 2.7). Please give more clarity if here only a subset of the scenarios from 2.3.1 is being referred to or please ensure consistency between 2.4.2.3 and 2.3.1. [Germany]	not applicable: text removed
30952	65	22	65	24	“all” should be replaced by “both”. Is the high BECCS scenario one of the ones on page 57? It is not clear. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	not applicable: text has been removed
37878	65	22	65	25	Statements about BECCS do not seem to be substantiated by Fig. 2.22 (except that "some scenarios implement significantly more BECCS than others"), and certainly not in part c). [Michiel Schaeffer, Netherlands]	not applicable: text removed
824	65	23	65	23	budget, however' .should be budget. However,. [Robert Shapiro, United States of America]	not applicable: text removed
11880	65	24	65	25	Is this an average of BECCS as a proprtion of total biomass demand? The fact that the figure referred to is results from just one model implies not. And is 2.22c the right part of the figure to reference. [United Kingdom (of Great Britain and Northern Ireland)]	not applicable: text removed

Comment No	From Page	From Line	To Page	To Line	Comment	Response
24124	65	25	65	25	296 EJ is 48 billion barrels of oil per year. 19 EJ is 3 billion bbl per year. The whole of OPEC produces around 10 billion bbl per year. The world consumes around 30 billion bbl. Saudi Arabia produces around 3.5 billion bbl. It should be at least worth a sentence to point out how silly these numbers for BECCS look. In general, I was expecting this section on the pace of change to look at the pace of change for 1.5C in the context of previous transitions and likely limits to change. [Simon Bennett, France]	not applicable: text removed
37880	65	26			Again, Fig. 2.22c is not the correct reference for (primary?) energy shares as 2.22c shows installed capacity [Michiel Schaeffer, Netherlands]	not applicable: figure removed
42492	65	27			worldwide ===> the worldwide [Egypt]	not applicable: text has been removed
37882	65	28	65	32	An incorrect figure citation - Fig. 2.14 should probably be 2.22. Reference is to a correlation of BECCS vs FF but only two data points can be extracted from the two plots. Is this more generally true? [Michiel Schaeffer, Netherlands]	not applicable: text removed
19570	66		66		Figure 2.22 This figure is not doing a good job at presenting what it is supposed to present (trade offs between BECCS and fossil fuel use). Consider replacing with something more helpful. [Jennifer Morgan, Netherlands]	not applicable: figure removed
58476	66		77		Section 2.4.3: lots of interesting data in this section, but consider expanding the sector-based studies used to compare to the range of IAM scenarios. Use only one sector-based study (IEA-ETP) could be limiting; consider for example also comparing to other IEA Scenarios (World ENergy OUtlook 2017: Faster Transition Scenario and Sustainable Development Scenario) or others [Andrew Prag, France]	Added IEA/IRENA 66%2DS and Shell-Sky scenarios.
21472	66	1	66	9	Figure 2.22: Consider using example scenarios of Section 2.3 [Volker Krey, Austria]	not applicable: figure removed
826	66	4	66	4	EJ scale totally different for (a) and (b). [Robert Shapiro, United States of America]	not applicable: figure removed
2470	66	4	66	5	Consider adding the average total capacity additions per year to Figure 22c. The cross model average of each category could sum to a capacity addition much higher (or lower) than the average total capacity additions. [Jared Woollacott, United States of America]	not applicable: figure removed
30422	66	4	66	9	Figure 2.2 : EJ, which is the variable of interest, depends not only on the installed capacity but also on the load factor. The load factor is much, much higher for nuclear than it is for solar (for instance). Although it is mentionned in the legend, we recommend to use typical load factor and show this figure in energy produced rather than capacity [France]	not applicable: figure removed
36708	66	4	66	9	The rapid scale-up of BECCs between 2030 and 2050 in Figure 2.22a is hard to believe. More discussion is needed in the text about the feasibilty and high level of uncertainty in achieving this level of deployment. At a minimum, the reader should be referred to section 2.4.4 whether there's a longer discussion about land-use changes [Steve Clemmer, United States of America]	not applicable: figure removed
51800	66	4	66	4	A big improvement on the figure captions, do the others like this one!! [Jason Donev, Canada]	not applicable: figure has been removed
51802	66	4	66	4	Text in picture is impossible to read, please resize. [Jason Donev, Canada]	not applicable: figure has been removed
5874	66	5			In the review version draft this figure is not formatted correctly. I assume this shall be fixed in the final version. It would help to make all panels stylistically similar. [Peter Thorne, Ireland]	Accepted - Figure layout has been streamlined throughout the section.
46634	66	5	66	9	Colourblind check for this figure. Please avoid using greens and reds together in figures as they are hard to distinguish between. [Sarah Connors, France]	not applicable: figure removed
245	66	6	66	6	Fig 2.22 the highest building rate of nuclear reaches 300GW/y [Herve Nifenecker, France]	not applicable: figure removed
3310	66	6	66	6	This figure is misleading as the EJ production, which is the variable of interest, depends not only on the installed capacity but also on the load factor. The load factor is much, much higher for nuclear than it is for solar (for instance). Although it is mentionned in the legend, I recommend to use typical load factor and show this figure in energy produced rather than capacity [Francois-Marie Breon, France]	not applicable: figure removed
42494	66	6			primary ===> the primary [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51804	66	6	66	6	Capacity factors need to be quantified here. This is power output, not energy output. [Jason Donev, Canada]	not applicable: figure removed
51806	66	6	66	6	In addition to mentioning capacity factors, the deployability of wind and solar needs to be addressed here and losses due to storage, assuming that storage at the grid level ever becomes possible (which I'm skeptical of). [Jason Donev, Canada]	not applicable: figure removed
58130	66	6			Fgirue 2.22(a+b) I guess that the most important difference between REMIND and GCAM is that GCAM uses afforestation and REMIND BECCS to generate CDR. The authors should probably rely on the 5 individual scenarios that have been considered most of the chapter. [Nico Bauer, Germany]	not applicable: figure removed
1612	66	12	77	8	It is not accurate to say IEA ETP-B2DS is a sectoral based analysis. The methdology for IEA ETP-B2DS based on TIMES modeling (ETP is a multi-region TIMES model) is quite similar to some IAMs. "between IAMs and secoral (IEA-ETP) studies" shown in titles of Figure 2.23, 2.24, 2.25 and 2,26 would be better to revise to "bewteen IAMs and IEA-ETP studies" [Wenying Chen, China]	IEA scenarios are made based on both the IAM-type top-down model and also the sectoral bottom-up models. Advantage of IEA scenarios is that they provide very details data and analysis for each of end-use sectors, while most of IAM scenarios do not. We added two more scenarios to expand the coverage.
11884	66	12	66	12	As this section is going into a lot of detail on IAM vs IEA, it would be helpful to know a little more about how the latter are derived and how they compare to the former. For example, is it a like for like comparison in terms of assumptions about economic and population growth. Additionally, the differences between the IAMs and the sectoral approaches are really interesting (e.g. IAMs conservative in some respectives, more optimistic in others). As the headline messages in this chapter and SPM seem ultimately more weighted towards the IAM scenarios, it would be helpful to highlight in such summaries where they may be more or less optimistic than other forms of analysis, so we can properly contextualise. [United Kingdom (of Great Britain and Northern Ireland)]	Since the basic assumptions such as GDP and population growth are rather different among the IAM models, it is not easy to compare them between IAM and sectoral studies, but they are not much different. In the text, more information on the sectoral studies are added in the revised text.
14040	66	12	66	12	Section 2.4.3 is heavily based on IEA ETP analysis. IPCC does assessments so should not simply concentrate on one other model and repeat the outputs from one publication (IEA ETP) in such detail. A reader could get the original if wished. The section compares the outputs of IAMs with the outputs of the IEA analysis in some detail (which all comes down to assumptions used). Needs to include other analyses rather than describe the IEA report in so much detail. [Ralph Sims, New Zealand]	The selection of IEA ETP is justified by the fact that their work is not the single study, but there is a long history of publications, and also this is the only source to show the detailed sectoral information. In order to cover more studies, the IEA/IRENA and Shell-Sky scenario are added in the revised text.
34204	66	12	81	36	Special attention should be paid to the deployment of low emission technologies in the short term (2020-2030) since policy intervention might be necessary to bring this about in a world less idealized than the models. For example, the IEA B2DS-scenario used extensively in this part of the report relies on extremely rapid deployment of CCS, almost 1 billion tonnes captured and stored in 2025. In our opinion, the long lead times of such project suggest that this is probably not possible. The number of active CCS-projects in different levels of planning globally remain only a handful (see relevant GCCSI reports). [Norway]	Taken into account - In section 2.3.4 we highlight the near-term deployment until 2030 of CDR measures in 1.5°C pathways

Comment No	From Page	From Line	To Page	To Line	Comment	Response
36986	66	12	67	31	Characterizing the end-use sectors without accounting for the indirect emissions associated with the electricity consumed by these sectors is misleading and results in smaller mitigation potential than is actually available at the end use sector level. For AR5, end-use sector fuel and electricity (direct and indirect) emissions were quantified - see figure SPM.2. This same approach should be used to discuss the end-use sectors in this report. [Lynn Price, United States of America]	Since the scenarios in the database provide only the direct emissions, we only use "direct" emissions in this section. The emissions from the electricity is almost zero in 2050, the impact of indirect emissions is very small.
36988	66	12	67	31	If you are not going to account for indirect emissions at the end-use level in this section, then you need to be *very* clear about this in your introductory text to this section. In fact, the introduction to this section needs to state that you are only reviewing energy-related CO2 emissions of the end-use sectors (which I believe is the case) and you are not including indirect CO2 emissions from electricity and heat, process-related CO2 emissions (e.g. from cement production), and other GHG emissions such as HFCs, etc. [Lynn Price, United States of America]	we added the sentence describing it.
60150	66	12	77	17	The prominence afforded the Energy Technology Perspectives (ETP) scenario in section 2.4.3 is puzzling. It appears to be beinig used as a "sectoral" scenario. Yet it is a global energy system model, and many of the IA models being used in this study have similar structures and substantial sectoral detail just as the ETP model does. What is it that justifies highlighting this particular scenario, even though it isn't even associated with the 1.5°C goal? More broadly, do not characterize the ETP scenario or the similar IA models as producing sectoral scenarios. Sectoral studies are those that actually focus on the details of a sector to a greater degree than models like the ETP and high-resolution IA models in this chapter. If the section is really about sectoral studies, then it shoudl actually use sectoral studies rather than the results from a global energy system model. [United States of America]	same as the above
28088	66	14	66	31	At least one sentence should be added that there is an increasing number of interdependencies between the three considered sectors, e.g. the intensified use of industrial process heat in the building sector. Electrification of individual motor car traffic will further push this trend of interdependencies, and separate statistics for the three sectors become less meaningful. Please clarify how these interlinkages are being considered in sub-chapter 2.4.3. [Germany]	In the sections of each end-use sectors, there exists some description on the interdependencies, but we added here a sentence on it This interdependencies are not treated explicitly in the modelling and pay little attention on it.
42496	66	17			modelling ===> modeling [Egypt]	noted
51808	66	17	66	17	IAMs are defined here, shouldn't that be earlier? [Jason Donev, Canada]	noted
54588	66	17	66	17	Integrated assessment modelling' has already been defined at Page 8, line 13, should be used in abbreviation through rest of the Chapter [Qudsia Zafar, Pakistan]	fixed
58038	66	17	66	17	There is a missing word "to" in the phrase "compared each other" that may read "compared to each other." [Siir KILKIS, Turkey]	fixed
828	66	21	66	21	scenarios' no plural 'scenario' [Robert Shapiro, United States of America]	fixed
11886	66	21	66	23	Don't exclude the non-overshoot scenarios just because there are few of them. Policy makers need to know what they entail. [United Kingdom (of Great Britain and Northern Ireland)]	We are including the scenarios for 1.5DS with low overshoot. The excluded scenarios are for those aiming the temperature rise below 1.5C.
34206	66	21	66	23	We are surprised that you are leaving out "below 1.5C 50"-scenarioes from the section about end-use sector. How rapid decarbonisation of the end use sectors can occur and what assumptions that is included is policy relevant information. Please consider to include these scenarios when presenting your findings. [Norway]	If we select only data of accepted paper, only one or two scenarios are available. Therefore we can not draw the reliable information from them.
51810	66	23	66	23	referring to these as IAM-1.5DS seems inconsistent with how this is used elsewhere. [Jason Donev, Canada]	noted
830	66	24	66	24	And the difference' should be 'Also the difference' [Robert Shapiro, United States of America]	noted
15758	66	24	66	25	Clarify: 'And the difference between data of subgroups with probability of 50% and 60% are small, then both data are aggregated into one group for simplicity.' [Australia]	noted
42498	66	24			probability ===> a probability [Egypt]	noted
58040	66	24	66	25	The sentence may not start with "And" and the phrase "so that" may be used in the sentence "And the difference between data of subgroups with probability of 50% and 60% are small, then both data are aggregated into one group for simplicity" to read "The difference between data of subgroups with probability of 50% and 60% are small so that both data are aggregated into one group for simplicity."Additional clarification may be also given. [Siir KILKIS, Turkey]	noted
832	66	25	66	25	then both data' should be 'so both data' [Robert Shapiro, United States of America]	noted
1614	66	27	67	4	It would be better to compare the cumlative emission constraint (2010-2050) for IEA ETP-B2DS and IAM-1.5DS. [Wenying Chen, China]	It is already mentioned in this section.
18134	66	27	66	30	This insight belongs in Section 2.4.1 since it is essentially a CDR sensitivity: i.e. compares 1.5°C to 2°C with limited BECCS. Because of this, its message (that 1.5°C & 2°C are similar up to 2050) is strikingly different from the rest of the chapter, which emphasises the need for faster short-term reductions in 1.5°C scenarios. [Andrea TILCHE, Belgium]	This comment is for the different section of chap2, but we can not find the part of the draft related to this.
21474	66	27	66	30	The mentioning of the 1.75 C temperature change for the IEA ETP-B2DS scenario is confusing as it brings in a third temperature target in addition to 1.5 and 2C. It remains unlcear how this scenarios relates to the others presented in Chapter 2 with respect to temperature change. If the scenario is continued to be used, a consistent evaluation of the temperature implications as presented in Table 2.1 is needed. [Volker Krey, Austria]	We added the figure to show where the CO2 emission trajectories of sectoral studies including IEA-B2DS among the range of IAM scenarios. This clearly indicates that IEA-B2DS can be considered as one of 1.5DS.
15760	66	28	66	28	Use brackets within parentheses. [Australia]	noted
5978	66	29			co2 emission (space missing) [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	noted
22602	66	29			Insert a space between "CO2emissions" [LUIS VALDES, Spain]	noted
39402	66	29	66	29	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
44222	66	29	66	29	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
3232	66	30	67	4	Very unclear. Why can the global CO2 emissions not turn net negative after 2060? I also don't follow the "therefore" argument. The fact that the scenarios are comparable doesn't follow from the fact that emissions cannot terun net negative after 2060… [Vassilis Daioglou, Netherlands]	added a figure and changed text to describe this more clearly.
58042	66	30	66	30	There is a missing word "with" in the phrase "consistent each other" that may read "consistent with each other." [Siir KILKIS, Turkey]	fixed
58452	66	30	66	30	suggest replacing IEA with "IEA-ETP" [Andrew Prag, France]	fixed
14132	67		76		In 2.4.3 energy end-use sectors, the "energy-related emissions" are pointed out in three sectors respectively; however regarding global final energy use & demand, only numbers in building and transport sector are mentioned. It would be more clear to have the same baseline to make the comparision and also would be nice to refer to IEA Tracking Clean Energy Progress 2016 report, which indicates global energy consumption in three sectors. [Yi-Chieh Chan, China]	No, in ease sections, we have discussed final energy of each end-use sector. Also, the figures in each section show the energy consumption in 2030 and 2050.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
14134	67		67		Figure 2.23 is a good presentation that shows the ratio of CO2 emission among three sectors under 2DS & 1.5DS in different years. It would further nice to also show "CO2 reduction potential" in three sectors. The information is also mentioned in IEA Tracking Clean Energy Progress 2016 but under 2DS. [Yi-Chieh Chan, China]	The number of studies to assess the potential of reduction is limited, so only mentioned in the following sections of each end-use sector if available.
47808	67		67		Please use CO2 along Y-axis in the unit of expression in table 2.23 [Sarah Connors, France]	fixed
11888	67	1	67	4	Confusing sentence [United Kingdom (of Great Britain and Northern Ireland)]	fixed
5980	67	2			co2 emission (space missing) [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	noted
39404	67	2	67	2	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
44224	67	2	67	2	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
51812	67	2	100	10	Every time CO2emissions is used, there's no space between CO2 and emissions, is that on purpose? [Jason Donev, Canada]	noted
36990	67	6	67	6	Regarding the text describing Figure 2.23, the wording should be "direct energy-related CO2 emissions of the end-use sectors", not "CO2 emissions of energy end-use sectors". [Lynn Price, United States of America]	fixed
36992	67	6	67	6	Regarding the text "carbon intensity of each sector" - this is only the CO2 intensity of the direct CO2 emissions from each sector, correct? Since the indirect CO2 emissions from electricity consumption are not included, this needs to be clarified here. [Lynn Price, United States of America]	fixed
60152	67	6	68	20	The discussion of industrial emissions should be compared with the pithy statement on page 4-29 (lines 31-32) that "If global temperatures are to remain under 1.5°C, industry will need to reach near-zero emissions in 2050." The importance of reducing industrial emissions does not come through strongly enough in the Chapter 2 Executive Summary or in the SPM. This discussion should also be cross-checked with the policy targets in Table 4-1, which don't appear to be consistent. [United States of America]	The description of Chap4 is wrong (see Fig 2.24). We will exchange the information among chapters to cross-check the content in each chapter.
18136	67	9	67	9	To the extent CCS is relevant to energy end use at all, it should be mentioned that it greatly reduces energy efficiency due to the energy penaly. Similarly, it should be clarified how declining EROEI is taken into account. [Andrea TILCHE, Belgium]	The details on CCS is discussed in Section 2.3.
42500	67	10			behavioural ===> behavioral [Egypt]	noted
60154	67	11	67	11	Is the "factor of 3.4" a cumulative or annual value? [United States of America]	clarified
2472	67	13	67	13	Strike the "minus" in the first range given on this line. [Jared Woollacott, United States of America]	noted
18138	67	13	67	15	On decoupling sources like the following should be reflected on: Krausmann, F. et al. 2017. Global socioeconomic material stocks rise 23-fold over the 20th century and require half of annual resource use. Proceedings of the National Academy of Sciences of the USA, 114(8), 1880-1885, doi/10.1073/pnas.1613773114 It shows that material stocks (i.e. the mass of buildings, infrastructures, cars, machinery, human bodies, livestock, etc. we accumulate grows 1:1 with GDP. [Andrea TILCHE, Belgium]	we are discussing the future trend, not the historical trend.
45942	67	13	67	15	I would suggest to rephrase as efficiency improvements including energy demand reductions, electrification technologies and renewable energy applications in power, heating, cooling and transport applications. [Deger Saygin, Turkey]	Here it is only related to the reduction of energy consumption, so renewable energy has nothing to do with here.
51814	67	13	67	13	minus' is a word here. [Jason Donev, Canada]	noted
46610	67	15	67	15	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	fixed
47058	67	15	67	16	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	fixed
44226	67	16	67	16	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
42502	67	18			very ===> the very [Egypt]	fixed
44228	67	20	67	20	needs space between "Co2 emmissions" and line 23 [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
51816	67	20	67	20	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	noted
13514	67	21	67	21	more space around figure [Sergio Aquino, Canada]	fixed
39406	67	21	67	21	Between line 21 and figure 2.23 it is needed a free space [Olga Alcaraz, Spain]	fixed
3234	67	22	67	22	Is there a need for the triangles in panel a? Isnt the top of the column the median? [Vassilis Daioglou, Netherlands]	noted
21476	67	22	67	31	The sectoral split of IAM scenarios presented in the left panel of Figure 2.23 is not meaningful as it does not reflect the range across models which I assume is substantial given the range of total end-use sector CO2 emissions. Without the ranges for hte sectors a comparison with the IEA ETP scenarios does not seem to be meaningful as there are likely scenarios very similar to IEA ETP and some very different. [Volker Krey, Austria]	noted
36994	67	22	67	31	Figure 2.23 (a) should be labeled "direct energy-related CO2 emissions". When these values for 2010 are compared to the values in Figure SPM.2 from AR5, you can see the impact of only focusing on direct energy-related CO2 emissions. GHG emissions in 2010 in Figure SPM.2 from AR5 are 49 GtCO2eq, with the following break-down by end-use sector: Industry - 10.29 GtCO2eq direct emissions and (10.29+5.39) = 15.68 GtCO2eq direct+indirect emissions; Buildings - 3.136 GtCO2eq direct emissions and (3.136+5.88) = 9.016 GtCO2eq direct+indirect emissions; Transport - 6.86 GtCO2eq direct and (6.86+0.147) = 7.007 GtCO2eq direct+indirect emissions. Figure 2.23 (a) shows only Industry: 7? GtCO2, Buildings: 3?GtCO2, Transport: 6.5 GtCO2? for a total of about 16.5 GtCO2 which is significantly less than the total shown in SPM.2 from AR5 which is nearly 32 GtCO2eq. This is an especially important point for the industry and buildings sectors which both use significant amounts of electricity. Since many scenarios rely on increasing electrification of the end-use sectors, the full benefits of such electrification are not reflected when only direct emissions are accounted for. [Lynn Price, United States of America]	fixed
36996	67	22	67	31	Figure 2.23 (b) should be labeled "direct energy-related CO2 emissions intensity of the end-use sectors". It should be clarified that indirect CO2 emissions associated with heat and electricity production are not shown here, assuming that is the case. Process-related CO2 emissions (e.g. from cement production) are also not included, correct? If so, this should be noted in the text too. [Lynn Price, United States of America]	The impact of indirect emissions is relatively large today, but much smaller in 2050 for 1.5DS.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
51818	67	22	67	22	The text refers to circles in the figures which aren't present. [Jason Donev, Canada]	not find
44870	67	23	67	31	What means by solid lines in Figure 2.23b? Are these lines from IAM? [Hiroaki Kondo, Japan]	Figure is revised.
42504	67	24			and ===> , and [Egypt]	fixed
42506	67	26			coloured ===> colored [Egypt]	noted
18140	67	33	67	33	This section should mention the role (if any) of biomass both to substitute for products (as in wood replacing more emission-intensive building materials). [Andrea TILCHE, Belgium]	This is already included in this section.
36998	67	33	67	40	It would be better to discuss the end-use sectors in terms of primary energy demand since the transformation losses associated with end-use demand will also be reduced if end-use demand is reduced. Also, this statement says that industry is the largest end-use in terms of greenhouse gas emissions, but there first is no source provided and second this is not correct if you look at the breakdown in Figure SPM.2 from AR5 which shows industry at 21% of direct emissions in 2010, behind electricity and heat production (25%) and AFOLU (24%) - perhaps you are not considering these as end use sectors? In this case, then the statement is technically correct. If indirect emissions are included (as I am strongly suggesting), then industry grows to 32% and then is the largest GHG emitter. This statement needs a source and needs to be clarified in terms of what is included when you say industry is the largest GHG emitter. [Lynn Price, United States of America]	This statement is only for the "end-use" sectors, so power sector is out of this discussion. Reference is given for the first two sentences (already there).
37028	67	33	67	37	You might want to look back at AR5 when describing industry energy and emissions, at least as a model of what to include in the description. See AR5 (WGIII) chapter 10: "In 2010, the industry sector accounted for around 28% of final energy use (IEA, 2013). Global industry and waste / wastewater GHG emissions grew from 10.37 GtCO2eq in 1990 to 13.04 GtCO2eq in 2005 to 15.44 GtCO2eq in 2010. These emissions are larger than the emissions from either the buildings or transport end-use sectors and represent just over 30 % of global GHG emissions in 2010 (just over 40% if AFOLU emissions are not included). These total emissions are comprised of: • Direct energy-related CO2 emissions for industry2 • Indirect CO2 emissions from production of electricity and heat for industry3 • Process CO2 emissions • Non-CO2 GHG emissions • Direct emissions for waste / wastewater 2 This also includes CO2 emissions from non-energy uses of fossil fuels. 3 The methodology for calculating indirect CO2 emissions is based on de la Rue du Can and Price (2008) and described in Annex II.5." [Lynn Price, United States of America]	Thank you for the information.
62286	67	34	67	43	The section does not specify the energy or electricity demand of the industry sector. In that context, it becomes difficult to evaluate the statement in line 42 that materials cause 66% of the energy demand of industry. Please supplement information with information on indirect emissions from electricity. [Edgar Hertwich, United States of America]	noted
37000	67	35	67	35	Please use gender-neutral terms instead of "man-caused". [Lynn Price, United States of America]	fixed
37002	67	35	67	37	Again, it would be best to be discussion total (direct + indirect) emissions associated with industry. It would also be good to provide more information on which sectors and which countries/regions have been the drivers behind the significantly faster growth. Is it the energy-intensive industries (steel, cement, chemicals)? I believe that industrial production in China is clearly driving this overall growth, so it would be good to mention that this isn't a universal/world-wide increase, but rather is in specific industries and countries. [Lynn Price, United States of America]	Yes, it is good to include indirect emissions in the discussion, but that database does not provide them. The impact of indirect emissions in 2050 is very small. Discussion on the role of each subsector is useful, but the space is limited.
58304	67	35	67	35	Plesae conside the use of "man-cuased". Perhaps "human-caused" or anthropogenic? [Peter Marcotullio, United States of America]	fixed
5982	67	36			co2 emission (space missing) [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	noted
22604	67	36			Insert a space between "CO2emissions" [LUIS VALDES, Spain]	noted
42508	67	36			CO2emissions ===> CO2 emissions [Egypt]	noted
44230	67	36	67	36	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
60156	67	36	67	36	Is the "rate of 3.4" a cumulative or annual value? [United States of America]	Same as #1526.
37004	67	37	67	40	This is true of industry's CO2 emissions inventory, but industry also has other GHG emissions that are important. More information on these emissions should be provided here. [Lynn Price, United States of America]	Since the information on detailed GHG emissions in industry is limited, we focus on the CO2 emissions here. It will be a task of future AR6 report.
5984	67	40			co2 emission (space missing) [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	noted
22606	67	40			Insert a space between "CO2emissions" [LUIS VALDES, Spain]	noted
39408	67	40	67	40	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
44232	67	40	67	40	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
37006	67	42	67	42	Please note whether the 66% of energy demand is final or primary energy. [Lynn Price, United States of America]	fixed
32776	68				Here I miss the discussion and quantification of industrial process emissions (came only later, see page 71, line 29) [Manfred Treber, Germany]	added the data in 2014,
22608	68	1		2	There is no need to write "International Energy Agency" in full as it was already done just four lines above. Please use IEA only [LUIS VALDES, Spain]	noted
18142	68	4	68	8	Link this observation (on the need for additional decarbonisation in industry) to the earlier observations about industry being a major demand source for BECCS (e.g. implied in the higher CDR scenarios of Fig 2.15). [Andrea TILCHE, Belgium]	As the measures of emission reduction in the industry sector, the efficiency improvement is most important. So CCS is not the top priority.
5986	68	6			co2 emission (space missing) [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	noted
22610	68	6		12	Insert a space between "CO2emission" (lines 6, 10, 12) [LUIS VALDES, Spain]	noted
39410	68	6	68	6	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
44234	68	6	68	10	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
42510	68	7			supply side ===> supply-side [Egypt]	fixed
39412	68	10	68	10	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
42512	68	10			CO2emissions ===> CO2 emissions [Egypt]	noted
42514	68	10			and ===> , and [Egypt]	fixed

Comment No	From Page	From Line	To Page	To Line	Comment	Response
5988	68	12			co2 emission (space missing). I am not commenting on this error further, it seems systematic and should be checked througout the report [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	noted
37008	68	12	68	12	optimistic sounds a bit biased and doesn't clearly convey how one is different from the other - I would suggest using a different term here. [Lynn Price, United States of America]	Since in AR5 same words are used, so we also use same words here.
39414	68	12	68	12	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
56466	68	13			Also at companies that produce large amounts of CO2, CCU with a GPV and Olivine can be used [Henk Daalder, Netherlands]	Thank you for the information.
11890	68	14	68	14	What's the different CCS strategy? [United Kingdom (of Great Britain and Northern Ireland)]	IAM assumes more aggressive CCS deployment.
44872	68	16	68	16	What is 'REF'? [Hiroaki Kondo, Japan]	these words were misplaced here, so cut them down.
44236	68	18	68	18	CO2, 2 should be subscript [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
47810	68	18	68	18	Please use CO2 [Sarah Connors, France]	noted
15762	69				Figure 2.24 please explain "electricity" and "bioenergy" (not clear in caption) [Australia]	Change the caption; (f) consumption of low carbon fuels (electricity and bioenergy)
62112	69		77		In the three (very interesting and clear) figures 2.24, 2.25, 2.26, there could be more clarity by emphasizing the sector in a separate title or from the start of the caption in bold. For example "Industry: Comparaison of (a) final energy, (b)…" [Antoine Bonduelle, France]	fixed
189	69		69	2	The unit of ordinate in Figure 2.24(c) is error. [Mingshah Su, China]	fixed
3236	69	1	69	1	Unlcear what columns and triangles are. Are they IAM results or a combination of IAM and ETP? [Vassilis Daioglou, Netherlands]	improve
18144	69	1	69	7	In the chart, no explanation is given for "bioenergy" box. Its relation to the other boxes should be clarified. Does it represent only bioenergy for electricity (e.g., if the units of the Y axis are shared with (f), which is unclear), or all bioenergy? Is bioenergy excluded from the other charts, or included, and this just separates it for transparency? If (b), (c) and (e) include bioenergy, do they assume any CO2 emission from bioenergy, or consider it entirely free of CO2 emissions? [Andrea TILCHE, Belgium]	Change the caption; (f) consumption of low carbon fuels (electricity and bioenergy)
30954	69	1	69	8	why does Figure 2.24 not have any mention of below 1.5 degree 50% scenarios? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	The number of scenarios is small, so we can not get reliable data form them.
51820	69	1	69	1	What does 'percentile' mean in this context? It's unclear. [Jason Donev, Canada]	noted
18146	69	2	69	7	Legend does not make clear as to what is IEA number and what is IAM [Andrea TILCHE, Belgium]	fixed
39416	69	2	69	2	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
44238	69	2	69	14	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
37010	69	9	69	13	I like the framing of the five strategies here. I would just like to point out that the mitigation potential for strategies (i) and (ii) are not fully reflected using final energy and direct emissions. Even if you can't change from final energy because of the references you are basing your assessment on, you should add a statement that the mitigation potential is underestimated because it doesn't include indirect emissions that are also reduced when industry production and processes are made more energy efficient. [Lynn Price, United States of America]	Thank you. This is already mentioned in the introductory section.
11892	69	13	70	2	why only present this percentage breakdown for IEA scenarios? Why not also present for IAMs? [United Kingdom (of Great Britain and Northern Ireland)]	Unfortunately data are not available.
22612	69	13		14	As explained above, there is no need to write "International Energy Agency" in full. Please use IEA only [LUIS VALDES, Spain]	noted
22614	69	14			Insert a space between "CO2emissions" [LUIS VALDES, Spain]	noted
5990	69	16			ref (reduction final energy) [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Rejected. Unclear what is meant here.
5992	69	18			CO2 2 not subscripted [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	noted
18148	69	44	69	48	Invoking thermodynamics and efficiency losses is highly pertinent, but should be more systematic throughout the report. It is odd that the energy penalty associated with CCS is never explicitly mentioned, neither its implications for BECCS (e.g., on increasing land demand compared to non-CCS bioenergy). Discussion should also include reference to the declining EROEI due to the depletion of fosill fuels (E.g., Cutler J. Cleveland * and Peter A. O'Connor, 2011: Energy Return on Investment (EROI) of Oil Shale. Sustainability 2011, 3, 2307-2322; doi:10.3390/su3112307) and, more importantly, from swithing from fossil fuels to renewables (e.g., Galán et al. Widening the analysis of Energy Return On Investment (EROI) in agro-ecosystems: socio-ecological transitions to industrialized farm systems (the Vallès County, Catalonia, c.1860 and 1999)) [Andrea TILCHE, Belgium]	The details of CCS and related topics are discussed in Section 2.3.
4556	70	7	70	21	Discussing the option of reducing the demand for industrial products is commendable. This option should be explored in much more detail however and the concept (reducing demand instead of increasing efficiency) should be investigated in all sectors, [Kai Kuhnhenn, Germany]	This is already mentioned in this section and detailed discussion is not possible because of page limit.
35826	70	7	71	16	It would be helpful to include the assumptions for the various industry sector interventions. More clarity is required on what is the relative share of the various interventions in reducing industry demand. [India]	Detailed information as aggregated level is not available.
35828	70	7	70	21	There is growing demand for industry outputs in developing countries where much of the infrastructure is yet to be built. More clarity is required on as to what extent reduction in demand can make a meaningful impact. [India]	Yes, you are right, but detailed discussion is not possible because of page limit.
62288	70	7	70	21	This section seems to both contradict and ignore the findings of the industry chapter in AR5 (Fischedick et al. 2014) and the substantial litature on the role of material efficiency, reuse, remanufacturing, and recycling. You will have to decide on whether you admit that the underlying models in fact do not address any of these measures or whether you take into account case studies and assessments in the bottom-up literature. (These are not well covered in Ch.4, either). See, e.g., http://dx.doi.org/10.1021/acs.est.7b04477, http://dx.doi.org/10.1016/j.jclepro.2017.06.16910.1021/es502930w, 10.1146/annurev-environ-110615-085737, DOI: 10.1098/rspa.2014.0170, DOI: DOI: 10.1111/jiec.12722) [Edgar Hertwich, United States of America]	I can not understand how we are contradicting and ignoring the findings of AR5. Rather the content of this section is consistent with the findings of AR5.
2476	70	8	70	41	The discussion of structural change in these section should provide a discussion of emissions leakage. It is of little consequence to emissions if a county decarbonizes by migrating toward a service economy and then imports its energy intensive goods from countries with similarly carbon-intensive production. [Jared Woollacott, United States of America]	This is discussed in Chapter 4.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
37012	70	8	70	10	Urbanization is also an important driver. There are studies that compare the energy or emissions intensity of urban vs rural dwellers that could be cited. Chapter 4 of this report has the following information: "Urban economies in all countries tend to be energy intensive due to higher levels of per capita income, mobility and consumption than in rural areas (Broto, 2017; Gota et al., 2017; Kennedy et al., 2015)." (page 4-24). [Lynn Price, United States of America]	added
42516	70	8			service intensive ===> service-intensive [Egypt]	fixed
51822	70	8	70	21	It would be nice to have a 'for more information please see ___' for this. [Jason Donev, Canada]	noted
37014	70	10	70	16	Improving material quality is also extremely important (and leads to longer product lifetimes). [Lynn Price, United States of America]	added
22616	70	12			Insert a space between "CO2emissions" [LUIS VALDES, Spain]	noted
44240	70	12	70	12	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
44242	70	12	70	12	needs space between "meterials (International" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
2474	70	13	70	14	This sentence has in the first clause - rewrite. [Jared Woollacott, United States of America]	noted
37016	70	16	70	17	Other options for reducing material demand are prefabricated building components and 3D printing, both of which reduce waste. [Lynn Price, United States of America]	Thank you for the information.
5994	70	17			for example. efficiency [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	fixed
28090	70	17	70	21	The reduction of the use of energy-intensive materials ("material substitution") can be substantial and should be reflected in more detail. [Germany]	Yes it is, but the space is limited.
46050	70	17	70	21	Sugar cane ethanol can replace oil in making ethilene plastics, while phasing out a fossil fuel. [Milton Nogueira da Silva, Brazil]	Thank you for the information.
45944	70	19	70	21	Not entirely the case that bio-based feedstocks would reduce demand formaterials, actually their use may require more energy than the fossil fuels. It is only fossil fuels feedstocks are reduced. Please see: DOI: 10.1039/C3EE42667J, https://doi.org/10.1016/j.rser.2014.07.114. [Deger Saygin, Turkey]	Thank you for the information.
15764	70	20	70	20	Is competition for biomass between bioenergy and bio-based materials considered in the models? [Australia]	Yes, total amount of biomass is set as limiting factor..
22618	70	21			Please use IEA only [LUIS VALDES, Spain]	noted
51824	70	21	70	21	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	noted
11894	70	24	70	41	This section is unreferenced. What studies exist that explore these issues? [United Kingdom (of Great Britain and Northern Ireland)]	added
15766	70	24	70	41	Suggest address the issue of energy peak demand in more detail. [Australia]	This is interesting topics to discuss more, but the page is limited.
35830	70	24	70	33	The global average specific energy consumption of most energy intensive industries is already quite low. Therefore, on a global level, there may be limited room to improve SEC further. [India]	Taken into account - This section has been edited in light of the available literature, which indeed shows that energy demand in the industrial sector can be reduced from baseline levels, but is still projected to increase in the two IEA scenarios discussed here.
45406	70	24		41	This entire section misses references. But there are a number of relevent ones, e.g., Kermeli, Katerina, Wina H. J. Graus, and Ernst Worrell. “Energy Efficiency Improvement Potentials and a Low Energy Demand Scenario for the Global Industrial Sector.” Energy Efficiency 7, no. 6 (December 1, 2014): 987–1011. https://doi.org/10.1007/s12053-014-9267-5. Worrell, Ernst, Lenny Bernstein, Joyashree Roy, Lynn Price, and Jochen Harnisch. “Industrial Energy Efficiency and Climate Change Mitigation.” Energy Efficiency 2, no. 2 (May 1, 2009): 109–23. https://doi.org/10.1007/s12053-008-9032-8., and also Luderer, Vrontisi et al. for an IAM perspective on the role of efficiency in industry. [Gunnar Luderer, Germany]	added
54550	70	24	70	33	The presentation and discussion of energy efficiency option in industry is also present in section 4.3, therefore it could be deleted here. [Paolo BERTOLDI, Italy]	It is better to see the all related discussion here.
28092	70	25	70	25	Energy efficiency improvements will undoubtedly always be of importance, also as long-term mitigation measures. Therefore, the wording "particularly...as short-term mitigation measures" is somewhat misleading. Please revise. [Germany]	fixed
57894	70	28	70	29	The statement "Although excess energy, usually as waste heat, would be inevitable, recovering and reusing this waste heat to economic levels benefits the overall energy system" is a very important statement to be included in the chapter. The statement is open to being expanded to include further evidence. For example, there is quantitative source of data that indicates that "Large-scale industry currently supplies ~7 TWh of heat to district heating each year, but it could potentially produce ~750 TWh of heat" according to the Heat Roadmap Europe. The reference for this statement is page 9 in "Connolly, D., Mathiesen, B. V., Lund, H., Møller, B., Hvelplund, F. K., Sperling, K., ... Werner, S. (2015). Heat Roadmap Europe: Inputs for Technical Modelling and Policy Recommendations" that is available at <http://vbn.aau.dk/files/229437546/Heat_Roadmap_Europe_Technical_and_Policy_Recommendations.pdf>. There are also other references based on the Pan-European Thermal Atlas (Peta) that maps the locations of waste heat from industry as well as those from electricity production in 14 European countries <http://www.heatroadmap.eu/peta4.php>. For this reason, cross-sectoral integration, including between the industry, power and buildings sectors are important. [Siir KILKIS, Turkey]	Thank you for the useful information, but space is limited.
1756	70	29	70	29	Instead of '...resuse waste heat to economic levels…' it would be better to say '…reuse waste heat under economically and technically viable conditions..'. [Greece]	fixed
1758	70	29	70	31	Change to 'Furthermore, demand-side management strategies could modulate the level of industrial activity in line with the availability of resources in the power system' (as the industrial activity has needs, while the power sector serves it under a number of limitations). [Greece]	fixed
1760	70	31	70	33	Considering the stochastic character of critical renewable technologies (especially wind), such a large load shift may require that storage capacity is available (e.g. hydro pump storage). This issue should be added here , together with any available references on this. [Greece]	This is discussed in chapter 4.
51826	70	41	70	41	Needs a citation [Jason Donev, Canada]	These are based on the data taken from the scenario database.
13518	70	44	70	44	suggest a line between title/sub-title and paragraph [Sergio Aquino, Canada]	noted
42518	70	44			industry ===> industrial [Egypt]	noted
42520	70	45			increases ===> increase [Egypt]	fixed

Comment No	From Page	From Line	To Page	To Line	Comment	Response
60158	70	45	70	55	Could note that electrification is a mitigation strategy even where electricity is currently generated by coal (and other fossil fuels) since it positions the economy to reduce emissions more when low/zero-emisions generating plants are put on line in the future. [United States of America]	Thank you for the information.
1762	70	49	70	49	Instead of 'non-electric energy' it is better to say 'fossil fuels' supply'. The same goes for page 71, line 6. [Greece]	Here we means all other energy than electricity.
39418	70	50	70	50	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
42522	70	50			CO2emissions ===> CO2 emissions [Egypt]	noted
44244	70	50	70	50	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
37018	70	51	70	52	The timing of electrification of industry is extremely important, especially in countries with high coal-based electrical grids. We found that rapid electrification in China, for example, led to higher emissions in the early years (2020s). I recommend adding some statement about the importance of timing vis-a-vis the decarbonization of the electric grid and also some acknowledgement of the potential for on-site renewable electricity generation and the use of micro-grids with renewables. [Lynn Price, United States of America]	It is already mentioned.
42524	70	51			industry ===> industrial [Egypt]	noted
1764	70	52	70	53	a) Add what is the current share of electricity, so that the reader gets an idea about the effort needed to reach 36% b) In which industrial energy uses will this increase of electricication take place? [Greece]	added
5996	70	53			here the report should mention which subsectors or processes can be electrified more easily and which ones are unlikely to be electrified and why. The comment saying not everything in industry can be electrified is too generic [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	Good comment, we added some information related with this.
22620	70	55			Please use IEA only [LUIS VALDES, Spain]	noted
11896	71	2	71	3	What does this mean [United Kingdom (of Great Britain and Northern Ireland)]	For example, switch to electricity from oil or gas as heating energy will change the equipment and also after-treatment process. This changes the process structure of the plant and also more widely change the supply-chain of fuel and equipment.
58208	71	6	71	15	The role of liquid biofuels could be better explored in this sub-section, by using additional studies, such as the Scope Report “Bioenergy & Sustainability: bridging the gaps”. [Alexandre Strapasson, Brazil]	thank you for the information, but the space is limited.
42526	71	7			carbon ===> the carbon [Egypt]	fixed
42528	71	7			industry ===> the industry [Egypt]	fixed
11898	71	11	71	14	Inconsistency in presentation. Saying that biomass becomes important and then saying that biomass "only" accounts for small percentage [United Kingdom (of Great Britain and Northern Ireland)]	increasingly
37020	71	11	71	12	Perhaps you should acknowledge some of the barriers/problems with biomass use? See, for example: Rentizelas, Athanasios A. and Tolis, Athanasios J. and Tatsiopoulos, Ilias P., 2009. “Logistics issues of biomass : the storage problem and the multi-biomass supply chain,” Renewable and Sustainable Energy Reviews, 13 (4): 887-894. ISSN 1364-0321 , http://dx.doi.org/10.1016/j.rser.2008.01.003 [Lynn Price, United States of America]	discuss this in chapter 4.
42530	71	11			phase out ===> phase-out [Egypt]	fixed
834	71	13	71	13	biomass accounts only' should be 'accounts for only' [Robert Shapiro, United States of America]	noted
28094	71	14	71	15	This statement could be slightly stronger since there are numerous scenarios (not only "some") where hydrogen plays a considerable role. [Germany]	There is a very large variation among the IAM scenarios, so we can not state this strongly.
35504	71	14	71	15	It is not clear how carbon content/emissions is calculated for hydrogen since it is also only an energy carrier and needs to be produced from something. [Ashok Sreenivas, India]	In the models, hydrogen is produced in the process of low carbon emissions at least in 2050.
62114	71	15	71	15	Maybe mention the very complete scenario made for the Belgian governments by VITO, Climact and others (2012), with combined electricity and hydrogen in industry, transport and buildings, allowing the continuation of heavy industries in the no emissions context. [Antoine Bonduelle, France]	thank you for the information but the space is limited.
60160	71	21	71	22	This is not likely to happen without the active role of public policy. [United States of America]	Yes, fundamental research is promoted by the policies.
42532	71	24			aluminium ===> aluminum [Egypt]	noted
44246	71	24	71	24	DRI is not used so is it needed? [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
45946	71	24	71	24	This can also include renewables-based H2 / NG DRI systems. [Deger Saygin, Turkey]	thank you for the information but the space is limited.
22622	71	26			Please use IEA only [LUIS VALDES, Spain]	fixed
51828	71	26	71	26	The IEA is wonderful, but this report is being relied on too heavily. [Jason Donev, Canada]	Especially for the detailed discussion of end-use sectors, IEA publications are the best source of information. We tried to refer other sources, if available.
34208	71	28	71	40	Consider describing the rapid deployment of CCS from today to 2030 in the scenarios. The IEA B2DS captures and stores 400 million tonnes from the cement industry alone in 2025, while only two large scale CCS-projects are currently in early stage planning in this industry. [Norway]	This is described more in section 2.3 and chapter 4.
8340	71	29	71	29	The industrial CCS is exemplified with the sectors of cement and steel. However, according to IEA’s 20 Years of Carbon Capture and Storage released in 2016, the contribution of the industrial CCS to emission reduction by sector is ranked as chemical 38%, steel 33% and cement 29%. If there is relevant literature, it is suggested to add data on the chemical sector. [China]	thank you for the information. According to IEA-ETP2017, major contributors of CCS in 2060 under B2DS scenario are cement and iron & steel subsectors. But this is strongly dependent on the assumptions of scenarios, so defers largely among the scenarios.
1766	71	32	71	33	See comment #33 above. I suggest to change it to "Given project long-lead times and the need for technological innovation, an early scale up of industry CCS is a prerequisite for CCS to make the expected contribution in meeting a 2°C or 1.5°C target." [Greece]	changed
42534	71	32			scale up ===> scale-up [Egypt]	fixed
60162	71	32	71	33	This does not bode well for hitting the 1.5°C goal. [United States of America]	Reduction of process emission is very important for 1.5DS.
42536	71	34			has ===> have [Egypt]	fixed
4272	71	35	71	37	It is important to state if these cost figures are First of a kind (FOAK) or projected after a few plants have been built (NOAK). A major review of cost of CCS, 10 years after the IPCC SR on CCS has been published recently, supporting these figures: The cost of CO2 capture and storage; by Edward S. Rubin, John E. Davison, Howard J. Herzog; International Journal of Greenhouse Gas Control 40 (2015) 378–400 [Abanades Carlos, Spain]	these are FOAK, so added this in the text.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
5998	71	35			CO2avoided. It seems spaces went missing wherever there is a 2 subscribed after "CO". Please check the full report [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	noted
13520	71	35	71	35	separate CO2avoided [Sergio Aquino, Canada]	noted
37264	71	35	71	35	Use more recent update from GCCSI, 2017 instead of GCCSI, 2016. See similar ref in Ch4. [Ton Wildenborg, Netherlands]	this is same as one in chap4
39420	71	35	71	35	Between CO2avoided there must be a free space: CO2 avoided [Olga Alcaraz, Spain]	noted
44248	71	35	71	35	needs space between "Co2 avoided" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
45948	71	36	71	38	Are these the costs of actual plants? Otherwise, for which year they refer to? [Deger Saygin, Turkey]	These are estimated cost based on the current information .
47896	71	37	71	37	Please check the citation: Irlam, 2017……..not complete reference available in reference section [Sarah Connors, France]	changed reference
836	71	38	71	38	Carbon pricing is one of key' should be 'Carbon pricing is one of the key' [Robert Shapiro, United States of America]	fixed
34210	71	38	71	40	This sentence lacks clear reference to issues around market failure, which is clearly addressed in other (non-CCS) areas . Referring amongst other to this report:: https://www.thecrownestate.co.uk/media/501895/ei-balancing-the-carbon-cycle.pdf. One could therefore argue that carbon pricing are important but far from sufficient to drive large scale CCS projects. [Norway]	We recognize this, so we mention "one of key enablers". Details are discussing in the chap4.
42538	71	38			key ===> the key [Egypt]	fixed
51830	71	40	71	41	Needs a citation [Jason Donev, Canada]	This part was removed from the text.
6000	71	42			this section could go under a different heading [Sara Budinis, United Kingdom (of Great Britain and Northern Ireland)]	this part was removed form the text.
62290	71	42	71	43	This statement is speculation. There is no evidence provided to support this statement. Please delete or adequately expand and provide a quanitification of the limitation based on evidence in the literature. This is an area that is not covered by IAMs, so it may be misplaced in this chapter. [Edgar Hertwich, United States of America]	not applicable, since we cut this portion.
37022	71	44	71	44	Yes, there are thermodynamic limits, but the mitigation potential of energy efficiency is *nowhere* near its limit in terms of implimentation. I'm sure this is clearly documented in the end-use sector chapters of AR5. [Lynn Price, United States of America]	thank you for the information.
2478	71	45	71	46	Strike this sentence. It is not specific and is not based on specific findings within the report. [Jared Woollacott, United States of America]	not applicable, since we cut this portion.
28096	71	46	71	46	Possibly, the high potential of low temperature heat recovery could be explicitly underlined. On the other hand, technologies for heat recovery at high temperatures are widely state-of-the-art. [Germany]	Noted. However, the assessment can only draw upon the scientific evidence available, while the reviewer provides no references to such evidence.
42540	71	49			energy sources, ===> energy sources [Egypt]	fixed
45950	71	50	71	51	Please also see the following study as an additional reference: https://doi.org/10.1016/j.rser.2014.07.114 [Deger Saygin, Turkey]	thank you for the information.
18150	71	51	71	51	sustainable should be explained or deleted. "Sustainable" is not a scientific term and not defined in this report. It appears twice in the executive summary of the chapter, but only here in the text. Rather that using this vague term, the chapter should clarify the assumptions behind the use of bioenergy, in particular whether/how its impacts on terrestrial carbon are taken into account. If it is a synonym for biomass from waste/residue (mentioned elsewhere as desirable sources), then that is what is should say. [Andrea TILCHE, Belgium]	not applicable, since we cut this portion.
44874	71	51	71	51	CO2-->CO2 [Hiroaki Kondo, Japan]	noted
18152	71	54	72	6	This para can be merged with discussion done earlier on HFC [Andrea TILCHE, Belgium]	we cut down this because of page limit.
37024	71	54	72	6	See also: Shah, Nihar, Max Wei, Virginie E Letschert, and Amol A Phadke. Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning. Berkeley, CA: Lawrence Berkeley National Labortory, 2015. LBNL-1003671. http://eta-publications.lbl.gov/sites/default/files/lbnl-1003671.pdf [Lynn Price, United States of America]	thank you for the information - IPCC assessments are encouraged to base their assessment as much as possible on peer-reviewed literature with grey literature potentially complementing in some areas. Due to limits to the scope and page count of this chapter, the HFC discussion has been reduced in the FGD as it was assessed to be less central than the other aspects.
42776	71	54	72	6	Avoiding production and usage of HFCs will also avoid banks of the refrigerants that would be emitted at the end of life. Velders et al. (2014), Growth of climate change commitments from HFC banks and emissions, Atmos. Chem. & Phys. 14:4563–4572, doi:10.5194/acp-14-4563-2014 (“If, for example, HFC production were to be phased out in 2020 instead of 2050, not only could about 91–146GtCO2-eq of cumulative emission be avoided from 2020 to 2050, but an additional bank of about 39–64 GtCO2- eq could also be avoided in 2050. Choices of later phaseout dates lead to larger commitments to climate change unless growing banks of HFCs from millions of dispersed locations are collected and destroyed.”). [Kristin Campbell, United States of America]	thank you for the information. Due to limits to the scope and page count of this chapter, the HFC discussion has been reduced in the FGD as it was assessed to be less central than the other aspects.
43004	71	54	72	6	Estimates of warming from HFCs without the Kigali Amendment projected that HFCs could reach 4.0–5.3 GtCO2-eq per year in 2050. Velders et al (2015) Future atmospheric abundances and climate forcings from scenarios of global and regional hydrofluorocarbon (HFC) emissions. Avoiding production and usage of HFCs will also avoid banks of the refrigerants that would be emitted at the end of life. Velders et al. (2014), Growth of climate change commitments from HFC banks and emissions, Atmos. Chem. & Phys. 14:4563–4572, doi:10.5194/acp-14-4563-2014 (“If, for example, HFC production were to be phased out in 2020 instead of 2050, not only could about 91–146GtCO2-eq of cumulative emission be avoided from 2020 to 2050, but an additional bank of about 39–64 GtCO2- eq could also be avoided in 2050. Choices of later phaseout dates lead to larger commitments to climate change unless growing banks of HFCs from millions of dispersed locations are collected and destroyed.”). [Durwood Zaelke, United States of America]	Thank you for the information.
61772	72	1	73	43	I am wondering where emissions of CO2 from infrastructure development itself (e.g. use of cement / concrete and associated CO2 emissions not linked to energy itself) are addressed in the 1.5°C pathways (in relationship with e.g. Müller et al, Environ. Sci. Tec. 2013) (not building as end users of energy, but the expansion of e.g. city infrastructure due to urbanization etc). [Valérie Masson-Delmotte, France]	The energy and emissions from the construction is allocated to the industry (construction) sector. Of course, more systematic approach is necessary to understand better. Some attempts well be taken in AR6.
60164	72	2	72	4	There could be some statement about the level of control given the current state of ratification. For example, what do the "Kigali" emissions estimates in the future mean if there is not global ratification and compliance. [United States of America]	Policy issues are discussed later in this chapter.
60166	72	3	72	3	Replace "out" with "down" and insert "production and" just before the word "consumption", to read as "... which mandates the phase-down of the production and consumption of". This edit more accurately describes the goals set out in the Kigali Amendment to the Montreal Protocol. [United States of America]	we cut down this because of page limit.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
60168	72	4	72	6	Describe the assumptions underlying the 60% estimate, and define "pre-Kigali baseline" (i.e., as a cumulative emissions baseline from 2018-2050). It may not be clear to readers that this figure is a cumulative measure over a defined period, whereas the 1.5°C scenario projection for HFC emissions, referred to elsewhere in this chapter, is described only as 80% below 2010 levels in 2050 (a single year target). This potential issue might also be addressed by clarifying the estimated cumulative emissions under the IPCC 1.5°C projections over this same period. [United States of America]	we cut down this because of page limit.
42542	72	8			modelling ===> modeling [Egypt]	noted
42544	72	8			as well as sectoral studies ===> , as well as sectoral studies, [Egypt]	noted
60170	72	8	72	10	This result is common sense. If the studies suggested otherwise, they would be discredited. [United States of America]	we cut down this because of page limit.
42546	72	10			above listed ===> above-listed [Egypt]	noted
47256	72	17	74	9	Comment submitted by Afra Hamid (afra_hamid@yahoo.com) via the TSU: Add Use of performant household appliances and building insulation [Sarah Connors, France]	already discussed in the section.
37026	72	18	72	19	You might want to look back at AR5 when describing buildings energy and emissions, at least as a model of what to include in the description. See AR5 (WGIII) chapter 9: "Greenhouse gas (GHG) emissions from the building sector have more than doubled since 1970 to reach 9.18 GtCO2eq in 2010 (Figure 9.1), representing 25% of total emissions without the Agriculture, Forestry, and Land Use (AFOLU) sector; and 19% of all global 2010 GHG emissions (IEA, 2012a; JRC / PBL, 2013; see Annex II.8). Furthermore, they account for approximately one-third of black carbon emissions (GEA, 2012), and one-eighth to one-third of F-gas emissions, depending partially on the accounting convention used (UNEP, 2011a; EEA, 2013; US EPA, 2013; JRC / PBL, 2013; IEA, 2012a; see Annex II.8). Most of GHG emissions (6.02 Gt) are indirect CO2 emissions from electricity use in buildings, and these have shown dynamic growth in the studied period in contrast to direct emissions, which have roughly stagnated during these four decades (Figure 9.1). For instance, residential indirect emissions quintupled and commercial emissions quadrupled." [Lynn Price, United States of America]	Thank you for the information. Unfortunately we can't describe the details here because of the page limit.
37044	72	18	72	21	Can you explain why the share of final energy use is 31% but the share of global energy-related CO2 emisions is 23%? Is there a significant amount of biomass in the final energy use value? [Lynn Price, United States of America]	yes, biomass share is about 27%.
56468	72	18			Par 2.4.3.2 Why are consumers ignored, more or less? When consumers generate their own renewable power with a family sized lot of a wind farm, they have cheap power. And they can use that power for a heat pump, to replace fossil fuel heating. Because of the cheap power, costly building insulation is not required. A typical Dutch example A home needs 2000 m3 natural gas, for 1400 EUR per year, dutch commercial gas price + taxes That 2000 m3 gas is about 20.000 kWh of heat. A heat pump with COP 4 needs 5000 kWh of electrical power, to generate the heat That home could buy a lot of a wind farm to generate that 5000 kWh of power, at a purchase price of 2000 EUR, with power at cost price of 4 cents per kWh. The 5000 kWh of power costs only 200 EUR, and the writeoff cost of heatpump and lot of a windfarm are much more, but together less than the commercial natural gas, about 800 EUR per year This approach is a solution for energy poverty, and missing in most, if not all models, because these are business oriented by “nature” This approach works, because consumers are given the opportunity to buy themselves int a significant advantage. But it helps when fossil power prices rise, because all fossil power plants are made climate neutral mandatory [Henk Daalder, Netherlands]	noted
62292	72	18	72	21	Buildings are also major consumers of steel, cement, glass, and wood. These materials are responsible for a significant fraction of GHG emissions from industry. My own calculations show that on a global basis, materials in buildings are of comparable importance to the combustion of fossil fuels in buildings. Issues of efficient organization of space, light-weighting of buildings, and material substitution such as wood-based construction are not discussed here. See, e.g. DOI: 10.1021/acs.est.5b01735 [Edgar Hertwich, United States of America]	Since this is a topic for the industry sections, we only added to mention this briefly here.
13522	72	19	72	48	separate CO2emissions [Sergio Aquino, Canada]	noted
22624	72	19			Insert a space between "CO2emissions" [LUIS VALDES, Spain]	noted
39422	72	19	72	19	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
44250	72	19	72	49	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
22626	72	20			Insert a space between "CO2emissions" [LUIS VALDES, Spain]	noted
39424	72	21	72	21	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
22628	72	22			Please use IEA only [LUIS VALDES, Spain]	noted
42548	72	22			emissions, ===> emissions [Egypt]	noted
28098	72	24	72	24	The effects of population growth on energy consumption are relevant for all three sectors, not only for buildings. [Germany]	Yes, it is right. Economic and population growth are major driver of future energy consumption. Population growth affects more directly to the building sector.
37046	72	24	72	24	Growth is also driven by urbanization. [Lynn Price, United States of America]	noted
30842	72	28	72	29	Isn´t this - that sectoral studies show different trends than IAMs - very important? Could the authors use figure 2.25 to further explain the differences? Could it be further stressed overall in the report? [Érika Mata, Sweden]	Yes, it is important, since most of discussion in this report are based on the IAM model studies, and other source of information is needed.
22630	72	30		41	Insert a space between "CO2emissions" (lines 30,31, 37, 39 and 41) [LUIS VALDES, Spain]	noted
39426	72	30	72	30	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
1768	72	31	72	32	Is this the only explanation for the deviation between IAMs and sectoral studies? For example, in IAMs the whole economy is represented and thus any trade-offs between reduction of GHG emissions and economic development, or trade-offs between productive sectors, are taken into account (while this is not always the case in sectoral studies). [Greece]	noted

Comment No	From Page	From Line	To Page	To Line	Comment	Response
30846	72	31	72	32	The statement seems oversimplified. What does "fully represented" mean to start with? FULLY? An spontaneus first development of this sentence could be to distinguish between Granularity (sectorial models have more options and therefore more smaller decisions are taken, whereas IAMs implement - or not - a big option with a big impact) and Logics of the decision making (sectorial models tend to be more techno-economic which results in optimal investments that do not correspond to reality). [Érika Mata, Sweden]	Fully means more options than IAM covers, so we changed to widely. Details can not discussed here because of page limit.
55544	72	31	72	31	Some global and well integrated studies are also available. Labriet et al. (2015) assess the impacts of heating and cooling on GHG mitigation at global level, as well as the feedback with the climate system, using an integrated assessment model, TIAM-WORLD, coupled with a climate model, PLASIM-ENTS. The key results are as follows. At the global level, the climate feedback induced by adaptation of the energy system to heating and cooling is found to be insignificant, partly because heating and cooling-induced changes compensate and partly because they represent a limited share of total final energy consumption. However, significant changes are observed at regional levels, more particularly in terms of additional power capacity required to satisfy additional cooling services, resulting in increases in electricity prices. Labriet M., S.R. Joshi, F. Babonneau, N.R. Edwards, P.B. Holden, A. Kanudia, R. Loulou, M. Vielle. 2015. Worldwide impacts of climate change on energy for heating and cooling. Mitigation and Adaptation Strategies for Global Change, 20(7):1111-1136 10.1007/s11027-013-9522-7 [Maryse Labriet, Spain]	Thank you for the interesting information.
39428	72	32	72	32	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
62116	72	32	72	32	higher energy consumption reduction is misleading, maybe replace by "additional energy consumption reductions" [Antoine Bonduelle, France]	see Fig.2.25
57896	72	34	72	35	Lines 34-35 indicate that "The emission reductions are driven by a clear tempering of energy demand and a strong electrification of the buildings sector." This statement requires additional clarification to better represent the best available guidance in the literature. Electrification of the building sector is not an aim in itself since buildings have both high grade (high exergy) and low grade (low exergy) energy demands. The appropriate energy resources need to be provided at the right grade and quality to maximize energy savings and CO2 emissions with the use of renewable electricity and thermal energy whenever possible. Guidance in the literature indicates that electricity should be allocated to high grade (high exergy) demands in the energy system, such as electricity for industry and electricity for lighting and electrical appliance in buildings. In contrast, low grade (low exergy) demands, such as space heating and cooling, should be satisfied with similarly matching low grade (low exergy) energy resources, including low temperature renewable energy sources and residual heat. Related guidance is provided based on three International Energy Agency Annexes, namely Annex 37 (Low Exergy for Heating and Cooling of Buildings), Annex 49 (Low Exergy Systems for High Performance Buildings and Communities) and Annex 64 (Optimised Performance of Energy Supply Systems with Exergy Principles). As an example, the final summary report of Annex 49 with an emphasis in this respect is available at <https://www.annex49.info/download/summary_report.pdf>. An overview of Annex 64 at the community level is available at <https://www.annex64.org/objectives.php> including an emphasis on matching energy grade levels. [Siir KILKIS, Turkey]	Thank you for the useful information, but the space is limited.
39430	72	37	72	37	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
42550	72	37			carbon intensive ===> carbon-intensive [Egypt]	fixed
18154	72	38	72	39	It is unclear what is meant by "indirect CO2 emissions". Does it include land use emissions (for the bioenergy part), or are those internalised (as "direct" emission)? [Andrea TILCHE, Belgium]	Emission from power generation. Made clear.
39432	72	39	72	39	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
39434	72	41	72	41	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
48644	72	41	72	42	Authors refer only to air conditioning as an end use in buildings which leads to HFC emissions. Actually, heat supplied by heat pumps also contribute to HFC emissions and the projected electricitifcation of the building sector means electrification of heating. Thus, more HFC emissions in the future [Yamina Saheb, France]	Heat pump is also a part of the air-conditioning.
43006	72	41	72	45	Suggest rephrasing to avoid ambiguity along the lines of: “In addition to CO2 emissions associated with electricity generation, air conditioning in buildings also contribute to warming through direct emissions associated with f-gases used as refrigerants (i.e., HCFCs and HFCs). Improving air conditioner energy efficiency and switching to low-GWP refrigerants as required by the Kigali Amendment to the Montreal Protocol could avoid up to 100 Gt CO2-eq cumulatively through 2050 (Shah et al., 2015; Purohit and Höglund-Isaksson, 2017). See Shah et al. (2015), Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning. Berkeley, CA, USA. (“While there is some uncertainty associated with emissions and growth projections, moving to efficient room air conditioning (~30% more efficient than current technology) in parallel with low-GWP refrigerants in room air conditioning could avoid up to ~25 billion tonnes of CO2 in 2030, ~33billion in 2040, and ~40 billion in 2050, i.e. cumulative savings up to 98 billion tonnes of CO2 by 2050. [Durwood Zaelke, United States of America]	noted
60172	72	41	72	45	Replace the full three sentences contained in these lines to read as follows: "Besides CO2emissions, increasing global demand for air conditioning in buildings may also lead to increased emissions of HFCs in this sector over the next few decades. Although these gases are currently a relatively small proportion of annual GHG emissions, their use in the air conditioning sector is expected to grow rapidly over the next few decades if alternatives are not adopted. However, their projected future impact can be significantly mitigated through better servicing and maintenance of equipment and switching of cooling gases (Purohit and Hoglund-Isaksson, 2017; Shah et al., 2015)." Rationale: The suggested edits clarify more precisely how the growth of the air conditioning sector globally may lead to increased emissions of HFCs, and how those emissions may be mitigated. The current version contains a number of ideas that do not precisely link the role of the air conditioning sector with HFC emissions and their mitigation potential as separate from CO2 emissions. [United States of America]	done
22632	72	47			Please use IEA only [LUIS VALDES, Spain]	noted
30836	72	47	73	23	It is not clear how this part links to the 1.5C scenarios previously presented. What does it say on how the system transformation for 1.5C specifically? The three paragraphs are based on 2 references for which only evident conclusions are given, and globally. I [Érika Mata, Sweden]	Since the IAM database does not provide the detailed information for the end-use sectors, so IEA studies are cited to describe the details.
39436	72	48	72	48	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
45952	72	49	72	49	Is this only space heating or also including domestic hot water? [Deger Saygin, Turkey]	only space heating as an example.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
60174	72	49	72	49	Why is this finding not surprising? [United States of America]	fixed
42552	72	53			high performance ===> high-performance [Egypt]	fixed
42554	72	53			appliances and water ===> appliances, and water [Egypt]	fixed
42556	72	54			long term ===> long-term [Egypt]	fixed
22634	73	1			Insert a space between "CO2emissions" (2 times in this line) [LUIS VALDES, Spain]	noted
39438	73	1	73	1	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
42558	73	1			CO2emissions ===> CO2 emissions [Egypt]	noted
44252	73	1	73	13	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
54552	73	5	73	14	Similar text is also in Section 4.3, hence it cande deleted from Ch.2 if page budget is exhausted [Paolo BERTOLDI, Italy]	Thanks.
58454	73	5	73	10	Suggest adding "As example, in the WEO FTS scenario, the entire existing building stock in the buildings sector, would need to be retrofitted by the middle of this century." (WEO-2017) [Andrew Prag, France]	Thank you for the useful information, but it is for 2DS, not for 1.5DS.
62118	73	12	73	12	maybe skip "condensing boilers", a technology already mainstreamed in many countries, and that cannot be sustained beyond the next decades to be part of a zero emission system (with maybe exception for wood pellet stoves for example) [Antoine Bonduelle, France]	deleted
22636	73	13		23	Please use IEA only (just as in line 19 in this page) [LUIS VALDES, Spain]	noted
39440	73	13	73	13	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
42562	73	13			CO2emissions ===> CO2 emissions [Egypt]	noted
42560	73	16			behaviour ===> behavior [Egypt]	noted
53864	73	16	73	23	There is a broad and nuanced social science literature on occupant behaviour, consumer choices and how that affects the actual mitigation (decreased energy use) in buildings. See: Castán Broto, V. (2015). Contradiction, intervention, and urban low carbon transitions. Environment and Planning D: Society and Space. http://doi.org/10.1177/0263775815594297. For a recent review, see Grandin, J., Haarstad, H., Kjærås, K., & Bouzarovski, S. (2018). The politics of rapid urban transformation. Current Opinion in Environmental Sustainability, 31, 16–22. http://doi.org/10.1016/j.cosust.2017.12.002 [Grandin Jakob, Norway]	thank you for the useful information.
42564	73	18			behaviour ===> behavior [Egypt]	noted
838	73	20	73	20	to assists the various' should be 'to assist the various' [Robert Shapiro, United States of America]	fixed
42566	73	22			behavioural ===> behavioral [Egypt]	noted
190	74		74	2	The unit of ordinate in Figure 2.25(c) is error. [Mingshah Su, China]	fixed
30956	74	1	74	7	why does Figure 2.25 not have any mention of below 1.5 degree 50% scenarios? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	The number of scenarios is very small, so we can not get reliable data form them.
44254	74	1	74	4	All sections of Figure 2.25 are labelled a to f. If f does not include electricity and biomass then g is missing. The same comment in on Figure 2.26 [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	biomass is part of g
30838	74	2	74	2	Figure 2.25 has changed much from FODs Fig 2.16, and is now more linked to the SR narrative. Still there are many abbreviations in the caption and no information to actually understand which sectoral studies and how these can be compared to IAM (unless the sectoral studies are global as well?). Still I´d like to have regional figures instead of global, but I assume the details will be addressed in AR6. [Érika Mata, Sweden]	These are explained in the top of this section. We will add more information in the caption.
3288	74	10	77	17	One of key options for transport is to make 100% electricity use, there is lack of discussion about assumption on hydrogen airplane, and other transport mode, how they are assumed in the model? [Xiu Yang, China]	It is one of possible options, but biofuel is more impact on the decarbonization of aviation.
14044	74	10	77	17	Not clear what assumptions were made in the various scenarios for the carbon emissions during generation of electricity, production of biofuels or manufacture of hydrogen. Obviously this varies from grid to grid and plant to plant, but some indication of ranges could be presented. An EV using coal-fired power gives little GHG reduction, if any, over a petroleum fuelled vehicle so the carbon intensities used should be referenced. HDVs are mentioned but there is little mention of E-bikes and buses (both growing rapidly). It states aviation and shipping need "highly ambitious" energy efficiency measures, although good progress in fuel efficiency has been made in recent 2-3 decades. So it would be good to show the trends in emissions per person km or per tonne km over this period and to reference section 4.3.2.4 that states there is good potential for efficiency. Table 8.3 in AR5 Chapter 8 could be a start if updated. [Ralph Sims, New Zealand]	Our major discussion here is for 1.5DS. As discussed in energy supply section, electricity is almost zero-emission in 2050, and hydrogen processed in the low carbon emission.
15768	74	10			What about the uptake of energy efficient vehicles? The transition to fuel-efficient and zero-emission vehicles will have to face technological and economic uncertainties that need to be taken into account in order to avoid unexpected effects, including rebound effects and social inequalities. [Australia]	Efficiency improvement is the most important and promising measure, but for 1.5DS, more advanced technologies are needed.
54810	74	10	74	10	The section 2.4.3.3 needs to make clear, at some point, that ambitious transport electrification rates need to go in pair with ambitious electricity supply decarbonisation, in order to effectively deliver 1.5DS/B2DS -type decarbonisation rates. [Marine Gorner, France]	we will add
22638	74	12			Insert a space between "CO2emissions" [LUIS VALDES, Spain]	noted
39442	74	12	74	12	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
44256	74	12	74	12	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
22640	74	14			Please use IEA only [LUIS VALDES, Spain]	noted
54792	74	15	74	15	major challenges for deep decarbonisation: can this be rephrased into "deep changes to be undertaken" or some other formulation that is not pessimistic to the reader? [Marine Gorner, France]	It is the intention here.
60176	74	15	74	15	This statement needs caveating. It is based on history and not the technology and social preference changes currently taking place in transport – including the shift to hybrid and electtric vehicles, driverless cars, increases in fuel efficiency, and the move to pay-as-go use of cars vs. ownership. These factors all point to significant short- and medium-term opportunities that could deeply decarbonize transportation, even if there is no direct incentive to do so. [United States of America]	In terms of pace of change and impact, recent trend is not enough to decarbonize significantly in the future. Of course, recent trend is very promising.
60178	75	2	75	9	This paragraph needs editing. It is based on history and not the technology and social preference changes currently taking place in transport – including the shift to hybrid and electtric vehicles, driverless cars, increases in fuel efficiency, and the move to pay-as-go use of cars vs. ownership. These factors all point to significant short- and medium-term opportunities that could deeply decarbonize transportation, even if there is no direct incentive to do so. [United States of America]	In terms of pace of change and impact, recent trend is not enough to decarbonize significantly in the future. Of course, recent trend is very promising.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
57786	75	6	75	9	At the end of the phrase: "Developing a better understanding of this sector's role in meeting these targets is critical, given that over the past half century the sector has witnessed faster emissions growth than any other (reaching 6.7 Gt-CO2yr–1 in 2010 – direct emissions; approximately 23% of total energy-related CO2 emissions (Clarke et al., 2014)." I suggest to add: "According to the study of Hydrogen Council "Hydrogen, Scaling up" Hydrogen-powered Fuel Cell Vehicles could complement Battery EVs to achieve a deep decarbonization of transport sector. The potential for hydrogen is to power about 10 to 15 million cars and 500,000 trucks by 2030 and more than 400 million cars, 15 to 20 million trucks, and around 5 million buses in 2050 with results of 20 million barrels of oil replaced per day and 3.2 Gt CO2 abated per year (Hydrogen Council, 2017)." - NEW REFERENCE: Hydrogen Council "Hydrogen scaling up - A sustainable pathway for the global energy transition" (2017), <http://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-Scaling-up_Hydrogen-Council_2017.compressed.pdf >. [Mario Valentino Romeri, Italy]	thank you for the useful information.
44258	75	8	75	8	states "other (reaching 6.7" needs close bracket or needs to be removed [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	fixed
13524	75	9	75	9	separate CO2emissions [Sergio Aquino, Canada]	noted
22642	75	9		24	Insert a space between "CO2emissions" (lines 9,12 (twice) and 24) [LUIS VALDES, Spain]	noted
39444	75	9	75	9	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
44260	75	9	75	47	needs space between "Co2 emmissions" found 9 in this section [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
54794	75	9	75	9	CO2emissions --> "CO2 emissions", with a space. This occurs in several places in 2.4.3.3. [Marine Gorner, France]	noted
9702	75	11	75	25	IEA-ETP projections need to be taken with additional considerations for: 1-IEA-ETP is onlly one modeling study, so it does not summarize wide views on technologies or other parameters compared to results obtained from a number of models as the case of IAM. 2-Although the ETP has a rich technology represenations, bottom-up modeling may not capture important interdependencies across the different components of the economy. 3-Bottom-up modeling may overestimate technology penetration and impacts for missing both price elasticities and rebound effects. [Mustafa BABIKER, Sudan]	Thank you for the comments. We are using sectoral studies including IEA-ETP as the source of supplemental information for IAM studies.
55494	75	11	75	16	I would emphasize the agreement on the deep cuts of emissions (39% and 55%) at the start of this paragrah, and get only afte rthat to the discussion on the differences between the two approaches. [Pierpaolo Cazzola, France]	changed
39446	75	12	75	12	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
42568	75	12			CO2emissions ===> CO2 emissions [Egypt]	noted
42570	75	12			and ===> , and [Egypt]	fixed
62120	75	13	75	17	The word conservative lines 13 and 17 in the context of the review can mean "with more certainty" when the text means differently, with sectoral projections more precise and embedded in real technology evolutions and thus more precise. Maybe replace by "pessimistic"? It is also linked to more recent evolutions of techniques in sectoral studies. [Antoine Bonduelle, France]	changed
42572	75	14			significant ===> A significant [Egypt]	noted
54796	75	15	75	16	39% vs 55%: is it right to call this "significant difference"? The underlying message is the same: significant action needs to be undertaken. Passing the message that these studies are contradictory or "significantly different" undermines the message to the reader that rapid and ambitious action in reducing CO2 emissions is a priority. [Marine Gorner, France]	Agree, changed
54798	75	19	75	19	both projections: what does "both" refer to? Clarify [Marine Gorner, France]	done
58044	75	19	75	19	The phrase "found that both projections are in good agreement each other" may read "both projections were found to be in good agreement with each other" with an alternative phrasing and insertion of the word "with." [Siir KILKIS, Turkey]	fixed
58046	75	19	75	30	The phrase "avoid (reduction of mobility demand) and shift (shifting to more efficient modes)" takes place in exactly the same way in the above lines 23-24 (same page 75) so that the repetition may be addressed. [Siir KILKIS, Turkey]	fixed
42574	75	21			behavioural ===> behavioral [Egypt]	noted
55496	75	21	75	21	I recommend to use "structural changes" instead of "behavioural changes". Structural changes can be induced by planning measures, the reorientation of investments from road building towards high capacity public transport infrastructure and other compact city policies - including taxation on land use that favours higher density, for example. The behavioural aspect matters, but this is not just about behaviour. It is more about policy drivers capable to induce changes that favour conditions that are more favourable to behavioural choices having a closer match with energy efficiency (for example: people in densier cities travel lower distances that people in sprawled cities. If policies induce higher densities, there is a chance in behaviour, but this is primarily induced by the change instructure, rather than by a modification of the choices that ndividual make without a chance in the cntext where they live). [Pierpaolo Cazzola, France]	done
54800	75	22	75	22	The former contributes to the reduction… [Marine Gorner, France]	noted
54802	75	22	75	22	This sentence is not completely true: electrification also contributes to energy consumption reduction, as electric vehicles are more energy efficient than internal combustion engine vehicles. All in all, technology and behavioural changes contribute at the same time to energy consumption reduction and CO2 emissions reduction. [Marine Gorner, France]	EV is very efficient, but if we include the loss during power generation, it is not necessarily energy -efficient.
42576	75	23			avoid ===> avoiding [Egypt]	noted
39448	75	24	75	24	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
22644	75	25			Please use IEA only [LUIS VALDES, Spain]	noted
55498	75	28	75	30	I think that grouping "avoid" (reduction of mobility demand) and "shift" (shifting to more efficient modes) under the category of "behavioural measures" is strictive. I would suggest "Also important are structural changes in transport activity such as [...]" instead of "Also important are behavioural measures such as [...]". [Pierpaolo Cazzola, France]	done
42578	75	29			behavioural ===> behavioral [Egypt]	noted
18156	75	32	75	32	Agree with result. It is also corraborated with country studies e.g., Dhar & Shukla, 2015 find that CO2 reductions due to demand side interventions within passenger and freight side in India can result in 21% reduction from a business as usual scenario between 2010 and 2050. Reference : Dhar, S., & Shukla, P. R. 2015. Low carbon scenarios for transport in India: Co-benefits analysis. Energy Policy, 81(June 2015): 186-198. [Andrea TILCHE, Belgium]	Thanks.
22646	75	32			In this sentence, the citation should be written as "Yeh et al. (2016)" instead of "(Yeh et al., 2016)" [LUIS VALDES, Spain]	noted
42580	75	33			behavioural ===> behavioral [Egypt]	noted

Comment No	From Page	From Line	To Page	To Line	Comment	Response
55500	75	33	75	33	I would recommend to talk about "structural changes in transport activity and modal choice" than "behavioural solutions". [Pierpaolo Cazzola, France]	done
22648	75	35			I think that the list in brackets reads better if the elements are listed in the following order: "cars, buses, trucks, trains and airplanes" [LUIS VALDES, Spain]	no, sift from cars, trucks and airplanes to buses and trains
3238	75	36	75	37	It is unclear what "telecommuting" is. It would be helpful if It was explained how these action can lead to a reduction in emissions. [Vassilis Daioglou, Netherlands]	deleted
42582	75	37			tele-commuting ===> telecommuting [Egypt]	fixed
55502	75	38	75	39	I would again recommend to talk about "structural changes in transport activity and modal choice" rather than "behavioural-related mitigation options". [Pierpaolo Cazzola, France]	done
42584	75	39	75	40	behavioural- related ===> behavioral-related [Egypt]	noted
13526	75	43	75	43	separate CO2emissions [Sergio Aquino, Canada]	noted
14042	75	43	75	55	This level of detail better in a small Table - very hard to follow as presented with strings of numbers. [Ralph Sims, New Zealand]	made table
22650	75	43		47	Insert a space between "CO2emission" (lines 43, 44 and 47) [LUIS VALDES, Spain]	noted
39450	75	43	75	43	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
62122	75	43	76	4	This paragraph includes too complicated sentences and even completely obscure text such as in line 45. Maybe a table would help or even some synthetic conclusions without figures so as to be understandable (or maybe your reader is R2D2?) [Antoine Bonduelle, France]	made table containing all related data, and removed numbers in the text.
39452	75	44	75	44	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
42586	75	46			aviation and shipping ===> aviation, and shipping [Egypt]	noted
39454	75	47	72	47	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
35506	75	50	75	53	Given current trends in battery storage technology and current state of play, it is hard to believe that biofuels will contribute more than double of electricity in transport by 2050. [Ashok Sreenivas, India]	Since electrification is limited to road transport, especially LDV. But biofuels are expected to use more widely in the transport sector, especially for the difficult-decarbonize transport mode. Another important point is carbon intensity of electricity and biofuels in 2050. IEA projects that biofuels have a lower carbon intensity than electricity.
44262	75	51	75	51	CO2, 2 should be subscript [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
47812	75	51	75	51	Please use CO2 [Sarah Connors, France]	noted
18158	75	53	75	53	For biofuels, it should be clarified how they are taken into account in terms of emissions (or emission reductions). Even when their combustion and land use emissions are ignored, their life cycle emissions are considerable compared to the fossil fuels they replace. Taking into account thein impact on biogenic carbon (combustion emissions or the carbon impacts of using land, such as foregone land benefits), their CO2 reduction potential is further reduced or even eliminated. This study (https://ec.europa.eu/energy/sites/ener/files/documents/Final%20Report_GLOBIOM_publication.pdf) found that "If total LUC emissions would be amortised over 50 years instead of 20 years, annual emissions would amount to 79 gCO2e/MJ in the EU 2020 biofuel mix scenario." See also: Searchinger at al., 2015: Do biofuel policies seek to cut emissions by cutting food? Science 27 Mar 2015: Vol. 347, Issue 6229, pp. 1420-1422. DOI: 10.1126/science.1261221 [Andrea TILCHE, Belgium]	Yes, it is true. But most of the biofuels in the model are assumed to be produced in the more sustainable pass, which minimizes the LUC emissions and competition with food.
45954	75	55	75	55	It is not entirely clear what is meant with allocation of biomass? Do you perhaps mean that the biomass use is prioritised for transport modes where no or limited electricity technologies exist? [Deger Saygin, Turkey]	no, it means allocation into each mode of transport, as described in the text.
54804	76	1	76	1	24EJ: this stems from a cap on the amount of biofuels that can be produced in a "sustainable manner". It is important to state it, as this is the main driver behind this number. [Marine Gorner, France]	done
42588	76	2			that is to say ===> that is to say, [Egypt]	fixed
51832	76	2	76	2	Define LDV. [Jason Donev, Canada]	defined above
42590	76	10			logistics and routing ===> logistics, and routing [Egypt]	noted
8254	76	11	76	13	The limited potential for decarbonisation of the shipping and aviation sectors is not only a sign of the need for efficiency improvements and low-carbon fuels, but also of the need to spur behavioural changes and modal shifts, including through carbon pricing measures. [Kelsey Perlman, France]	noted
28100	76	11	76	11	Rather the opposite could be true if disruptive new power technologies replace traditional engines in the shipping and aviation subsectors. In this regard, long-term technological predictions are very difficult. Consider adding a sentence "...unless disruptive new power technologies replace traditional engines in the shipping and aviation subsectors" [Germany]	Same things can be applied for everything. We can estimate the future evolution only based on the current information.
54806	76	11	76	11	limited potential to decarbonise: change into "are more challenging to decarbonise". (These modes will have to decarbonise quite deeply too, regardless of the easiness to achieve this decarbonisation; therefore it is contradictory to say that their decarbonisation potential is limited). (Decarbonisation there will be delivered through biofuels, energy efficiency measures, mode shift...) [Marine Gorner, France]	done
42592	76	14			long term ===> long-term [Egypt]	noted
22652	76	15			Please use IEA only [LUIS VALDES, Spain]	noted
3348	76	16	76	16	Shipping may be moving from oil to NG [Kamel Bennaceur, United Arab Emirates]	noted
22654	76	22			Insert a space between "CO2emissions" [LUIS VALDES, Spain]	noted
39456	76	22	76	22	Between CO2emission there must be a free space: CO2 emission [Olga Alcaraz, Spain]	noted
44264	76	22	76	22	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
54808	76	23	76	28	This difference: this is unclear. Which difference? Don't both ETP and IAM demonstrate the necessity for energy efficiency and avoid+shift and biofuels + electrification? [Marine Gorner, France]	clarified
42594	76	24			and higher ===> and the higher [Egypt]	fixed
60180	76	27	76	28	Yes, but R&D and start-up costs have been largely incurred. Costs are dropping fast and consumer acceptance is rising quickly. In this area, the past is not a good measure of the future. [United States of America]	Yes, you are right, but it is also true that the history was a good indicator of the future in many cases.
191	77		77	2	The unit of ordinate in Figure 2.26(c) is error. [Mingshah Su, China]	fixed

Comment No	From Page	From Line	To Page	To Line	Comment	Response
30958	77	1	77	7	why does Figure 2.26 not have any mention of below 1.5 degree 50% scenarios? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	as stated in the top of this section, the number of the scenarios are so small to extract the meaningful data to compare among each category.
44266	77	2	77	3	needs space between "Co2 emmissions" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	noted
53866	77	9	77	17	The whole of ch. 2.4.3.3 is very dominated by technological "solutions". I suggest that you expand the section on mode-shifting and travel demand management. In cities, urban structure and the everyday social practices interplay with transport options are key to understand the potential for changed travel behaviour and mode shifting. Suggested references: Grandin, J., Haarstad, H., Kjærås, K., & Bouzarovski, S. (2018). The politics of rapid urban transformation. Current Opinion in Environmental Sustainability, 31, 16–22. http://doi.org/10.1016/j.cosust.2017.12.002; Shove, E., Watson, M., & Spurling, N. (2015). Conceptualizing connections: Energy demand, infrastructures and social practices. European Journal of Social Theory, 18(3), 274–287. http://doi.org/10.1177/1368431015579964; Cass, N., & Faulconbridge, J. (2016). Commuting practices: New insights into modal shift from theories of social practice. Transport Policy, 45(C), 1–14. http://doi.org/10.1016/j.tranpol.2015.08.002; [Grandin Jakob, Norway]	I agree with the importance of these aspects. Since the space is limited, we focus on the discussion more specific to 1.5DS.
54812	77	9	77	9	well below 2°C : if this refers to the ETP-B2DS, rephrase into "beyond 2 Degree", which is the official scenario title for the B2DS. [Marine Gorner, France]	here it is used as a more general meaning, related with the Paris agreement.
42596	77	14			on demand ===> on-demand [Egypt]	noted
54814	77	15	77	17	Generally do not include…: is this verified? This is not the case for ETP transport scenarios, at least. [Marine Gorner, France]	most of IAM scenario do not include these.
42598	77	17			travellers ===> travelers [Egypt]	noted
42600	77	17			behaviour ===> behavior [Egypt]	noted
18168	78		83	10	These insights are similar to those identified on page 59. Consider merging into a single section? Also, 79-80 should give some indication of total land use requirements per type (not just rate of annual conversion). [Andrea TILCHE, Belgium]	Taken into account - the land-use evolutions included in Section 2.3.3.2 of the SOD have been merged with section on AFOLU. The insights from section 2.3.4.2 have not been merged with this section, but a clear description of what section SOD section 2.4.4. covers is included to guide the reader. The FGD reports land use change, but also reports the land use in the 2010 base year, so total land use requirements become evident. Including both is not possible due to space constraints.
45582	78				Agro-forestry should play a major role in the section '2.4.4. Land-use transitions and changes in the agricultural sector'. At the moment it is even not mentioned in this section, but should play an essential role to reconcile both land uses, as it is a great alternative to sustainable food production in rural, urban and peri-urban contexts. [Adela M Sánchez-Moreiras, Spain]	Rejected - Section 2.4.4. is focusing on existing scenarios which do not contain agroforestry. However, agroforestry is included in SOD Table 2.8 where options not considered in IAMs are listed. This table has been updated and is now included in the technical annex to this chapter.
2086	78	1	78	55	views CDR uses as generally competitive, doesn't properly consider literature on no-till, soil carbon restoration, cover crops, etc. - which can be combined with other methods [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - This section discusses the land implications of the literature of 1.5°C-consistent mitigation pathways. The implications of individual measures is outside the scope of the Special Report and would be covered in either AR6 or the Special Report on Climate Change and Land.
7676	78	1	83	10	Clarifing waht are the terms used when defining the land uses will be desirable. For example, natural forest and managed forest, other natural land, etc.. [Maria Jose Sanz Sanchez, Spain]	Accepted - an overview of their definition and use in the IAM pathways literature has been included in the technical annex
15770	78	1			Impacts on crop yields would be useful to be explored further in this susection, as this is of major importance into the future and needs to be assessed at a country by country (i.e. spatial) level. [Australia]	Rejected - While the future evolution of crop yields is indeed important, its assessment falls outside the scope of the Special Report, in particular given the Special Report on Climate Change and Land that is also being prepared. To provide some indication of the underlying assumptions in scenarios, some examples of yield increases are provided.
18160	78	1			2.4.4 Section and relevant parts of the whole chapter: It would be helpful (more transparent and more correct) if the land use sector better distinguished between terrestial carbon (LULUCF) and non-CO2 emissions. The report tends to lump them under "AFOLU", which may be reasonable for brevity, but often confusing or even incorrect. [Andrea TILCHE, Belgium]	Taken into account - Sectorial AFOLU emissions are discussed in Section 2.3 (CO2) as well as Section 2.4.4 (non-CO2 emissions). This ensures that they are not lumped together.
52818	78	1	83	10	Consider explaining how the scenarios for land use transition compare to the scenarios considered by IPBES [Iulain Florin VLADU, Germany]	Rejected - a detailed comparison of these two sets of scenarios falls outside the scope of this report focussed on 1.5°C and should be done in the SRCCL.
56470	78	1			Land use may be less critical and have multiple benefits for climate refugees heading for Europe and european countries, when a 100 km area of Northern Africa coastal land is used for new agricultural activity to grow and harvest new biomass and do aforestation, with energy from sun and wind, fresh water from the mediterranian sea water for people and to bring new prosperity for many inhabitants on land not used there, and produce bio based fuel for Europe [Henk Daalder, Netherlands]	Noted - This is not a suggestion but rather a general comment.
33504	78	3	78	21	this paragraph should recognise there are also potential impacts on ecosystems and biodiversity [Stephen Cornelius, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The second paragraph of Section 2.4.4. now cross-references the many other sections in this report that discuss implications of land-related mitigation.
29502	78	4	78	4	Suggested addition here or elsewhere in the text (bold red): Given the difference in estimating the "anthropogenic" sink between countries and the global carbon modelling community (Grassi et al. 2017), the land-related emission estimates included here are not necessarily directly comparable with countries' estimates at global level . [Giacomo GRASSI, Italy]	Taken into account - This point has been made when reporting land-use CO2 emissions in Section 2.3.3
47068	78	5	78	5	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted. The statement has been amended, but uses the chemical symbols: "atmospheric N and Fe deposition"
60182	78	7	78	7	Biomass will likely also be increasingly important as a building material that both stores carbon and displaces higher-emissions materials. [United States of America]	Noted. However, without a clear reference to a study that shows this it is difficult to make this point explicitly.
63216	78	10	78	11	Add: "A multitude of options are available to achieve this (Popp et al., 2017; Smith and Bustamante, 2014) 11 (see Table 2.8 and Chapter 4, Section 4.3). On the other hand, greater use of marine biomass (see additions below for chapter 4) and of abiotic CDR (e.g. DAC) can help aleviate such land use pressures." [Greg Rau, United States of America]	Rejected - The addition suggested by the reviewer was not supported by a scientific publication.
840	78	11	78	11	Table 2.8' should be 'Figure 2.8' [Robert Shapiro, United States of America]	Rejected. It truly is a table, now moved to the Annex.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
37392	78	11	85	2	In my view it is highly problematic to base such an assessment primarily on one group of models, i.e. Integrated Assessment Models. These models are hugely valuable, but they also have important drawbacks. In theory, they are transparent, but in practice they are not, and they are often based on datasets that are in themselves problematic, e.g. the pasture area datasets from FAO which are well-known to be very unreliable due to lacking standardization across countries and ambiguous definitions (see, e.g. Erb et al., 2007, J Land Use Sci, vol 2, p191ff). I therefore think that other models (e.g. Earth System Models) as well as more strongly data-based approaches (e.g. using diagnostic, data-based models such as the Biomass Balance Model (Erb et al., 2016, Nature Communications) should also be used to achieve a more comprehensive assessment. I appreciate that some caveats are addressed in this text, but I think there are important other caveats as well that could also very much reduce their climate benefits. It should therefore be explicitly discussed if, and if so to what extent, these modell address some key issues: The most important of those are related to the correct and comprehensive representation of the global C balance, in particular with reference to stocks and flows of C in biota and soils. In this context it is crucial to explicitly discuss whether, and if not entirely, to what extent these models ascertain that double counting of C is avoided (e.g., the same C is assumed to be sequestered in biota and soils, used as bioenergy and/or for the production of biochar). Doing so requires an explicit C balance module cross-checking all potentially competing uses of land and biomass for potential double-counting errors (see e.g. Searchinger 2010, Env Res Lett, Haberl et al., 2012, Energy Policy). It is also crucial to check whether all relevant processes were included. It was recently shown, for example, that land-cover change is responsible for only about one half of the global C losses from vegetation, while land management activities that do not alter the land cover are responsible for another half, in particular forest management and land use taking place in other ecosystems such as savannas and grazing land (Erb et al., 2018, 10.1038/nature25138), mainly because these land management practices accelerate the C cycle (Erb et al., 2016, Nature GeoScience). This is highly relevant for judging the full C implications of land-use/land-management changes associated with realizing large bioenergy/biomass-production potentials, which need to be mobilized if substantial amounts of CO2 should be taken from the atmosphere using BECCS. To the extent that upfront C costs of sourcing this biomass are not adequantely represented, the net amount of CO2 taken from the atmosphere will be overestimated. To the best of my knowledge, most, if not all IAMs consider C-effects of land-cover change (deforestation, conversion of land to forests) but few, if any, do not represent other C effects related to changes in land management within a land-cover class. As more than half of all biomass harvested for human purposes is used to feed livestock (Krausmann et al., 2018, Ecol Econ), repercussions resulting from converting pasture/grazing lands to energy crop plantations and intensification required to feed the animals on smaller remaining grassland areas must be explicitly checked not only for their feasibility (e.g. Erb et al., 2016, Nat. Comm.) but also for their full GHG implications. An issue of similar, if not larger magnitude is to be expected when a relevant proportion of the additional biomass needed for BECCS is foreseen to be sourced from forests by raising wood harvests there. A meanwhile large and robust literature clearly shows that this requires raising the intensity of forest management (e.g. shorter regrowth periods) which reduces the amount of C stored in the forest ecosystems compared to a baseline with less intensive use of forests. See e.g. Schulze, 2012. GCB Bioenergy 4, 611–616, Naudts et al. 2016. Science 351, 597–600; various papers by Holtsmark (2012, Climatic Change, several later papers in GCB Bioenergy and others), Pingoud, et al. 2018. J Environmental Management 210, 96–103. Kurz et al. 2016. Unasylva 67, 61 and many other papers. Moreover, I think the issue of other GHG emissions related with producing so much biomass (e.g. N2O, CH4 and upstream CO2 emissions (including fertilizer production, increased use of ag. machinery, etc.) not only for energy crops, but also for the intensification of food crops required to make sufficiently large areas available to grow the energy crops. These emissions could potentially be hugely relevant, and in my view there is a need to comprehensively assess to what extent the IAM literature cited here can robustly account for all these crucial factors - otherwise the potentials to reduce atmospheric CO2 respectively climate forcing through BECCS will be greatly overestimated. All uncertainties related to these issues must in my view be discussed in a transparent manner if the aim is to present a robust assessment. Given the enormous amounts of biomass for bioenergy/BECCS (about as much as the entire biomass humanity currently harvests!) assumed in almost all scenarios staying within the 1.5° range, this is not just a minor technical detail. This is a hugely important issue that may in my view completely undermine the credibility of key conclusions from the whole report, if not addressed transparently and robustly. At the very least, if data are not fully sufficient today, suitable caveats must be introduced in order to avoid misleading conclusions. [Helmut Haberl, Austria]	Accepted - This comments asks to highlight potentially important limitations of the models that underlie the assessment in this chapter. While we agree with the importance of highlighting these issues, space, expertise and scope constraints do not allow this chapter to carry out a full assessment of these issues. However, because we fully acknowledge the importance of these points we have highlighted these limitations in the revised section and have taken them into account in our assessment of our level of confidence in the various key findings of this section.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
37398	78	11	85	2	In my view, the energy crop yields assumed in the high-bioenergy scenarios should be explicitly discussed. As this part of the report now stands, it is very difficult to see what energy crop yields are expected to be reached until 2050 and 2100. However, this parameter is one key variable for calculating bioenergy supply, as bioenergy supply from dedicated energy crops is essentially area [m2] x energy crop yield [J/m2/yr] (Haberl et al., 2010, COSUST; Global Energy Assessment, 2012, chapters 7 and 20). By not making this key parameter explicit, the tractability and credibility of the calculations is greatly reduced. Judging from the numbers presented in the various graphs, it seems that very high energy crop yields were assumed in many of the 1.5-degree compatible scenarios, as the area required for energy crops remains relatively small compared to the current cropland and grazing land area. This implies that the energy crop yields assumed/calculated must have been very substantially higher than the yields achieved on current croplands, grazing lands and in managed forests. This represents a key assumption respectively model result that has huge implications for the overall results of the storyline of the whole report. Judging from the graphs available in the current draft, it seems highly likely that the NPP of the energy crops assumed/modelled that must have been by factors between 2-7 higher than the current or potential net primary productivity (NPP) of these areas. For comparison: A recent paper (Niedertscheider et al., 2016. Environmental Research Letters, 11, 014008) showed that on average, NPP of current global croplands is about one-third lower (not higher!) than the NPP of the vegetation that would exist there without human impacts. On perhaps one-third of the global croplands, cropland NPP exceeds potential NPP, so it seems feasible to achieve plant growth exceeding natural NPP through intensive management, but the paper also shows that substantial inputs (e.g. N, which almost inevitably leads to N2O emissions) are required for that. Moreover, these inputs rise over-proportionally when natural NPP is to be exceeded. Large literatures discuss the feasiblity of achieving such high yields not only on test sites but over large areas, and the issue is highly controversial (e.g. Haberl et al. 2013. Environ. Res. Lett. 8, 031004; Smith et al. 2012. BioScience 62, 911–922; Searle, Malins, 2015. GCB Bioenergy 7, 328–336. Searle, Malins, 2014. Biomass and Bioenergy doi: 10.1016/j.biombioe.2014.01.001, Runnings, 2012, Science; and many more). This disagreement among researchers is not visible here. Moreover, many IAM studies projecting future energy crop yields (e.g. those by Popp and colleagues using the LPJ/MagPie/REMIND model system) apply learning curves derived from past growth of food crop yields to estimate future energy crop yields. This is in my view inadequate, for two reasons: (1) food crops produce "expensive" compounds with high nutrition value such as starch, protein and oily/fatty substances. Raising their yields means to raise the fraction of total plant growth allocated to these compounds, whereas raising energy crop yields (at last for second-generation energy crops where the entire aboveground plant can be used) requires raising their NPP. These are two very different optimization processes. (2) about half of the past yield increases of food crops derive from improvements of the so-called harvest index, i.e. the fraction of commercial product to total plant biomass. When talking about second-generation energy crops this mechanism is not available because the entire aboveground plant is used, so there is no harvest index to be raised. Given these concerns, I think it is necessary to present a table where area, biomass volume per year in 2050 and 2100 and yields (J/m2/y) are reported for selected scenarios covering a large part of the scenario space and to critically discuss how realistic achieving these yields is, thereby considering arguments from the many sides of this large scientific discourse, based on different disciplinary backgrounds, methods (not just modelling!) and sets of practical experience. If this critical set of assumptions/model results cannot be robustly corroborated, respectively uncertainties and caveats are also mentioned, the whole ensemble of narratives and key messages in the SPM around BECCS and C-negative energy systems would seem like a house of cards to me. [Helmut Haberl, Austria]	Accepted - This comments asks to highlight potentially important limitations of the models that underlie the assessment in this chapter. While we agree with the importance of highlighting these issues, space, expertise and scope constraints do not allow this chapter to carry out a full assessment of these issues. However, because we fully acknowledge the importance of these points we have highlighted these limitations in the revised section and have taken them into account in our assessment of our level of confidence in the various key findings of this section. Moreover, in as far as possible within the space constraints of this section, also the yield improvements for bioenergy have been reported.
11900	78	15	78	21	Could presumably also say that doesn't capture the beneficial impacts from warming/co2 increase [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - an additional point on climate damages being considered in the models underlying this assessment has been included.
15772	78	15	78	20	Please provide an estimate of the possible magnitude of this error. [Australia]	To the best of our knowledge, there is no literature available that provides an estimate of the possible magnitude of this error. A specific assessment of the body of literature that could inform such an estimate falls outside the scope of this Special Report
36662	78	15	78	21	Because earth system responses to both climate change and climate change mitigation are so important (e.g. page 78, lines 3-4), I believe these missing processes in IAMs represent a crucial gap in our ability to predict the efficiency of land-based mitigation strategies. This would be a good place to identify this gap while acknowledging that Earth System Models can represent many of the important processes, and benefits of integration between the IAM and ESM communities (ref to section 2.6.2, 2.6.4 and Thornton et al. 2017). [Anna Harper, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - This gap for models underlying the pathway literature has been acknowledged. At the same time a detailed discussion of the wider field of agricultural and land-use modelling would fall outside the scope of this Special Report and be better located in the Special Report on Climate Change and Land or the AR6.
60184	78	15	78	17	The fact that IAMs do not represent changes to crop yields with climate change is a serious deficiency. Crop yields in many key regions will fall substantially absent major adaptation, and this will affect the feasibility of many of the pathways analyzed here. [United States of America]	We agree with the reviewer's point and have therefore highlighted this as a key limitations of the modelling approaches available in the literature.
51834	78	17	78	17	Use nitrogen, not N, it's more clear. [Jason Donev, Canada]	Noted. The statement has been amended, but uses the chemical symbols: "atmospheric N and Fe deposition"
58048	78	17	78	17	The chemical element N may be expressed as nitrogen in the phrase "due to N deposition." [Siir KILKIS, Turkey]	Noted. The statement has been amended, but uses the chemical symbols: "atmospheric N and Fe deposition"
42602	78	19			in particular ===> in particular, [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
13914	78	23	78	29	Note that the rates of tropical deforestation in the RCPS used for the last IPCC, which were based on many of the same IAMs used, tend to underestimate current rates of deforestation compared to FAO, so it may well be that these rates are underestimated into the future (Mahowald et al., ERL, 2017). the IAMS need to make sure their land use conversion rates are accurate, otehrwise they will underestimate the impact of policy choices in deforestation and agriculture, as done previously (Mahowald et al., ERL, 2017). [Natalie MAHOWALD, United States of America]	Noted and agreed. However, a detailed assessment of this topic would be outside the scope of this Special Report and fit better in the Special Report on Climate Change and Land, or the AR6.
47814	78	23	78	23	Please use land-use [Sarah Connors, France]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
18162	78	25	78	26	Do the drivers not include the (policy-driven) increase of energy demand for biomass? [Andrea TILCHE, Belgium]	Not in the case of the baseline scenarios in absence of climate action, which this statement refers to.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
11902	78	31	78	34	This is a fairly major point and needs to be communicated more clearly. It also doesn't appear to be mentioned in chapter 4. Additionally, does this occur in all models? Does it occur in the more sustainable scenarios. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - This appears to be a feature that is present in most of the available scenarios. However, the assessment of land-use evolutions is based on the subset of SSP-based pathways, which do not include all sustainability options that are explored in other studies.
18164	78	31	78	33	It is good that it is recognised here that afforestation and BECCS compete for the same land and resources. It is unfortunate that this is not reflected in most parts of the document. [Andrea TILCHE, Belgium]	Noted. It is not always easy to have all messages permeate throughout the entire chapter and report.
36664	78	31	78	35	However at least one scenario (IMAGE1.5 SSP2 RCP1.9, van Vuuren et al 2017d) it was deemed benefiical in the IAM to replace some boreal forests with bioenergy crops. Harper et al. (accepted pending revisions at Nature Communications: "Relative effectiveness of land-based mitigation strategies in stablising climate change at 1.5C") tested the impact of the land-use patterns in the IMAGE 1.9 scenario and found a net loss of land carbon, even after considering the carbon sequestration potential from BECCS. Therefore IAM assumptions about the effectiveness of BECCS or afforestation/reforestation need to be scrutinized. [Anna Harper, United Kingdom (of Great Britain and Northern Ireland)]	Accepted. Chapter 4, section 4.3.7 discusses the potential limitations of carbon dioxide removal measures.
49614	78	32	78	32	Avoiding deforstation is a prerequisite, but not sufficient condition. It is important that systemic effects of e.g. forest use for BECCS are fully reflected. Management impacts (timber harvest, woodfuel collection, forest grazing, etc.) on carbon stocks in forests are massive at the global scale, and not reflected by a deforestation ban (Erb et al. 2018,nature 553, 73-76). It needs also be discussed how forestry is projected/modelled in the scenarios, and warranted that such systemic (see many publications by Holtsmark, and Schulze et al.) effects are reflected. [Karlheinz ERB, Austria]	Taken into account - While a complete assessment of land-related issues lies outside the scope of the Special Report, these are important aspects which are better dealt with in the Special Report on Climate Change and Land. In this section, we now highlight the potential impact of forest management practices on land carbon content with references to Erb et al (2016) and Naudts et al (2016).
7672	78	34	78	55	Since all scenarios for 1.5C imply expansion of second generation of energy crops, expanding on how this allows for zero net deforestation or even net increase in forest beyond the ones provided will be desirable. Reflecting the mayor geospacial shifts, where and when will make this more undestandable and credible. In the XXI century the land footprints are changing rapidly, and demand of food and land related products is generating land footprints that are far more complex than during the XX century. How this is taken into accout in the scenarios assumptions is missing or pearhaps not considered at all. [Maria Jose Sanz Sanchez, Spain]	Taken into account - The revised section now highlights that high agricultural yields and application of intensified animal husbandry, implementation of best-available technologies for reducing non-CO2 emissions, or lifestyle changes including a less-meat-intensive diet and less CO2-intensive transport modes, have been identified to allow for such a forest expansion. A deeper assessment of these issues would fall outside the scope of the Special Report and might be taken up by the Special Report on Climate Change and Land or the AR6.
11904	78	34	78	38	This is the first time I've seen mentioned what type of biomass the models are using (i.e. that some is coming from residues and waste). Bioenergy generally seems to be lumped in as a single category, but the different types of biomass all have quite different implications. Can this level of detail not be provided and discussed? Also, which discussion of land pathway types precisely? Where? [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - This section provides some detail as to which type of biomass is sources. However, in the reporting available from the integrated pathway literature it is not available to track these biomass types once they enter the energy system.
42604	78	34			waste, ===> waste [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
49612	78	34	78	34	The notion of marginal land needs to be explained. Most of land is already under use, and in particular, the so-called marginal land is used for subsistence (there are so many qoutes on this that I will only qoute the oldest one, Young 1999 Environment, Development and Sustainability 1: 3–18. It is important that this is reflected in the model runs, as using the "marginal land" will result in repercussions on food demand and urbanization. If it is not endogenous to the models, and the model cannot be re-run, it needs at minimum to be explicitly discussesd. [Karlheinz ERB, Austria]	Rejected - A detailed discussion of land-use types, including marginal lands, is considered to fall outside the scope of this chapter and rather something to be taken up in the Special Report on Climate Change and Land or the AR6.
18166	78	35	78	36	It would be useful to clarify what types of crops are assumed. As 2G technologies are generally presumed to be able to use any type of biomass, it could be annual crops, perennial agricultural crops or forest plantations. Moreover, all of these could/would also serve other needs, in particular electricity for heat and power (but also material uses). It is unclear why "second generation energy crops" could emerge as a separate, identifiable entity in the landscape. [Andrea TILCHE, Belgium]	Taken into account - The section now provides a few examples of the second generation bioenergy crops considered.
42606	78	35			second generation ===> second-generation [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
56038	78	35	78	35	How are second generation energy crops defined here? Second generation and advanced biofuels are not consistently defined in different national context. [Kelly Stone, United States of America]	Taken into account - The section now provides a few examples of the second generation bioenergy crops considered.
56040	78	35	78	35	The land devoted to second-generation energy crops is considered likely to expand, but how much land does the IPCC currently consider support second-genergation energy crops? [Kelly Stone, United States of America]	This chapter did not carry out such assessment, and can hence not provide an answer to this question.
15774	78	38	78	40	Sentence is confusing - may be corrected by deleting "...due to the use of afforestation and reforestation measures." or by adding a comma before "due". [Australia]	Taken into account - The sentence has been edited.
15776	78	42	78	42	Suggest the sentence starting " This is due…" is supposed to be associated with the "…varies highly across models." If so, it needs to move up a sentence. [Australia]	Taken into account - The paragraph has been edited.
42608	78	42			afforestation and reforestation is included ===> afforestation and reforestation are included [Egypt]	Noted. Afforestation and reforestation are considered a single mitigation option here.
842	78	43	78	43	Table 2.8' should be 'Figure 2.8' [Robert Shapiro, United States of America]	Rejected. It truly is a table, now moved to the Annex.
7188	78	43	78	49	This sounds very optimistic and a bit naïve - why don't we have such levels of intensification today? What are the very real barriers? [Petra Tschakert, Australia]	The past has seen comparable rates of intensification. These intensification rates are hence consistent continuations of historical experience.
11906	78	47	78	55	Again, this is very important and needs to be communicated more clearly. We can still feed people in a beccs world but it makes major assumptions about improved agricultural yields and changes in lifestyle. Need to make this clear in high level summaries and in the discussions around feasibility. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The intensification of agricultural production is discussed in more depth in the revised version of the chapter including a comparison to the domain literature in this area. However, this discussion is constrained by the scope, length limitations and selected expertise of the author team of this Special Report and would hence better fit in the Special Report on Climate Change and Land or the AR6. Messages in the SPM and ES are based on the most robust findings from the various sections.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
30960	78	47	78	55	here it is made clear that the Kriegler scenario contains very large levels of BECCS assume “rapid technological progress” inter alia to deliver major increases in crop yields above SSP5 scenarios, which are themselves considerably over 2010 yields. The use of the historical data on lines 54 of this page is apparently there to give the impression that such yield improvements are possible. My memory of IPCC 5AR is though that there are major risks to crop yields in future due to unavoidable warming. Is it not hubristic at best to assuming even higher crop yields than SSP5, given the major uncertainties and likely negative impacts on crops due to climate change? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The revised section now puts the increased crop yields in context of the domain literature. However, this discussion is constrained by the scope, length limitations and selected expertise of the author team of this Special Report and would hence better fit in the Special Report on Climate Change and Land or the AR6.
40056	78	47		49	How are these reductions in agricultural land for food and feed production square with the expected increase demand for land for agriculture to meet the growing food demand by at least by 50% by 2050? [Aziz ELBEHRI, Italy]	Taken into account - The models underlying the literature on pathways limiting warming to 1.5°C take into account both food demand and additional bioenergy demands. This is now explained in more detail in Section 2.A.2.4 in the Technical Annex to Chapter 2.
49624	78	47	78	55	The implications of these yield increase, including their feasibility (Ray 10.1038/ncomms2296) and GHG implications need to be openly discussed here. A yield increase of this degree will have massive implications, also on carbon stocks in soils, required global governance (due to the exploitation of geographically favourable regions; Mauser 10.1038/ncomms9946) and are likely to have considerable biodiversity impacts. Completely missing in this context is a discussion on the assumed yields of dedicated energy crops. [Karlheinz ERB, Austria]	Taken into account - The revised section now puts the increased crop yields in context of the domain literature. However, this discussion is constrained by the scope, length limitations and selected expertise of the author team of this Special Report and would hence better fit in the Special Report on Climate Change and Land or the AR6.
37390	78	48	78	48	It is important to discuss not only the area covered with forests, but also the quality of the land used for additional forests, as well as the stocking density of the forests. Neglecting the latter may result in double-counting, e.g. if C sequestration of growing forest is counted, while they are also assumed to deliver biomass for energy, which again reduces their stocking density and hence C content. [Helmut Haberl, Austria]	Taken into account - The impact of forest management on forest carbon content is now explicitly mentioned as one of the caveats and knowledge gaps in this kind of modelling.
15778	78	50	78	52	Is this magnitude of yield increase likely, especially under climate change? [Australia]	A comparison of the assumed yields with the domain literature on this topic shows that these are not outside the range of what is already achieved. However, they will undoubtedly not materialize without dedicated efforts. A detailed assessment of the likelihood of these increases lies outside the scope of the chapter.
51836	78	51	78	51	Please define tDMha/yr [Jason Donev, Canada]	This refers to tones of dry matter per hectare per year
37388	78	52	78	52	To what extent have the GHG costs of the agricultural intensification assumed to happen here considered? Adding fertilizer will raise N2O emissions, for example. Please explicitly clarify how robustly such trade-offs were considered. [Helmut Haberl, Austria]	Taken into account - The integrated models underlying the 1.5°C-consistent pathways discussed in this chapter take into account the increased emissions from nitrogen fertilizer. This aspect is now also highlighted in the higher level summaries of the chapter and the SPM.
30962	78	53	78	53	the wording of the text “similar improvements are present in 1.5 degree variants of such scenarios” implies that “such scenarios” are not themselves 1.5 compatible. I assume this is not intended. Do you need to change to say “other 1.5 degree variants”? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	The scenarios discussed in the previous sentence are 4.5 W/m2 and 2.6 W/m2 scenario and hence not considered 1.5°C scenarios.
37394	79	1	79	12	Please explicitly discuss to what extent the GHG emissions resulting from the land-take of energy crops has been assessed in the various scenarios. [Helmut Haberl, Austria]	Rejected - The IAM literature generally accounts for land-use change emissions. However, due to space limitations and questions of scope, this issue will be treated in much more detail in the SRCLL but has also been covered in chapter 4. An explanatory text has been added to the Technical Annex.
31416	79	1	80	19	Regarding the mean values of the annual pace of land change in Table 2.11, the full range covers both positive to negative values. While the concept of "mean" itself is understandable and is a common approach in this report, positive area change and negative area change represent opposite directions of land use change and it is difficult to envision the future from the mean value, even though different scenarios are presented in Figure 2.28. It would be helpful to policy makers to include a brief explanation of which situations cause increase of pasture and/or cropland area and which lead to a decrease of pasture and/or cropland area. [Japan]	Agreed - We excluded the median values as suggested by the reviewer and others. In addition, we added the sentence on the high uncertainty of land-use outcomes but due to space limitations could not discuss in detail on the reasons and assumptions. However, we refer to 2 publication with detailed discussion on this. In addition, more discussion will happen in the SRCCL.
51838	79	10	79	10	Problem with exponent [Jason Donev, Canada]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
844	79	16	79	16	Table 2.11' should be 'Figure 2.11' [Robert Shapiro, United States of America]	Rejected - Table 2.11 was correctly referenced in the SOD
11908	79	19	79	19	so do 1.5c scenarios start in 2010? This hasn't been made clear previously. If yes the implications of this need to be discussed [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - The starting point and the implications of varying these starting points are discussed in Section 2.3 of this Chapter
22656	79	19			Insert a space between "hectares).In" [LUIS VALDES, Spain]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
44268	79	19	79	19	needs space between "hectares). In" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51840	79	19	79	19	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51842	79	19	79	25	Show this graphically, it would clarify it considerably. [Jason Donev, Canada]	Noted. However, due to time constraints, no additional figure was added.
56042	79	19	79	23	The ranges for land-use changes are so large that they need additional context to have their inclusion be useful. When the range is from -9 to +16, some discussion needs to be included on the assumptions and reasons behind such large ranges. [Kelly Stone, United States of America]	Accepted - We added the sentence on the high uncertainty of land-use outcomes but due to space limitations could not discuss in detail on the reasons and assumptions. However, we refer to 2 publication with detailed discussion on this. In addition, more discussion will happen in the SRCCL.
39458	79	21	79	21	Between Mhayr–1 there must be a free space: Mha yr–1 [Olga Alcaraz, Spain]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
11910	79	26	79	29	earlier it was stated that cropland was decreasing (page 78, line 45-47). Needs to be greater clarity on increases/decreases in crop and pasture land and then greater clarity on the fundamental implications of this i.e. are we expected to feed a growing population on more or less land, rely more or less on intensification etc etc [United Kingdom (of Great Britain and Northern Ireland)]	Accepted - the 4 potential land-use pathways are used to disentangle potential drivers and land-use futures. In addition text incl references on the large uncertainty of land-use outcomes has been added.
55474	79	26	79	26	This should say "decreases" for cropland rather than increases, should it not? Based on Figure 2.27 and Table 2.11 [Andy Reisinger, New Zealand]	Rejected - text has been referring to medians of 'total cropland' which is consistent to fig 2.27 and table 2.11

Comment No	From Page	From Line	To Page	To Line	Comment	Response
18170	79	29	79	31	The increase in forest cover would not only contrast with past trends, but also with the greatly increased demand for bioenergy, inlcuding biofuels. [Andrea TILCHE, Belgium]	Taken into account - This point has been added to the text
49896	79	29	79	31	REDD+ is being implemented across several developing countries and is being proven to be effective in both mitigation and adaptation with or without finance. There are fewer references for this in the chapter. The stress is more on the CDR, particularly afforestation for which there is unavailability of land, especially at the scale at which it is required to abate climate change. Therefore, regulation of existing forests for carbon sustenance could be stressed more [Himangana Gupta, India]	Taken into account - Avoided deforestation is assessed both as an adaptation and mitigation option in Section 4.3.3. This is now cross-referenced in this section, while the discussion of this assessment is not repeated.
42610	79	30			Changes of the ===> Changes in the [Egypt]	Noted. We kept Changes "of the"
14046	79	33	83	10	This is a complex scenario with many uncertainties. Reducing GHG emissions from the agr-food sector involves 1) improving productivity (eg t/ha) with fewer inputs; 2) displacing fossil fuels along the food supply chain with renewables coupled with improved energy efficiency; 3) changing consumption patterns away from animal protein; 4) increased urban agriculture including synthetic "meat" production. Perhaps the key one is the potential move away from animal protein. Producing fewer animals would free up grazing and feed cropping land for more vegetable, fruit and edible crop production (where the soils are suitable) to meet human protein demand. The rate of change would partly depend on a carbon price, particularly if placed on methane from ruminants and paddy rice. The section as it stands is on AFOLU but should still include brief discussion on energy demand in the sector (32% of end-use energy); impacts from soil carbon changes; potential rate of uptake of vegetable and synthetic protein; low-carbon manufacture of fertilisers; uptake of circular economy in the agr-food sector; increased protein demand from middle classes in Asia; unless these topics are covered elsewhere in the report when cross-referencing would be helpful. [Ralph Sims, New Zealand]	Taken into account - the reviewer seems to request a broader cross-sector perspective. This is provided in Section 2.3, a cross-reference is now included.
40058	79	33			Trade is expected to play an important role here under the AFOLU story. In fact, trade has been largely ignored throughout the 1.5SR. Agricultural trade is an important driver in AFOLU sector. Although the mitigation impact of trade per se is yet to be sufficiently documented, trade role needs explicit consideration. More broadly, within the AFOLU sector, exported food products from high productivity regions to low productivity regions imply net GHG savings. Likewise, importing wood products from countries with sustainable land and forestland management practices is more likely to generate lower carbon footprint compared to countries following unsustainable practices. However, observed trade patterns call for caution to avoid the rebound effect. According to one study, the national-scale reforestation of Vietnam since 1992 was achieved by the displacement of forest extraction to other countries equivalent to 39% of the regrowth of Vietnam's forests from 1987 to 2006 [Lambin and Meyfroidth, 2011). Many developed nations with returning forests seem to accelerate this recovery by importing wood products either from other developed countries with stable forests or relatively poor countries with declining forests [Kastner et al., 2011). Cited references: Lambin, E. & P. Meyfroidtb. 2011. Global land use change, economic globalization, and the looming land scarcity. PNAS, 108(9): 3465–3472. Kastner, T., K. Erb & S. Nonhebel. 2011. International wood trade and forest change: A global analysis. Global Environmental Change, 21: 947–956. [Aziz ELBEHRI, Italy]	Accepted - Trade is explicitly listed in this section as an important driver for land-use dynamics and consequences (additional citations have been added to highlight the importance of trade). However, due to space limitations we cannot include more discussion on this issue. However, trade will be of much higher importance in the SRCCL.
40060	79	34	80	3	Increased water scarcity is also another driver likely to affect demand for agricultural land. (Addams et al., 2009) estimated that by 2030, global water requirements are likely to be 40% greater than current supplies, and one-third of the world's population, mostly in developing countries, might live in areas where this deficit is larger than 50%. (Liu et al., 2014) reported that the expected loss of productivity due to increasing water scarcity would require an additional 7.6 million hectares of new cropland to meet the demand for food. The actual amount will depend on future diets, food wastages, and food-to-feed efficiency in animal production. [Cited references: Addams, L., G. Boccaletti, M. Kerlin & M. Stuchtey. 2009. Charting Our Water Future: Economic Frameworks to Inform Decision-making. McKinsey & Company, New York, USA. Liu, J., T. Hertel, F. Taheripour,T. Zhu & C. Ringler. 2014. International trade buffers the impact of future irrigation shortfalls. Global Environmental Change, 29: 22–31. [Aziz ELBEHRI, Italy]	Rejected - due to space limitations this issue will be treated in much more detail in the SRCLL but has also been covered in chapter 4. The limitations have been taken into account in the assessment of the level of confidence of the AFOLU results.
15784	80				Suggest including a description of the types of energy crops modelled. [Australia]	Accepted - We now list typical energy crops such as miscanthus or poplar
54728	80		80		Table 2-11 specifically, the reader is left with the impression that land use trade-offs are blunt and linear. The narrative shold be strengthened with respect to the key idea that the landscape planning, design and landscape ecology principles are crucial to re-building landscape mosaics with BECSS and other AFOLU CDR technologies inter-laced into landscape function and not in competition with food crops. This paradigm is the rural equivalent of the Urban Green Infrastructure/Circular Economy discussion in Section 4.3.4. The literature base is for the Rural Natural Infrastructure paradigm as synergy space for mitigation and climate adaptation is spread across many disciplines but does exist and should be pursued. [Henry David Venema, Canada]	Rejected - The indirectly suggested literature falls outside the scope of Chapter 2.
63218	80	2	80	6	Rewrite: "For instance, the availability of affordable carbon-dioxide removal technologies that are not land based (like marine CDR, chapter 4, see additions below) or that do not rely on biology (like direct air capture – DAC, Chapter 4, Section 4.3.8) could greatly reduce land and societal impacts (Popp et al., 2014b; Figure 2.27). [Greg Rau, United States of America]	Rejected. It is unclear how the suggested edit would apply to the section indicated.
42612	80	3			2014).Efficiency ===> 2014). The efficiency [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
44270	80	3	80	3	needs space between "2014). Efficiency" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
55966	80	5	80	5	Add, "production, and avoidance of emissions from agricultural field burning especially with higher associated wildfire risk in drier climates." [Pamela Pearson, United States of America]	Rejected - due to space limitations for this section such details cannot be included. More details on tis will be included in the SRCCL.
42614	80	6			intensification ===> the intensification [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
7668	80	11	80	18	Table 2.11. Please clarify the period or how the basiline is produced. [Maria Jose Sanz Sanchez, Spain]	Accepted -Subtitle of tab 2.1 now contains a description of baselines.
21478	80	11	80	18	For many land-related indicators shown in Table 2.11, the sign is uncertain and so I am wondering how meaningful the median is. Therefore, focusing this discussion around example scenarios as used in Section 2.3 and also in Sigure 2.28 (although based on other scnearios as in Section 2.3) would allow providing clearer insights. [Volker Krey, Austria]	Accepted - median has been excluded from the text.
35508	80	11	80	12	Land is perhaps the most "non-global" resource in that it is extremely local. So would be good to see some local/regional break-ups of the land-use change figures to understand where this land is going to come from. [Ashok Sreenivas, India]	Rejected - While the reviewer is correct about the local character of land-use changes, limits in scope and page length do not allow us to cover this topic adequately.
35510	80	11	80	12	The pace of change expected, particularly for 2030-2050, for pasture and croplands seems to be highly ambitious and unprecedented. Is this likely at all? [Ashok Sreenivas, India]	Noted - The assessment of the pathway literature in this chapter does not make additional assessments of the likelihood of particular changes. This assessment is part of the feasibility dimensions assessed in Chapter 4.
61774	80	11	80	18	Is land use for fiber production (e.g. cotton, etc) not considered at all? [Valérie Masson-Delmotte, France]	Accepted - The table has been modified to include: Cropland for food, feed and material
34212	80	12	80	18	Table 2.11 caption: Please describe briefly that the "baseline" are scenarios without land-based mitigation, if this is correct. Also, if possible, please explain how the baseline numbers for the period 2010-2030 relates to the current pace (e.g. 2014-2017) of land-use change. [Norway]	Accepted - Changed as suggested by the reviewer.
11912	80	13	80	13	Missing two helpful historical comparisons [United Kingdom (of Great Britain and Northern Ireland)]	Rejected - comment provides too little specification to understand what precisely is meant here.
39460	80	13	80	13	Between Mhayr–1 there must be a free space: Mha yr–1 [Olga Alcaraz, Spain]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
49616	80	20	80	25	It should be discussed to which degree the increased energy demand (fertilizers, mechanization) and carbon stock changes (e.g. SOC) induced by changes at the production side are reflected here. Furthermore, the likelyhood of rebound effects must be mentioned here (ceddia 2013 doi 10.1016/j.gloenvcha.2013.07.005), as well as the benefits to reduce concentrate feed when diets change (Muller 2017 10.1038/s41467-017-01410-w; Schader 210.1098/rsif.2015.0891). [Karlheinz ERB, Austria]	Rejected - These aspects fall outside the scope of the SR1.5, in particular given the parallel preparation of a the SRCCL.
62124	80	22	80	22	Is the figure given in GWP100? Maybe another metric could help? [Antoine Bonduelle, France]	The figure is indeed given in GWP-100. Alternative metrics are discussed in a box in Chapter 1. However, for this report no alternative metrics are reported, as metric choice is a more general topic which is not 1.5°C specific.
31418	80	23	80	25	Please reconsider the quantitative figures: "For livestock production, another study ……and cumulative carbon losses (34-57%).". It is apparently unbalanced to only describe the quantitative figures as the result of evaluating the effect of lowering livestock consumption. Alternative to deleting the sentence may be to elaborate the whole story (e.g. by also introducing the quantitative figures about "minor productivity growth in extensive livestock production systems leads to substantial CO2 emission abatement (L26-L27)" or "a transition from extensive to more productive systems bears substantial GHG abatement potential (L29-30)", or introducing the logic, limitation, uncertainties as well as tradeoffs including those to food security and livelihood) rather than extracting only the most extreme result. [Japan]	Taken into account - Space constraints and limited scope of the SR1.5 report do not allow for a extensive discussion of this issue. However, the statements have been made less precise by only referring to the orders of magnitude here. At the same time, in the context of the SR1.5 it makes sense to highlight identified mitigation potentials. Potential trade-offs with food security are discussed in Chapter 5.
31420	80	24	80	24	Weindl et al., 2017 2015 (correct error) This cited article is "Weindl et al., 2017", not "Weindl et al., 2015". [Japan]	Accepted. This has been corrected.
44272	80	24	80	24	needs space between "2015) demontrates " [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51844	80	24	80	24	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
58050	80	24	80	24	There is a spacing issue after the reference in "(Weindl et al., 2015)demonstrates." [Siir KILKIS, Turkey]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
15780	80	27	80	28	Suggest provide reference and/or futher explanation for 'soil carbon trade-off'. [Australia]	Accepted - A reference has been added.
55476	80	28	80	28	To avoid a rather heavy and obvious IAM bias, please at least add a citation to Gerber et al (2013), Tackling climate change through livestock, FAO (Rome), pp139. This work also clearly demonstrates, using a different modelling approach with a lot more detail than GLOBIOM, the emissions reductions that are possible through productivity/efficiency gains. [Andy Reisinger, New Zealand]	The suggested reference was cited in the context of the following sentence: "In addition, even within existing livestock production systems, a transition from extensive to more productive systems bears substantial GHG abatement potential, while improving food availability (Gerber et al., 2013; Havlík et al., 2014)."
49618	80	29	80	30	The caveats of such strategies should also be discussed, see Muller 2017 doi10.1038/s41467-017-01410-w, Loos et al 2014 doi10.1890/130157, including the rebound problematic, the land-competition problematic, the livestock-desease problematic,etc, and alternative strategies should be presented. [Karlheinz ERB, Austria]	Taken into account - side effects of all CDR options are assessed in 4.3.8, bioenergy in 4.3.2 and other land-based mitigation options in 4.3.3. Implications for food security are covered in Chapter 5. More efficient cross-referencing has been implemented to make a better link to this complementary information.
11914	80	31	80	32	What are the wider implications and trade-offs of some of these mitigation efforts in agriculture. Presumably, for example, intensification comes with environmental costs. Yet these don't seem to be discussed in chapter 4 or 5. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - side effects of all CDR options are assessed in 4.3.8, bioenergy in 4.3.2 and other land-based mitigation options in 4.3.3. Implications for food security are covered in Chapter 5. More efficient cross-referencing has been implemented to make a better link to this complementary information.
15782	80	31	80	32	The opposing statements - reducing or even enhancing - makes the messqge of the sentence unclear. Reword, explaining the situations in which it may reduce or increase SOC. [Australia]	Accepted - The sentence has been modified
42616	80	32			Also ===> Also, [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
47816	80	32	80	32	Valin et al., 2013; Popp et al., 2014a; Wise et al., 2014…..Kindly check: citations in running text may be rearranged sequentially according to the year of publication as per the format of the report. This applies to all instances. [Sarah Connors, France]	Noted. The chapter follows the template as provided by the TSU. Ordering of references is automatic.
42618	81	3			land based ===> land-based [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
30964	81	8	81	35	this is a powerful and clear explanation of the potential pathways for land-use etc, and I think some of this should be put into the ES. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Noted

Comment No	From Page	From Line	To Page	To Line	Comment	Response
42620	81	16			baseline ===> baseline, [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
49620	81	18	81	20	To which degree are the carbon implications of the increase of forest harvest reflected? This is essential and must be disclosed. If the effect is not implemented in the model, the model results must be questioned altogether. [Karlheinz ERB, Austria]	Rejected - An in-depth assessment of this issue falls outside the scope of this SR1.5 chapter, but can be taken up in the context of the SRCCL. T
55478	81	21	81	27	At the risk of sounding like a broken record, this discussion is heavily biased towards the mitigation options that are included in IAMs, rather than those that have been identified in the sector-specific literature (and that are no more, and in most cases less, speculative than large-scale BECCS). See comments on pages 50, 40, 35. I don't expect the authors to assess those other technologies, but I expect them to disclose clearly that the following approaches are not generally considered in IAMs and hence their quantification within the IAM scenario literature is limited if not impossible, but they could offer significant mitigation options (and, I repat emphatically, are no more speculative than 500 Gt CO2 removal via BECCS, including the idea that BECCS is kicking in from 2020 in some IAMs). [Andy Reisinger, New Zealand]	Accepted - Acknowledging that the mitigation measures assumed in IAMs do not cover the full set of identified measures in this area, the text in this section has been reworded to clearly reflect these caveats. Moreover, the mitigation measure overview table in the Technical Annex (to which reference is made in this section) now clearly illustrates the imbalance between energy-system and land-system mitigation measures in IAMs
58210	81	21	81	23	What is the mean per capita calorie consumption suggested here? It does not seem to be reasonable to suggest a lower calorie consumption for the current per capita average globally. Please note that, although obesity is a growing problem, many people are under starvation or malnutrition worldwide. The current average consumption (male and female) is already approximately in mid-point (around 2100 kcal a day, already excluding losses), with a large standard deviation for these two extremes. [Alexandre Strapasson, Brazil]	Rejected: The mean per capita calorie consumption is higher compared to 2005 but lower compared to the baseline cases in the BAU scenarios w/o mitigation. There is no space in this chapter for extended discussion on this but more detailed information can be found in Popp et al. 2017 and will be elaborated in the SRCCL.
60186	81	21	81	23	Clarify the sentence "By 2050, global food production is reduced by 10% compared to a no-climate policy baseline – for livestock products this number is almost doubled (18%)." Does this refer to total calories? Total tonnes of food? Total hectares used for food? Assume the definition used for this scenario is consistent with feeding a growing global population. [United States of America]	Rejected: The mean per capita calorie consumption is higher compared to 2005 but lower compared to the baseline cases in the BAU scenarios w/o mitigation. There is no space in this chapter for extended discussion on this but more detailed information can be found in Popp et al. 2017 and will be elaborated in the SRCCL.
42622	81	22			products ===> products, [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
42624	81	23			differently ===> different [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51846	81	23	81	23	Is this 18% or -18%? This is a little unclear. [Jason Donev, Canada]	Taken into account. This sentence was edited for clarity.
49622	81	25	81	25	add a link to Erb et al. 2016 doi10.1038/ncomms11382, and discuss the grassland constraints. [Karlheinz ERB, Austria]	Taken into account - an in-depth discussion of this issue falls outside the scope of this report, but the reference has been included here.
18172	81	28	81	29	It is unlcear what "highly efficient" CDR through BECCS is supposed to mean. What would be its land use efficiency (e.g., tons of CO2 removed per ha/yr)? What would it be for less efficient (standard) BECCS? [Andrea TILCHE, Belgium]	Accepted: 'highly efficient' has been excluded from the text.
11916	81	30			It would be helpful to have a definition of bioenergy crops vs short rotation forestry crops. This definition is critical for interpretation of Figure 2-28. [United Kingdom (of Great Britain and Northern Ireland)]	Noted. No expansive definition of bioenergy vs other crops was provided. However, a table of land-use types used in IAMs and in this section was included in the Technical Annex specifying that land for energy crops is considered: "Land dedicated to second generation energy crops. (e.g., switchgrass, miscanthus, fast-growing wood species)"
7674	81	31	81	35	This is an important statement. How appropiate choices are defined and coherently promoted at the scales that is needed?. What is meant by expansion of "natural" forest area? (natural regeneration?... If it is the case the fenomena of land degradation needs to be considered). Elaborate more on the Scenarios 1 to 4 in figure 2.28, perhaps adding a table adding waht sort of measures are foreseen and geographycally in borad terms where. [Maria Jose Sanz Sanchez, Spain]	Rejected - Due to space restrictions and a focussed scope, this cannot be covered in the SR1.5. More detail on scenarios (including degradation) will be elaborated in the SRCCL
42626	81	32			for land use ===> for the land use [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
15786	81	34	81	35	Incentives for reforestation/afforestation are not likely to result in "natural forests" unless policy restricts forest types. Policies that favour high rate of C sequestration will favour intensively managed plantations - eg monocultures of exotic species - this should be acceptible if the goal is max C sequestration in short term. [Australia]	Accepted - 'natural' has been excluded from the text
18174	81	34	81	35	The expansion of natural forest area seems inconruent with the assumptions given (push for AR and BECCS). Such policies compete directly with land available for the expansion of natural forests, and likely to reduce existing natural forest (e.g., through accelerated harvest followed by conversion to plantations). [Andrea TILCHE, Belgium]	Noted - Because it is often perceived as being inconsistent, the assessment in this chapter highlights the conditions under which they can occur simultaneously.
5876	82	1			In the figure and accompanying text it would greatly aid readability if, rather than referring to scenarios by numbers instead you gave descriptive names for each scenario that defines them in a manner that the reader can easily grasp. [Peter Thorne, Ireland]	Accepted - In this figure and throughout the chapter a consistent set of scenario archetypes was used.
18176	82	1	82	14	The illustrated land use categories seem odd and would require a detailed explanation (and probably correction). - It is unclear whether the charts represent all land or only productive land - It is unclear whether the total land area within charts (over time) and across charts (across scenarios) are the same. If not, the absolute changes should be indicated. - At the very least, the permanent and monotonous loss of productive land (due to urban sprawl and other land take, desertification, sea level rise and salinisation) should be noted and, if possible, quantified. - The relation of "natural forest" and "managed forest" is bizarre. Globally, most forests are "managed" less than 20% is primary forest (considered to be natural and unmanaged. "Managed" and "natural" and not alternatives (it should be managed vs unmanaged and natural vs semi-natural or plantation). If "managed forest" means plantations, that is what it shoudl say, but recognising that most of the wood productionis not coming from plantations, and the bulk of the "natural forest" is managed. - It would be essential to clarify the nature of "other natural land" and the assumptions related to it. Given that forest and agricultural lands seem to be fully covered in the other categories, (even extensive pasture systems, given teh very big share assigned to pasture), "other natural land" is likely to be mostly hot and cold deserts. If so, it should eb stated, and their apparent transition to other land uses (e.g., in Scenario 4) would require explanation. [Andrea TILCHE, Belgium]	Accepted - an overview of their definition and use in the IAM pathways literature has been included in the technical annex

Comment No	From Page	From Line	To Page	To Line	Comment	Response
37396	82	1	82	10	Please explain the definitions of "managed forest" versus "natural forest" used in the work behind Figure 2.28. To me it seems completely implausible that the "natural forests" shown in these plots should be entirely unmanaged/unharvested. For example, Erb et al., 2016, Nature GeoScience and Erb et al., 2018, show that forests globally today have a substantially faster C turnover and lower C stock than in the hypothetical absence of land management, in this case forest management. These impacts are visible across much of the entire global forest area, except some very remote and truly pristine forests. [Helmut Haberl, Austria]	Accepted - an overview of their definition and use in the IAM pathways literature has been included in the technical annex
39152	82	1	82	14	Figure 2.28 are hard to understand if you want to reflect the crucial statements of p.81 lines 11-35. [Lindsey Cook, Germany]	Noted. However, the figure could not be updated in time and was removed from the Final Government Draft.
51848	82	1	82	2	Figure 2.28 is important and should have been referred to earlier in the text. This is a graphical representation of much of what's talked about. [Jason Donev, Canada]	Noted. However, the figure could not be updated in time and was removed from the Final Government Draft.
55636	82	1	82	14	can the five scenarios introduced earlier (fig 2.7) be used for consistency, or some help provided to match them to improve understanding. [David Cooper, Canada]	Accepted - The same set of scenarios introduced in Section 2.1 is used consistently throughout the chapter. In this section.
40956	82	2	82	2	Should specify what scenarios and references are used for each panel [Shinichiro Fujimori, Japan]	Noted. However, the figure could not be updated in time and was removed from the Final Government Draft.
19628	82	20	82	27	When it comes to CDR, the land system is largely reduced to BECCS or afforestation/reforestation despite all other options. [Jennifer Morgan, Netherlands]	Accepted - This limitation is acknowledged. The restriction of the CDR options on BECCS and afforestation in IAMs is discussed in detail in chapter 4. Gaps are listed in table SOD Table 2.8, which is included in the Technical Appendix of the FGD.
18178	82	20	82	23	The low cost of reducing deforestation is questionable, in particular when at the same time very expensive abatement options that demand land and biomass (such as BECCS) are assumed. The biomass demand of BECCS, biofuels and unabated bioenergy will drive up the cost of land, as well as the opportunity cost of refraining from the harvest of existing forest. Moreover, relying on carbon price to reduce deforestation assumes that the price paid would offset the opportunity cost. However, as the opportunity cost is recurrent and deforestation can happen anywhere where there is forest, the payment would need to continue indefinitely and would need to be offered to anyone in the position to deforest (otherwise deforestation is likely to be just displaced to areas where there is no compensation for reduced deforestation). That is likely to make it a veyr costly policy. Last, but not the least, it is not only or mostly a matter of carbon price, but more a governance challenge. [Andrea TILCHE, Belgium]	Accepted - 'However, efficiency and costs of avoiding deforestation strongly depend on governance performance, institutions and macroeconomic factors (Wang et al. 2016).' has now been added to the text.
15788	82	21	82	23	Why are soil carbon rich pastures being avoided to achieve mitigation…? [Australia]	Accepted - 'Soil-carbon rich pastures' has been changed to ' land-use types with high carbon density'
846	82	22	88	22	effects into other regions' should be 'effects other regions' [Robert Shapiro, United States of America]	Rejected. The sentence was correct, but has nevertheless been edited for clarity.
42628	82	24			role for overall CDR ===> role in overall CDR [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
42630	82	25			and ===> , and [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
41550	82	26			Change "100USDD" to "100 USD" [Czech Republic]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51850	82	26	82	26	DD? [Jason Donev, Canada]	Noted and corrected.
62126	82	27	82	27	large mitigation potentials at carbon prices… contradicts the lack of quantified policies in models for agricultural nitrogen oxides mentioned before. Maybe mention this exception for the largest agricultural gas? [Antoine Bonduelle, France]	Accepted - We have highlighted that while there is a large potential, IAMs continue to project significant residual emissions.
19578	83		85		Box 2.1. "In energy sector, BECCS are key option in Japan and China's study, with share of total power generation 6% and 7.6% in 2050. Renewable energy (excludes BECCS) takes large share by around 70% and 53% in 2050. Nuclear is yet a major source in both studies, with 15% and 28% in 2050. Remaining fossil fuel power generation is equipped with CCS in 2050 in China." Current share of nuclear in electricity power generation is at around 2% in both countries, not speaking of even lower share of total energy consumption. It is unclear how Japan and China would reach 15% and 28% respectively. Also CCS has basically not even started in these two countries. [Jennifer Morgan, Netherlands]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
35836	83		83		Box 2.1, more citations on National pathways needs to be included. Also the key conclusions from Dhar et al. (2018) need more clarity. [India]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
39154	83	1	83	9	What you are stating is profound - reduction in livestock-intensive agriculture ticks many boxes - but is given little highlight. Get a graph on the mitigaiton potential that effective policy on sustainable agriculture could create. Remember, agriculture is defined by our diets. Address diets, you address the root causes. [Lindsey Cook, Germany]	Rejected. This has not been the focus of the assessment in this chapter.
42632	83	2			role for the achievement ===> role in the achievement [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
37400	83	3	83	9	Improving herd management is certainly an option to raise feeding efficiencies. However, many people are for good reasons concerned about animal product quality and livestock welfare resulting from only optimizing feeding efficiencies without any considerations about product quality or humane animal rearing. Letting animals roam requires area and reduces feeding efficiencies (as more feed is spent on animal motion than on growing muscle mass or fat), but it is required to maintain high product quality and ensure high standards of animal welfare. There are large literatures discussing these trade-offs and many people concerned about these issues, in particular those people who care about environmental issues like climate change, so I think it would be beneficial to discuss these tradeoffs and make sure that it would not be advisable to sacrifice product quality and animal welfare to squeeze the last little bit of feeding efficiency out of livestock. [Helmut Haberl, Austria]	Accepted - These trade-offs fall outside the scope of this chapter but are discussed in detail in chapter 4 and 5 of this special report.
42634	83	7	83	8	emissions- intensive ===> emissions intensive [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
44274	83	8	83	8	needs space between "products. N20" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51852	83	8	83	8	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
15790	83	9	83	10	This comment fails to recognise the potential for strategically placed bioenergy crops to "mop up" excess N applied to food crops (eg Gopalakrishnan, G., Negri, C. and Salas, W., 2012. Modeling biogeochemical impacts of bioenergy buffers with perennial grasses for a row?crop field in Illinois. Gcb Bioenergy, 4(6), pp.739-750. and others papers from this group ie Negri). The essential message is that the outcomes depend on the management (Davis, Sarah C., et al. "Management swing potential for bioenergy crops." Gcb Bioenergy 5.6 (2013): 623-638.) [Australia]	Taken into account - The text already stated that 'high levels of bioenergy production can also result in increased N2O emissions'. This has now been complemented by highlighting the importance of management, with reference to the second paper suggested by the reviewer.
30966	83	9	83	10	if the Kriegler scenario results in increased N2O I assume this is factored into the overall split in GHG in the scenario. This appears to be the case – figure 2.17 has net C02 levels way below the blue TPB line, implying that net CO2 is lower because non-CO2 is higher than median. If this is the case, is it that the N20 issue is the majority cause of higher non-CO2 emissions, or are there others? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Yes, the increase in N2O emissions from land-use is indeed factored in in the overarching requirement to limit radiative forcing and therewith global mean temperature rise. Both N2O and CH4 can contribute to variations in compatible CO2 emissions, see Section 2.2.
36	83	12	84	40	There is a significant recent literature on national pathways which is not cited here at all (see Herrala and Goel 2016 (cited in Ch. 4); du Pont 2017), even though it is clearly relevant for the topic. To address this issue, I would suggest to either 1) cite that literature; 2) change the box header, or 3) explain as an introduction that the above named literature on national pathways, which builds on a normative approach for burden sharing building on the Paris agreement, is not discussed here. [Risto Herrala, United States of America]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
3240	83	12	83	12	Language in Box 2.1 is very poor [Vassilis Daioglou, Netherlands]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
5858	83	12	85	2	I found this box very hard to read and understand. It picks a few countries and then discusses them in a way that does not feel structured. A thorough redraft of the box starting from a concept of the desired outcomes would be advisable in my view as a reader. [Peter Thorne, Ireland]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
18180	83	12			Useful since it brings in perspective from country level modelling studies however needs a better integration within the text and some reflection with the conclusions [Andrea TILCHE, Belgium]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
21480	83	12	85	2	The basic point of Box 2.1 beyond saying that there is a very rich literature on national pathways is unclear to me. The countries and scenarios shown in Box 2.1 seem to have been chosen on an ad-hoc basis and lack a logic. In particuar the figures shown in Box 2.1 don't provide much insights. I would therefore see potential to cut down the box to something like half a page and contribute to shortening the chapter. [Volker Krey, Austria]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
30844	83	12	83	12	Box 1.2 (nice!) is under section 2.4.4 so related only to Land use? If so the heading, at least, could be corrected, as for now the Box seems rather general. A similar Box, or expanded, for the other three sectors would be really appreciated. [Érika Mata, Sweden]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
1624	83	12	85	1	1) Why only four countries are presented here and only China present detail results? It is suggested to add more countries's studies. 2) What are the cumulative emission constraints assumed for China ? Only ADVACE project mentioned is not enough for readers to understand. For IPCC special report, whether it is politically senstivite? 3) This section presents the chanllenges to achive 1.5DS instead of feasbiliby. Modeling results presented can not explain "feasbility". 4) The data shown in Figure 2 didn't require much more non-fossile than former researches from other models for China on 2DS (Chen W et al., 2016. Towards low carbon development in China: a comparison of national and global models. Climatic Change, 136:95-108). Much higher chanllgens for energy system transformation after 2050 might be assumed in this study but no result provided, 5)Data shown in Figure 1 for cumulative coal and coke reductions fro 2010-2050 is very small compared to current coal cumsption (around 3700 million tons in 2016), indicating that there are still a large amount of coal exist by 2050. Data must be wrong. 6) 75US$/tCO2 (for 2050 or ? and Which year's constant price?) is much lower compared to other studies for 2DS (Chen W et al., 2016. Towards low carbon development in China: a comparison of national and global models. Climatic Change, 136:95-108). The author should compare and explain. [Wenying Chen, China]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
8342	83	12	85	2	In our opinion, the conclusion of the analysis concerning China in this paragraph does not match that of most of the Chinese studies on the transition to a low-carbon economy. It is suggested to delete box 2.1. The reasons include: 1. The realization of the global warming target depends on the joint efforts of all countries. However, this box lists only four countries that are not representative enough to support an analysis of the pathway to meet the global warming of 1.5?; 2. There are a lot of studies on China's future carbon emission scenario, the conclusions of which vary a lot. There are also significant differences in scenario settings and assumptions in different studies. There is still much uncertainty about how to achieve deep emission reduction. The conclusion in this box, which comes from a single paper, fails to fully consolidate research findings about China, hence irrational and unscientific; 3. The achievement of 1.5? is faced with many technical and economic challenges, which calls for a thorough analysis and demonstration of its feasibility under a sustainable framework; 4. There are several contradictions with regard to the findings about China. For example, according to the figure on the declining coal, only a decrease of 400 million tons in 2020-2050 can be obtained, which is substantially inconsistent with the annual decrease of 3% (equivalent to 60% in 30 years). Moreover, it is difficult to understand how a mere coal drop of 400 million tons enables the achievement of 1.5?. [China]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.

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35832	83	12	84	40	The significant progress made by India in the field of Renewable Energy may also be included. Following may be added in the report in Chapter-2. (Ref.:Draft National Energy Policy NITI Aayog, Government of India, 2017) Renewable energy accounted for 18.37% of the total power capacity in India in 2017. With rising maturity of renewable energy technologies, aided by decline in their costs and upon environment considerations, the India has already articulated its decision to boost Renewable Energy capacity. While a cumulative capacity target of 175 GW has been declared for the year 2022, by 2040 a likely capacity of 597-710 GW is expected to be achieved. The above capacity will translate into 50%-56% and 29%-36% Renewable Energy (excluding large hydro) capacity in installed capacity and generation from all power generation sources by 2040, in place of 14% and 6.5%, respectively in 2015-16. The period 2017-2040 will, therefore, witness a transformation in the electricity sector of India, calling for policy action across the entire value chain of generation, transmission and distribution. [India]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
37402	83	12	85	3	Much of this box is not up to the standards of an assessment report, in my view. There are many factual statements, even statements about the future, which is of course inherently uncertain, without any caveats. Moreover, large parts are not even backed up by references. Including such material in a report that will naturally be discussed critically in many aspects would greatly weaken the credibility of the whole report. In my view, this needs to be condensed and strongly revised, so that only statements supported by a broad assessment of the literature remain. All unbalanced or even speculative material as well as factual statements about the future need to be removed. [Helmut Haberl, Austria]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
60188	83	12	84	40	Framing four country case studies in terms of a 1.5°C carbon budget is unhelpful to the extent that the overall emissions from all other countries can vary. It may be better to focus on mitigation pathways based on feasible technology and policy options for these countries, and the associated emission reductions. [United States of America]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
61776	83	12	85	2	I do not understand the focus of this box. The title refers to "national pathway literature", the introduction describes basically four case studies (not literature), the text reads as a description rather than an assessment, and the second half of the box is only focused on China, with two illustrations for China, without any assessment of the discussed national pathway, described as a narrative of future changes rather than an assessment of feasibility issues. [Valérie Masson-Delmotte, France]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
848	83	14	83	14	analysis with looking into different background' should be 'analysis looking into different backgrounds' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
35834	83	17	83	18	More citations may be added here on India's emission trajectories (e.g. Anantha Lakshmi P., Nazar K., et al., (2018) A multi-model assessment of energy and emissions for India's transportation sector through 2050, Energy Policy; Srinivasan et al (2018) Water for electricity in India: A multi-model study of future challenges and linkages to climate change mitigation, Applied Energy; Byravan et al. (2017) Quality of life for all: A sustainable development framework for India's climate policy reduces greenhouse gas emissions, Energy for Sustainable Development 39 (2017) 48–58) [India]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
58052	83	21	83	21	The word "base" should be "based" in the phrase "carbon budget base on" to read "carbon budget based on." [Siir KILKIS, Turkey]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
55542	83	30	83	38	The following reference presents the use of MARKAL/TIMES to define well below 2D portfolios at global (5 case studies), national (15 case studies on 15 different countries) and local levels (3 case studies on cities). Giannakidis G., K. Karlsson, M. Labriet, B. Ó Gallachóir (eds.), 2018. Limiting Global Warming to Well Below 2°C: Energy System Modelling and Policy Development. Springer, Lecture Notes in Energy, in press. This book shows that a well below 2°C world is feasible but extremely challenging. [Maryse Labriet, Spain]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
850	83	32	83	32	used different type model, with downscaling from global model by SIAMESE is' should be 'used a different type model, with downscaling from global model by SIAMESE is then' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
42636	83	32			from global ===> from the global [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
852	83	49	83	49	In energy sector, BECCS are key option in Japan and China's study, with share of total power' should be 'In the energy sector, BECCS is a key option in Japan and China's study, with the share of total power' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
854	83	50	83	50	BECCS) takes large share by' should be 'BECCS) takes a large share by' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
856	83	51	83	51	Nuclear is yet a major source' should be 'Nuclear is still a major source' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
13528	83	53	83	53	approximately of of 590million tonnes per year. [Sergio Aquino, Canada]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
858	83	55	83	55	the top option in in Japan,' should be 'the top option in Japan,' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
39462	83	55	83	55	There are "in" two times together in the sentence [Olga Alcaraz, Spain]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
47818	83	55	83	55	Kindly delete repeated words: "in" [Sarah Connors, France]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
58054	83	55	83	55	There is an extra word "in" in the phrase "top option in in Japan." [Siir KILKIS, Turkey]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
354	84	1	85	50	adding more countries examples. [Zong-Ci Zhao, China]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
860	84	1	84	1	electricity use in end use increases' should be 'electricity use in end use sectors increases' [Robert Shapiro, United States of America]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
2088	84	1			incomprehensible [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
862	84	2	84	2	fossil fuel use in building in 2050' should be 'fossil fuel use in buildings in 2050' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
51854	84	2	84	2	What is meant by 'building' in this sentence? This is unclear. [Jason Donev, Canada]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
864	84	4	84	4	make transport nearly to be zero emission' should be 'make transport nearly zero emissions' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
18182	84	7	84	11	The carbon prices quoted in this study are quite high. In this context it is important to note that carbon prices emerging from modelling studies are often 'symbolic'. i.e. while they represent the shadow price required in a model, implementing such measures in reality would involve a number of non-tax-based approaches (e.g. efficiency standards for products, vehicles & buildings). [Andrea TILCHE, Belgium]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
13530	84	8	84	8	not clear: USD2200USD [Sergio Aquino, Canada]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
41552	84	8			Change "USD2200USD" to "2200 USD" [Czech Republic]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
51856	84	8	84	9	USD?? [Jason Donev, Canada]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
60190	84	8	84	9	These carbon taxes are not believable (especially in Japan). Also, when do they start? [United States of America]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
41554	84	9			Change "USD130USD" to "130 USD" and "USD75USD" to "75 USD" [Czech Republic]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
866	84	10	84	10	therefore the carbon price is relative' should be 'therefore the carbon price is relatively' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
51858	84	10	84	10	FIT isn't defined anywhere (I assume feed in tarrif, but that may not be clear to others) [Jason Donev, Canada]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
868	84	14	84	14	curve are included, and electric car could be cheaper than gasoline car after 2025. Role of carbon price' should be 'curve is included, and electric cars could be cheaper than gasoline cars after 2025. The role of carbon price' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
2090	84	14			curves plural [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
870	84	20	84	20	There will significantly change' should be 'There will be a significant change' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
13372	84	20	84	40	There will significantly change…. Hard to follow sentence - words missing? Section maybe not drafted by native english speaker so would benefit from an edit. [Scott Vivian, United Kingdom (of Great Britain and Northern Ireland)]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
58056	84	20	84	20	The phrase "There will significantly change" may be rephrased as "There will be a significant change" to comply with the context of the sentence. [Siir KILKIS, Turkey]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
872	84	21	84	21	especially in near term. If there is not near term rapid change' should be 'especially in the near term. If there is not a near term rapid change' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
874	84	25	84	25	18.4million ton per year' should be '18.4million tons per year' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
22658	84	25			Insert a space between "18.4million" [LUIS VALDES, Spain]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
44276	84	25	84	52	needs space between "18.4 million" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
876	84	27	84	27	car dominate market' should be 'cars dominating the market' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
878	84	28	84	28	heavy duty vehicle and vessels will departure for market after' should be 'heavy duty vehicles and vessels will dominate the market after' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
28102	84	30	84	32	Box 2.1, Figure 1: units of y-axis not indicated; by contrast, in Figure 2 these units are given. [Germany]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
46636	84	30	84	32	Colourblind check for this figure. Please avoid using greens and reds together in figures as they are hard to distinguish between. [Sarah Connors, France]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
51860	84	32	84	32	Is this percent? EJ? No axis on graph. [Jason Donev, Canada]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
246	84	34	84	40	The rôle of nuclear energy should also be stressed. Figure 2 in Box 2.1 is misleading because it relates to power and not energy production.In power the ratio of solar power to nuclear power is 4, while in produced energy it is only 0.5 [Herve Nifenecker, France]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
880	84	34	84	34	increase rapidly in future' should be 'increase rapidly in the future' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
882	84	35	84	35	2030, comparing' should be '2030, compared' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
51862	84	35	84	35	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
58058	84	35	84	38	There are missing spacings between the numerical values and the units of GW in multiple instances. [Siir KILKIS, Turkey]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
47070	84	36	84	40	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
51864	84	36	84	36	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
884	84	37	84	37	comparing with that' should be 'compared with that' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
886	84	38	84	38	power generation need to be 10GW' should be 'power generation needs to be 10GW' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
888	84	39	84	39	BECCS in long term.' should be 'BECCS in the long term.' [Robert Shapiro, United States of America]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.
18188	85		107		This section contains some crucial findings. However, it also requires substantial shortening and editing so that its most important findings (i.e. messages targeted 1.5°C compared to other pathways) stand out. At times it reads like a mini-assessment report. It also duplicates findings from elsewhere in the Ch2 and beyond. [Andrea TILCHE, Belgium]	Taken into account - During the revisions of the SOD, Section 2.5 has been streamlined and shortened. Discussions on IAMs have moved to Section 2.3. as well as the Technical Annex, while the overall text and assessment in Section 2.4 has been cleaned up and tightened
45584	85				Increased development of agro-forestry systems and promotion of urban and peri-urban agriculture should be both included in section '2.5. Challenges, opportunities and co-impacts of transformative mitigation pathways' to be considered among essential policies that should be implemented to mitigate climate change. Include also in Table 2.14. [Adela M Sánchez-Moreiras, Spain]	Rejected - The assessment should be based on evidence available in the literature. The reviewer's comment expresses an opinion without providing scientific evidence as to why these options should be included.
56472	85		98		Just imagine a different way to predict the future, ask business to project their product range and it succes on the consumer market. [Henk Daalder, Netherlands]	Noted. No further action by the author team.
58488	85		98		Section 2.5.1 could be usefully reviewed in parallel with parts of chapter 4, to ensure consistency and minimse overlap [Andrew Prag, France]	Taken into account - during the preparation of the final government draft, a cross-chapter review period allowed for authors from various chapters to comment and check sections from other chapters.
46638	85	1	85	2	Colourblind check for this figure. Please avoid using greens and reds together in figures as they are hard to distinguish between. [Sarah Connors, France]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
57210	85	1	85	2	the figure is obviously outdated for the case of solar in China, since in 2020-2025 it should be around 24 GW/a - in 2017 it had been alread 53 GW, i.e. 10 years faster than in that diagram. It may be embarassing to present in the final report such outdated numbers, and they would be outdated by about 1 year at the time of publishing, hence update of the diagram strongly recommended [Christian Breyer, Finland]	Not applicable anymore - Due to limitations in scope and space, this box has been removed during the revisions of the SOD.
10514	85	2	85	2	The style and quality of Figures 1 and 2 in Box 2.1 are not the same with other figures in this chapter. [Hong Yang, Switzerland]	Noted, but not applicable anymore. Box 2.1 has not been included in the FGD.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
18184	85	5			The section should be looking at barriers/ challenges, opportunities and co-impacts of the mitigation actions identified in Table 2.9. For this it should be looking at a barriers, value chains, life cycle analysis and not a description of policy narratives within IAMs which are not very useful for the reader. Some part of this discussion is already in Chapter 4 and therefore it would not do much harm if this section is taken out. [Andrea TILCHE, Belgium]	Noted - The examples mentioned by the reviewer are the domain of Chapter 4. In fact, most contents from table 2.9 have been moved to that Chapter. Ch2 concentrates on the mitigation integrated pathways available literature (see section 2.1), which is heavily dominated by IAM. So-called 'reality checks', or both adaptation and mitigation policy responses (e.g. policy choice) beyond the integrated pathway literature are treated in Ch4. Policy narratives in IAMs are the domain of Ch2.
40384	85	7	85	14	Clear examples of intergenerational policy should be inserted in Chapter 2 and Chapter 4 (policies and governance). [Erick Pajares, Peru]	Noted - These aspects are covered in Ch4 and Ch5, in particular, where sustainable development implications are assessed in detail. In addition, and from an economic and ethical point of view, please note that intergenerational aspects have been already treated in AR5 (WG3). See Chapter 3.
11918	85	17	85	17	this is a really interesting and very clear discussion. The significance of ssps and spas should be communicated more prominently however, e.g. through the executive summary [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - Key methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2. See section 2.1. and also technical annex.
30848	85	17	90	9	Section 2.5.1 seems a core methodological section to which a scientific reader should be directed since the very begining of Chapter 2 (and possibly of the SR). The understanding of the underlyging assumptions and modelling limitations is a condition for a proper interpretation of the previous sections in the chapter. [Érika Mata, Sweden]	Taken into account - Key methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2 and technical annex. This also includes limitations of IAMs.
50232	85	17	96	43	This section on the role of policy is very unsatisfactory. What I expect from a discussion on policy requirements for 1.5C strategies is insight in the role of various policy instruments. However, most of this section actually discusses mitigation options and the need to reduce emissions quickly and deeply. It hardly discusses the choice of policy instruments, while that is what policy makers need to hear. A huge limittaion of the IAM literature is (and that is even acknowledged in the section) the fact that the dominant instrument used in the studies is a carbon tax. And as we know that introducing effective carbon taxes (or at least a significant price of carbon) is politically very difficult (as past experience shows), it is not very helpful to rely on carbon pricing as the dominant policy instrument if useful advice to policy makers is given. What seems to emerge from the literature is a slowly growing recognition of modelers that assuming carbon pricing as the dominant policy instrument is not very helpful and so some studies now assume a mix of policy instruments. It is not very clear from the section what exactly these new assumptions are unfortunately and so the section does not draw clear conclusion that policy makers can use. I suggest to use a different approach in discussing the issue of policy and that is to acknowledge that strong carbon pricing would be ideal, but is unlikely to ermerge in time. And that this means that other policy instruments (regulation, standards, subsidies, influencing behaviour, etc) need to drive the rapid emission reductions. We simply cannot afford anymore (if we take the 1.5C limit seriously) to wait for a carbon price to be high enough to have sufficent impact. That such an approach is economically less efficient than economy wide carbon pricing needs to be acknowledged. But the overarching message should be that governments should not rely on carbon pricing to bring down emissions sufficiently fast. It can help as part of a package and the higher and the broader the carbon price the better, but that is it. Coming to such conclusions is probably hard, based only on IAM literature. Then a combination with the discussion in chapter 4 using other strands of literature might be needed, even in the form of moving the whole policy discussion to chapter 4, if needed. [Bert Metz, Netherlands]	Noted - The section focuses on the challenges and opportunities related to policy regimes, price of carbon and co-impacts, including sustainable development issues, which can be derived from the existing Integrated Pathway literature and scenario comparison. Based on this, and considering the available/accepted literature, attention is given various aspects raised by the reviewers. This includes needed policy portfolios beyond carbon pricing. This includes regulations, procurement, information schemes, fiscal policy, standards, mandates, etc. and carbon pricing. Various modelling studies (recently accepted: cut off date May 15, 2018) are assessed. That said, the latest scenario literature looks at existing policy instruments and those pledged under the NDCs quite explicitly. In a nutshell, the combined literature shows that policies addressing the decarbonisation of the power generation, fuel switching and energy efficiency are critical (e.g. to reduce the need of negative emission technologies) and that carbon pricing is important but insufficient to drive the changes that 1.5-2C pathways require. It also explicitly acknowledged that an 'optimal' carbon price of the magnitude estimated in needs to be compared with what is politically feasible at the international, national, and sectoral level. Anything beyond that is outside the mandate of Ch2. For details about the choice of instruments, please see Ch4: 'Strengthening and implementing the global response'.
58134	85	17			Sorry, but the sub-section title "Policy narratives" sounds not really serious. To me it appears like some academics do not take themselfes and the problem serious. I recommend to re-phrase it to "Policy Frameworks" [Nico Bauer, Germany]	Taken into account - The title has been slightly modified.
9704	85	19	87	19	Section 2.5.1: Policy realism would require that NDCs guide the thinking and feasiblity of 1.5c world. The current NDCs can only be revised after the first round of global stocktake in 2023. Assuming that countries would be willing to revise their NDCs upward, implementation may not be expected before 2025. I wonder if the current modeling work or any specific study has explored the implication of such realistic circumstances on the feasibility of 1.5c given the currrent conclusion that NDCs covering up to 2030 are not consistent with 1.5c. That is to say will current NDCs up to 2025 be made for to be consistent with 1.5c after enhancement in 2023? [Mustafa BABIKER, Sudan]	Noted - Current NDCs are estimated to result in greenhouse gas emissions of ~49-56 GtCO2-eq yr-1 in 2030. In contrast, 1.5°C scenarios available to this assessment show an interquartile range of 14 to 48 GtCO2-eq yr-1 in 2030. If current pledges are followed to 2030, there are no model scenarios in which average warming is kept below 1.5°C. See section 2.3. In 2023, NDCs for 2035 would be submitted. Strengthening of NDCs for 2030 would need to happen by 2020, before the 2023 stocktake. Section 2.3.5 assesses pathways that do not strengthen NDC emissions reductions before 2030. A key message is that not strengthening 2030 NDCs will make it very challenging to keep 1.5°C in reach.
18186	85	19	86	19	Studies that assume a global carbon price provide valuable insights even if such a carbon price is not feasible from a political-economy perspective. This should be stated more clearly. In the real world, scenarios of this kind could be implemented through a variety of measures (and potentially at lower cost than through a carbon price alone). In other words, global price scenarios are still useful even if the global price itself is not be implemented. In this sense, such scenarios are complementary to the discussion of policy instruments later in the chapter. See also p99 lines 43-48 which discuss carbon taxes/prices in the context of complementary measures. In a modelling setup, demand-side actions and command-and-control measures can appear to be free of charge, and also reduce the value of the carbon tax that would otherwise be necessary. This is an important finding for policymakers (with the caveat that in the real world, such measures are not 'free' but are more political/institutional than technoeconomic). [Andrea TILCHE, Belgium]	Taken into account - This issue is elaborated more explicitly and expanded with the latest accepted literature. More cases in which carbon pricing is complemented by other policy instruments are also assessed. This is based on peer-reviewed accepted literature (cut off date May 15, 2018).
45956	85	21	85	21	Please clarify how you define effective. Dies this perhaps refer to cost-effective? [Deger Saygin, Turkey]	Taken into account - This sentence has been removed during the revisions of Section 2.5
21502	85	23	85	23	How is the carbon price determined? [Nathalie HILMI, France]	Taken into account - The concept of carbon prices are clarified in the cross-chapter box on macro-economics. (cross-chapter Box 5)
39156	85	24	85	27	Noting global markets and economies, it is of concern if the SR 1.5C fails to collate research on how these global markets and economies are, in themselves, part of the problem. The AR5 stated that economic growth and polution growth were the main drivers of CO2, but it is unclear if the SR 1.5C really engages with this. We need the science community to speak plainly and unideologically to policy makers. [Lindsey Cook, Germany]	Noted. The SR1.5's mandate is to assess the scientific literature. If these aspects are available in the literature, they will be assessed.
51866	85	27	85	27	Missing space in footnote. [Jason Donev, Canada]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
44278	86	2	86	2	Perhaps the reference to the whole chapter 4 may make it difficult to find, therefore a section reference may be more appropriated. Same comment for page 2-87 line 4 And 2-90 line 39 [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - All cross-REF with ch4 are being updated based on the latest versions.
21504	86	6	86	19	Not clear: what has the modelisation concluded. We just know that they are not perfect. [Nathalie HILMI, France]	Noted - It is unclear what the comment is about. However, please note that key methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2. See section 2.1 and technical annex.
28104	86	6	86	14	The following paragraph points out the need for transformational change in mitigation and adaptation pathways; additionally it describes that transformation is an social process including stakeholder involvement. "Socio-technical transitions literature points to multiple complexities in real-world settings that prevent reaching such idealised policy conditions but at the same time can still accelerate transformative change through other co-evolutionary processes of technology and society (Geels et al., 2017; Rockström et al., 2017). Such co-evolutionary processes reach beyond the role of policy only and include the role of citizens, businesses, stakeholder groups or governments, as well as the interplay of institutional and socio-political dimensions in shaping mitigation pathways. It has been argued that large system transformations, similar to those in 1.5°C mitigation pathways, require prioritizing an evolutionary and behavioural framework in economic theory rather than an optimization or equilibrium framework as is common in current IAMs (Grubb et al.; Patt, 2017)." These findings are important for the future development and the implementation of pathways, hence we suggest they should be considered in the Executive Summary of the Chapter after P8L17 (or: P7L47; it also could be integrated after P5L51). [Germany]	Noted - The executive summary aims to capture the most important issues that are related to the purpose of the chapter and the integrated pathway literature. Aspects related to socio-technical transitions beyond the integrated pathway literature are addressed in Ch4. In this particular case, knowledge gaps are identified. Specific issues about policy implementation, policy choice, role of stakeholders and behavioural change can be found in Chapter 4.
21506	86	10	86	10	This point should be stressed: the role of policy in relation to all stakeholders [Nathalie HILMI, France]	Noted
4558	86	11	86	14	Pointing out these limitations of the present modeling tool set is very much appreciated but should be elaborated on: what are the boundaries of the current modeling tools with regard to the depiction of a socio-ecological transformation? [Kai Kuhnhenn, Germany]	Taken into account - Key methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2. This also includes limitations of IAMs and aspects related to socio-technical transformation (aspects that were in section 2.6 but now moved to section 2.1). See section 2.1 and technical annex.
42638	86	13			behavioural ===> behavioral [Egypt]	Editorial
42640	86	14			modelling ===> modeling [Egypt]	Editorial
47820	86	14	86	14	Kindly check: Grubb et al.;…….year missing in citation [Sarah Connors, France]	Noted - Year has been added to Mendeley database
42642	86	15			behavioural ===> behavioral [Egypt]	Editorial
13532	86	23	86	34	space between 'stabilisation.Modelling' [Sergio Aquino, Canada]	Editorial - Space was added
22660	86	23			Insert a space between "stabilization.Modelling" [LUIS VALDES, Spain]	Editorial - Space was added
39464	86	23	86	23	Between stabilisation.Modelling there must be a free space: stabilisation. Modelling [Olga Alcaraz, Spain]	Editorial - Space was added
44280	86	23	86	23	needs space between "stablisation. Modelling" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Editorial - Space was added
60192	86	28	86	28	National mitigation policies will start to converge and align in 2 years? A bit optimistic. [United States of America]	Noted - Clarification: Please note that SPAs assume fragmented mitigation policies until 2020, and vary in global convergence thereafter (Riahi et al., 2017). This does note mean that they converge immediately after 2 years. At all events, all methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2. See section 2.1 and technical annex.
890	86	34	86	34	Table 2.12' should be 'Figure 2.12' [Robert Shapiro, United States of America]	Rejected - Tables are correctly (and automatically) labelled
44282	86	34	86	34	needs space between "2.12). The" [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Editorial - Space was added
892	86	35	86	35	Table 2.12' should be 'Figure 2.12' [Robert Shapiro, United States of America]	Rejected - Tables are correctly (and automatically) labelled
51868	86	40	86	40	Energy intensity may not be well understood by the reader. Lower is better, but it wuold be more clear to simply say 'better' to remove the ambiguity. [Jason Donev, Canada]	Noted - energy intensity is used consistently across ch2
8256	86	45	86	47	This sentence on carbon leakage should be amended to read "... fragmented policy scenarios can sometimes also exhibit "carbon leakage"...". Carbon leakage does not necessarily materialise as soon as there is policy asymmetry between countries, and the evidence on the existence and extent of carbon leakage in existing climate policy around the world is limited. in addition, any potential risk of carbon leakage can be prevented through corrective policies such as revenue recycling or revenue-neutral auctions in carbon pricing schemes. [Kelsey Perlman, France]	Taken into account - the issue of carbon leakage has been made more specific. Please note that we refer to the integrated pathway literature. For real market issues see Ch4.
894	86	52	86	52	Table 2.13' should be 'Figure 2.13' [Robert Shapiro, United States of America]	Rejected - Tables are correctly (and automatically) labelled
39158	87	1	87	19	These are critical and profound findings, yet lost in complex language. Remember that your audience is primarily non-scientist, and non native English speakers. [Lindsey Cook, Germany]	Noted - Language is constantly improved across the report
39466	88		88		In the box SSP3-SPA3/Policy Coverage of land use emissions, limitedpricing must be limited pricing [Olga Alcaraz, Spain]	Editorial - Space was added
41556	88				Change "12600 USDUSDyr" to "12600 USD yr" in part F3 [Czech Republic]	Editorial - repeated 'USD' was removed
51260	88		88		In the entry at second column of row "SSP3-SPA3", "USD USD" may be replaced with "USD". [Muhammad Latif, Pakistan]	Editorial - repeated 'USD' was removed
44284	88		88		in second column ssp3 it states 12600 USDUSDyr-1 [Moshe Kinn, United Kingdom (of Great Britain and Northern Ireland)]	Editorial - repeated 'USD' was removed
39160	88	1	88	30	Why do the SSPs fail to include diet changes under land use, or clear agriculture practice shifts away from intensive and animal agriculture, when previously you wrote that these shifts would make a significant mitigation difference? [Lindsey Cook, Germany]	Taken into account - Dietary aspects of the SSPs are covered in Popp et al. 2017 (GEC) which clearly states the more climate friendly diet of SSP1 and the meat-intensive diets of SSP3 and SSP5.
44876	88	1	88	1	4th row, third column in Table 2.12: limitedpricing--> limited pricing [Hiroaki Kondo, Japan]	Editorial - Space was added
46538	88	1	88	1	Bottom-Right Cell of table: Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Noted - language being used in the table does not related to IPCC uncertainty langue and therefore is not in italics.
51870	88	1	88	1	Renewable energy sources like wind and solar, aren't 'energy carriers' they're primary energy sources. Electricity is a carrier. Appears in more than one box. [Jason Donev, Canada]	Noted - Key methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2. See section 2.1. and technical annex.
51872	88	1	88	1	The USD appearing more than once in a unit is confusing, is this right? [Jason Donev, Canada]	Editorial - repeated 'USD' was removed
42644	89	3			industry ===> industrial [Egypt]	Noted - Text is taken from source (Riahi et al. 2017).

Comment No	From Page	From Line	To Page	To Line	Comment	Response
11920	90	1	90	1	Why can GCAM and AIM solve an intermediate challenge sceanrio (SSP2-SPA2) but not a low one (SSP4-SPA4)? Are the descriptors right? [United Kingdom (of Great Britain and Northern Ireland)]	Noted - Because SPA4 does not allow to control land use emissions as well as in SPA2, which starts playing an increasing role in very deep mitigation scenarios. So the challenge in SSP4 increases with target stringency due to the challenges in the land sector
3242	90	1	90	1	For SSP4-SPA4, how come GCAM4 is the marker, while bieng infeasible, instead of WITCH-GLOBIOM which was the only successful scenario? [Vassilis Daioglou, Netherlands]	Taken into account - The idea of a marker is to be representative for that storyline. If x models for SSP4 at a given RCP level are not feasible and just one model is feasible, this des not speak in favour of picking that one as the marker as it would mean picking an outlier to be representative. Riahi et al. 2017 (GEC) describes the marker concept quite explicitly: "It is important to note that while the markers can be interpreted as representative of a specific SSP development, they are not meant to provide a central or median estimate." Please note that key methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2. See section 2.1. and technical annex.
39468	90	3	90	3	Between SSP3-SPA3for there must be a free space: SSP3-SPA3 for [Olga Alcaraz, Spain]	Editorial - Space was added
15792	90	8	90	8	Marker implementations - Suggest reword for clarity [Australia]	Taken into account - The idea of a marker is to be representative for that storyline. If x models for SSP4 at a given RCP level are not feasible and just one model is feasible, this des not speak in favour of picking that one as the marker as it would mean picking an outlier to be representative. Riahi et al. 2017 (GEC) describes the marker concept quite explicitly: "It is important to note that while the markers can be interpreted as representative of a specific SSP development, they are not meant to provide a central or median estimate." Please note that key methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2. See section 2.1. and Annex
39470	90	8	90	8	Between anew there must be a free space: a new [Olga Alcaraz, Spain]	Editorial - Space was added
42646	90	8			modelling ===> modeling [Egypt]	Editorial
1588	90	11	90	21	The authors should clarify at the very beginning that the most effective policies that have been put in place to dates are mandates and RPSs for 100% clean, renewable energy, At least 55 cities U.S. cities (e.g., https://www.sierraclub.org/ready-for-100), over 115 international companies (http://there100.org/companies), and four states (Hawaii, California, Massachusetts, New York) have either implemented or proposed into law or make commitments for 100% clean renewable energy in one or more sectors. This is also what 82% of the world wants, according to a poll of 26,000 people in 13 countries (https://orsted.com/-/media/WWW/Docs/Corp/COM/Barometer-campaign/Green-Energy-Barometer-2017_with-appendix.ashx?la=en&hash=65C5D0F30494C277249CA7622AF0229AD5B6D3CB) [Mark Jacobson, United States of America]	Rejected - Empirical aspects of already implemented policies are treated in Ch4, where 'reality checks' are elaborated; including policy choices.
56854	90	11	92	26	This section is very focused on carbon pricing and, even if it touches upon regulatory measures and other instruments inducing changes in consumer choices, it could do a better job to acknowledge the importance of these measures, given that they represent the bulk of policy action currently being deployed on the ground. Planning and compact city measures are a category of policy instruments that seem to be fully neglected here, even if it they are crucial to induce structural changes in building structure, tip distances and modal choices. These measures have been included as drivers of the B2DS results in the IEA-ETP transport analysis referenced earlier in Chapter 2. Gven the relevance given to these results, I think that this section should explicitly mention these policy instruments. [Pierpaolo Cazzola, France]	Taken into account - Key methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2. See section 2.1. The IEA-ETP B2DS is included in our chapter and the measures stressed by the reviewers duly included. See also section 2.4.
58132	90	11			The sub-section 2.5.1.1 should concentrate and focus on policies. It makes no sense for me to read something about the equilibrium climate sensitivity and other unrelated stuff. This sub-section must give insight and detail into carbon pricing regimes and the magnitudes. It must put extremely high carbon prices in context with strong emission reductions. It must clarify the additional emission reductions by sector, gas and region. And it must clarify the distributional consequences. The overall critique like on page [Nico Bauer, Germany]	Noted - The section has been streamlined and focused more on policy frameworks that can be derived from the integrated pathway literature. Emissions reductions by sector are in Sec 2.3 and 2.4. Distributional aspects are left to Ch3 (impacts - see also AR5 WGIII) and Ch5 (as far as sustainable development issues are concerned).
60194	90	11	92	28	Section 2.5.1.1 is repetitive and refers to several other sections in Chapters 2-5. This section could be one area for streamlining the length of the chapter. [United States of America]	Taken into account - Key methodological aspects driving/framing the assessment are now consolidated and explained at the beginning of Ch2 and Annex. See section 2.1 and technical annex.
29638	90	13	90	13	Please embed after "policy regimes": (see Michaelowa et al. 2018 for a discussion about appropriateness of policies for a 1.5°C scenario)." Reference: Michaelowa, Axel; Allen, Myles; Fu Sha (2018): Policy instruments for limiting global temperature rise to 1.5°C – can humanity rise to the challenge?, in: Climate Policy, 18, p. 275-286 [Mareike Blum, Germany]	Taken into account - Thanks for the suggestion. The paper was reviewed and issues pertaining to implementation challenges in integrated pathway studies were duly included.
11922	90	14	90	16	Scenarios that encompass weak and fragmented policy regimes are unable to limit global warming below a 1.5°C or 2°C limit with high likelihood (Blanford et al., 2014; Clarke et al., 2014; Luderer et al., 2016a). Such regimes also include the current NDCs - this is a very important statement: is it saying that not only are current efforts short of where we ideally should be, but also if followed they risk leaving it unatainable? [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - Aspects related to NDC have been sharpened and insufficiency issues are also addressed in the executive summary. Section 2.3.5 assesses pathways that do not strengthen NDC emissions reductions before 2030.
11924	90	16	90	16	this point about ndcs is important. If this is the case, you need to make clear to policy makers that not only are current ndc pledges inadequate but that the nature of ndcs is inadequate. Don't bury this point deep in the report. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - Aspects related to NDC have been sharpened and insufficiency issues are also addressed in the executive summary. Section 2.3.5 assesses pathways that do not strengthen NDC emissions reductions before 2030.
63220	90	20	90	21	Weak (or lack of integrated) policy portfolios also increase the risks of trade-offs between mitigation approaches and sustainable development objectives (See Chapter 5 Section 5.4). Why are trade-offs here necessarily risky/unwanted? The risk is not necesarily the size or number of trade-offs of a mitigation approach,the measure of merit should be the net benefit of the approach = (contribution to climate and SD goals) minus (climate and SD impeded, put at risk or made worse by the approach). An approach with high trade-offs could thus have much higher benefits, making the trade-off amount irrelevant. In any case a careful definitioin of "trade-offs" relative to benefits needs to be made up front in this chapter. [Greg Rau, United States of America]	Taken into account - The literature indeed often considers trade-offs in a rather narrow sense, that is, without considering the full systemic response to a specific policy. A good example of this are trade-offs of blanket carbon pricing for climate policy, without considering the benefits of avoiding climate change. See section 2.5.3 and Ch5.
21508	90	23	90	24	Any reference for "complete decarbonisation"? [Nathalie HILMI, France]	Noted - details in sections 2.3 and 2.4 of Ch2. Cross ref is now provided
35838	90	23	90	24	In the statement "Modelled policy options allow global emissions to peak by 2020 and can drive the complete 24 decarbonisation of the energy-economy system by approximately mid-century", approximate year to be added (e.g. 2050) [India]	Accepted - Approximate year added

Comment No	From Page	From Line	To Page	To Line	Comment	Response
13534	90	24	90	24	separate thatCO2 [Sergio Aquino, Canada]	Editorial - Space was added
22662	90	24			Insert a space between "thatCO2" [LUIS VALDES, Spain]	Editorial - Space was added
39472	90	24	90	24	Between thatCO2 there must be a free space: that CO2 [Olga Alcaraz, Spain]	Editorial - Space was added
51874	90	24	90	24	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Editorial - Indeed, these layout/formatting issues did not exist in the word version
58060	90	24	90	25	There are missing spacings in the phrases "Note thatCO?" and "2014and 2016." [Siir KILKIS, Turkey]	Editorial - Space was added
22664	90	25			Insert a space between "2014and" [LUIS VALDES, Spain]	Editorial - Space was added
39474	90	25	90	25	Between 2014and there must be a free space: 2014 and [Olga Alcaraz, Spain]	Editorial - Space was added
39162	90	26	90	36	Good, clear language, thank you, but you fail to include reduction in livestock / animal-intensive agriculture, while having stated earlier in the chapter that this would make a significant difference on GHG mitigation as well as environmental pollution levels. Why? [Lindsey Cook, Germany]	Noted - Detailed mitigation options are provided in sections 2.3 and 2.4. The reduction of GHG intensity of agriculture was mentioned in line 33.
38	90	29	90	29	Please also cite Herrala and Goel (2016, cited in Ch 4), which is a more recent study than the one cited, making the point that emission at country level need to peak at latest during the ongoing decade. [Risto Herrala, United States of America]	Noted - Aspects related to the timing of peak emissions are the domain of sections 2.3. and 2.4.
18190	90	29	90	34	It should be recognised here and elsewhere that, in the case of bioenergy (and, in particular, the critical role of BECCS), the "energy sector" cannot be separated from land use, as its existence and mitigation performance depends crucially on land use, and its development is likely to increasingly drive land use. Therefore, it is also incorrect to present as sectors "outside the energy supply", as these land uses and activities are going to be major sources of the energy supply and or the sole sources of the assumed "negative emissions" in the energy sector. [Andrea TILCHE, Belgium]	Taken into account - These issues are treated more explicitly in section 2.3 where CDR options are discussed more in detail. The sentence was revised and move to section 2.3.4. Ch 4 also addresses the role of BECCS.
55638	90	31	90	34	after "afforestation and/or reforestation), insert "restoration of other ecosystems". [David Cooper, Canada]	Editorial
11926	90	35	90	38	Studies also show that technology policies can have an important role with regards to development and uptake of zero-carbon technologies in the shorter term but that in the longer term, strong carbon pricing mechanisms can be necessary to ensure efficient reductions in GHG emissions (high confidence; Kriegler et al., 38 2015b). - what about energy efficiency policy? How does this link ot the discussion below on more bottom up and mixed policy approaches? [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - Demand side policies play a role in, e.g. keeping the 1.5C target within reach, reducing mitigation costs, etc. The emerging literature indicates that a carbon price is insufficient and a stringent policy mix (including energy efficiency) is required. Literature recently accepted (May 15) was assessed and included.
46588	90	37	90	37	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Noted - IPCC uncertainty language is now explicitly used across Ch2.
13536	90	38	90	38	separate 2015b).Model [Sergio Aquino, Canada]	Editorial - Space was added
22666	90	38			Insert a space between "2015b).Model" [LUIS VALDES, Spain]	Editorial - Space was added
39476	90	38	90	38	Between 2015b).Model there must be a free space: 2015b). Model [Olga Alcaraz, Spain]	Editorial - Space was added
42778	90	38	90	42	Contrast this with the potential for the fat tail risk of climate change, where there is a low probability but far higher risk from far more dramatic warming. Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1618481114. [Kristin Campbell, United States of America]	Taken into account - The paper has been reviewed and its contents reviewed. It is now duly integrated in the section. Thank you for the suggestion.
43008	90	38	90	42	Contrast this with the potential for the fat tail risk of climate change, where there is a low probability but far higher risk from far more dramatic warming. See Ramanathan and Feng (2008) On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.0803838105; and Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1618481114; and Report of the Committee to Prevent Extreme Climate Change (Chairs: V. Ramanathan, M. L. Molina, and D. Zaelke) (2017) Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change. [Durwood Zaelke, United States of America]	Taken into account - The paper has been reviewed and its contents reviewed. It is now duly integrated in the section. Thank you for the suggestion.
51876	90	38	90	38	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Editorial - Indeed, these layout/formatting issues did not exist in the word version
18192	91	2	91	14	In this paragraph or elsewhere (perhaps p. 92, row 5), reference should be made to the issue of split incentives between the energy and land use sectors. To the extent bioenergy (the USE of biomass for energy) is considered and promoted and "carbon neutral", it is likely to drive biomass and land demand in a way that may be counterproductive at the macro scale, as has been the case with first-generation biofuels and bioenergy from the harvest of forest (as opposed to using residues or creating additional biomass sources before deploying bioenergy). An optimal outcome would require a correct estimation and attribution of all emissions and removals, and applying incentives proportionally in all sectors. [Andrea TILCHE, Belgium]	Noted - Aspects related to the use of biomass for energy are treated in section 2.3. (including BECCS) and section 2.4.2 (energy supply). Aspects outside the integrated pathway literature that relates to bioenergy are treated in Ch4 and also Ch5 (e.g. in relation to sustainable development).
21510	91	2	91	14	About the role of regulatory policies and public budget (subsidies and taxes), the impact is different in developed and developing countries. [Nathalie HILMI, France]	Noted - Aspects outside the Integrated Pathway literature are treated in Ch4.
54554	91	2	91	14	Packages of policy instruments for mitigation are also discussed in details in section 4.4.5, I suggest to add a reference [Paolo BERTOLDI, Italy]	Taken into account - Cross REF with all chapters is updated.
54556	91	2	91	33	Role of carbon tax and recycling of carbon tax revenues are discussed in section 4.4.5, it should be quoated here. [Paolo BERTOLDI, Italy]	Taken into account - Cross REF with all chapters is updated.
54558	91	2	91	4	There are also limitation with regulatory instruments as indicated in Bertoldi P. "Are current policies promoting a change in behaviour, conservation and sufficiency? An analysis of existing policies and recommendations for new and effective policies", in Proceedings from eceee Summer Studies 2017. [Paolo BERTOLDI, Italy]	Taken into account - Various aspects related to policy choice and implementation in practice (and thus outside the Integrated Pathway literature) are mentioned. However the reader is directed to Ch4, where those aspects are elaborated in detail.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
56436	91	2	91	7	I recommend to revise this to acknowledge the importance that the combination of public procurement, financial incentives and regulatory policies have to foster early deployment of zero emission technologies, given their capacity to enable the progressive scale up of production and the achievement of cost savings through technology learning (see for example the discussuion of polices facilitating the transition to electric mobility in IEA, 2017a, or in https://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf). I also recommend to bring forward the muhc better capacity of regulatory policies (especially if compared with the exclusive use of carbon pricing, which come with inevtable uncertainties on the value of carbon) to reduce investment risks on zero emission technologies, enabling the mobilization of signifcant resources to foster the transition to the deep decarbonisation of the economy needed to meet the 1.5°C limit. I think that the sentence stating that "regulatory policies could serve as an entry point to strengthening mitigation and thus complement carbon pricing to drive the deep decarbonisation [...]" diminishes signfcantly the relevance of regulatory instruments to ensure that an eccective transition can materialize. [Pierpaolo Cazzola, France]	Taken into account - The literature has been reviewed (together with 'Investing in Climate, Investing in Growth') and various policies issues have been incorporated (e.g. procurement, fiscal reforms). Sentence about "regulatory policies" was revised.
13538	91	7	91	7	separate 2017d).Other [Sergio Aquino, Canada]	Editorial - Space was added
51878	91	7	91	7	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Editorial - Indeed, these layout/formatting issues did not exist in the word version
896	91	13	91	13	as emission fall' should be 'as emissions fall' [Robert Shapiro, United States of America]	Editorial
47822	91	13	91	13	Kindly use 'long-term' [Sarah Connors, France]	Editorial
898	91	16	91	16	existing policies mixes' should be 'existing policy mixes' [Robert Shapiro, United States of America]	Editorial
46398	91	16	91	21	USDUSD tCO2 –1. repeated USD needs to be deleted. [Ijaz Ahmad, Pakistan]	Editorial - typo was fixed
51880	91	16	91	16	Unclear 'policies mixes' what's meant by this? Not just the grammatical problem, I don't understand the meaning. [Jason Donev, Canada]	Editorial - we refer to policy mixes, that is the portfolio of policy instruments (e.g. market-based, command and control, information) that are used to encourage mitigation activities.
58308	91	16	91	22	USDUSD in at least 3 places in this paragraph. See also page 99, paragraph 36-56 where it happens again several times Perhaps use a "global" search and change? [Peter Marcotullio, United States of America]	Editorial - typo was fixed
41558	91	17			Change "5USDUSD" to "5 USD" [Czech Republic]	Editorial - typo was fixed
51262	91	17	91	17	5USDUSD may be replaced with "5 USD". [Muhammad Latif, Pakistan]	Editorial - typo was fixed
41560	91	18			Change "27USDUSD" to "27 USD" [Czech Republic]	Editorial - typo was fixed
51264	91	18	91	18	27USDUSD may be replaced with "27 USD". [Muhammad Latif, Pakistan]	Editorial - typo was fixed
13540	91	21	91	21	separate e.g., 27USD [Sergio Aquino, Canada]	Editorial - typo was fixed
41562	91	21			Change "27USDUSD" to "27 USD" [Czech Republic]	Editorial - typo was fixed
51266	91	21	91	21	27USDUSD may be replaced with "27 USD". [Muhammad Latif, Pakistan]	Editorial - typo was fixed
47898	91	27	91	42	Please check the citations: Knobloch et al.; Wachsmuth and Duscha; ……incomplete; not available in reference section [Sarah Connors, France]	Noted - These papers were under review at the time the SOD was submitted. To the best of our knowledge, only one of them will make the cut-off date. All references are being updated across the chapter
35840	91	29	91	41	It needs to be added that while Integrated Assessment Models are limited in their ability to capture transformative change, there is no mention of alternative framings of future scenarios, especially those bottom-up exercises that generate scenarios embodying deep lifestyle and cultural change (e.g., http://www.greattransition.org/publication/journey-to-earthland; Lövbrand, Eva, Silke Beck, Jason Chilvers, Tim Forsyth, Johan Hedrén, Mike Hulme, Rolf Lidskog, and Eleftheria Vasileiadou. "Who speaks for the future of Earth? How critical social science can extend the conversation on the Anthropocene." Global Environmental Change 32 (2015): 211-218; van Vuuren, Detlef P., Paul L. Lucas, and Sarah E. Cornell. "Horses for courses: analytical tools to explore planetary boundaries." Earth System Dynamics 7, no. 1 (2016): 267). While their semi-qualitative approaches might seem unfamiliar to the modelling community, they try to avoid the hubris of optimization or top-down CGE models, which hide behind their complexity, so to speak, while remaining opaque in their assumptions and parameterization techniques. [India]	Noted - Key methodological aspects driving/framing the assessment (including IAM limitations) are now consolidated and explained at the beginning of Ch2. See section 2.1 and also technical annex. Various of the issues raised by the reviewers were already included in the SOD.
18194	91	35	91	46	The message about other measures reducing the need for CDR has been made in other sections of this chapter. This message only needs to appear in one place. [Andrea TILCHE, Belgium]	Noted - The specific role of DSM is highlighted in the context of policy in section 2.5. DSM measures are treated horizontally across the Ch2 (see section 2.4) and also Chapters 4 and 5.
18196	91	39	91	41	The "share of bioenergy" presumably refers to the energy delivered. It is unclear what the relationship would be for biomass (and land) used for bioenergy, given the very high energy penalty of BECCS, and the associated collateral CO2 emissions (from harvest/cultivation/soil disturbance/transport/etc) that cannot be captured and stored. [Andrea TILCHE, Belgium]	Taken into account - The amount (or share) of bioenergy typically refers to primary energy delivered (in terms of the biomass' lower heating value). It is important to note that the energy penalty of BECCS varies greatly across the processes in which bioenergy is used. For example, the energy penalty for capturing CO2 from electricity generation is typically high (10-25%) while it tends to be low for processes like liquid fuel or hydrogen production from biomass that anyway generate quite pure streams of CO2 even in the absence of capture. In those cases, the energy penalty essentially relates to compressing and conditioning the CO2 for transport and storage. In many IAMs, the latter processes are dominant when it comes to BECCS utilization (see Rogelj et al. 2018 - NCC, supplementary material). See section 2.3 and 2.4.
22668	91	41			Insert a space between "2014).Ambitious" [LUIS VALDES, Spain]	Editorial - Space was added
47824	91	42	91	42	Kindly check: 'Wachsmuth and Duscha'…..year missing in citation [Sarah Connors, France]	Noted - These papers were under review at the time the SOD was submitted. To the best of our knowledge, only one of them will make the cut-off date. All references are being updated across the chapter
42648	91	44			absent ===> absence [Egypt]	Editorial - typo was fixed
58062	91	44	91	44	The word "absent" should be "absence" in the phrase "absent of coordinated carbon pricing" to read "absence of coordinated carbon pricing." [Siir KILKIS, Turkey]	Editorial - typo was fixed
11928	91	45	91	46	Likewise a rich and effective policy mix in the near term leads to emission reductions that are much less dependent on CDR options (Pollitt, 2017)." - does this mean in the near term, or it reduces the scale of CDR ever needed? [United Kingdom (of Great Britain and Northern Ireland)]	Noted - It refers to the long-term needs. Details in section 2.3. At all events, this specific paper didn't make the cut-off date so it was no possible to consider it the assessment.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
11930	91	48	91	51	Is there a difference between the short terms and the near term? The two are used in consecutive sentences which doesn't read well. [United Kingdom (of Great Britain and Northern Ireland)]	Noted - Yes, see sections 2.1 and 2.3.
46590	91	49	91	49	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Noted - IPCC uncertainty language is now explicitly used across Ch2.
46592	91	53	91	53	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Noted - IPCC uncertainty language is now explicitly used across Ch2.
60196	92	1	92	3	These two sentences highlight the futility of taking a 1.5°C goal too seriously. [United States of America]	Noted - Section 2.5 starts with "the assessment indicates unprecedented intra- and intergenerational policy and geopolitical challenges"
42650	92	2			behavioural ===> behavioral [Egypt]	Editorial - English style consistent across report
39164	92	3	92	30	Please ensure language is clear enough for policy makers undestand the connection with the AR5 conclusion that economic growth and population growth are the main drivers of CO2, when outlining these issues. [Lindsey Cook, Germany]	Noted - Marangoni et al. 2017 (NCC) presents a decomposition (using so-called global sensitivity analysis) of SSP1-3 to determine the most important drives of emissions which might be good to bring in here. That paper shows that GDP per capita and energy demand/efficiency are the most important drivers of CO2 emissions across the SSPs.
42652	92	6			policies, ===> policies [Egypt]	Editorial
29640	92	20	92	20	Please insert after "Mundaca ad Markandya 2015": "Michaelowa et al. 2018." Reference: Michaelowa, Axel; Allen, Myles; Fu Sha (2018): Policy instruments for limiting global temperature rise to 1.5°C – can humanity rise to the challenge?, in: Climate Policy, 18, p. 275-286 [Mareike Blum, Germany]	Taken into - Thanks for the suggestion. The paper was reviewed and issues pertaining to implementation challenges within the integrated pathway scope were duly included.
47900	92	20	92	20	Please check the citations: Elmar Kriegler et al. 2014; Mundaca and Markandya 2015;…… not available in reference section [Sarah Connors, France]	Noted - All REF are being cross checked. Mundaca and Markandya is 2016. Year is correct in Mendeley library.
49680	92	20	92	20	Include additional references after "Mundaca and Markandya 2015": Pearce, David (2006): The political economy of an energy tax: The United Kingdom's Climate Change Levy, Energy Economics, Volume 28, Issue 2, 2006, Pages 149-158; Michaelowa, Axel; Allen, Myles; Fu Sha (2018): Policy instruments for limiting global temperature rise to 1.5°C – can humanity rise to the challenge?, in: Climate Policy, 18, p. 275-286, Geels, Frank W, Tyfield, David, Urry, John (2014): Regime Resistance against Low-Carbon Transitions: Introducing Politics and Power into the Multi-Level Perspective. Theory, Culture & Society Vol 31, Issue 5, pp. 21 - 40; Jenkins, J.D. (2014), Political economy constraints on carbon pricing policies: What are the implications for economic ef?ciency, environmental ef?cacy, and climate policy design? Energy Policy, Vol 69, pp. 467-477 [Sabine Reinecke, Germany]	Noted - The literature has been reviewed and critical issues related to policy choice and implementation beyond the integrated pathway literature are explicitly mentioned. However, they are the domain of Ch4 and cross reference is explicitly given. See Ch4 for further details.
21512	92	22	92	26	Only microeconomic considerations (not macroeconomic). Why? [Nathalie HILMI, France]	Noted - Macroeconomic considerations are treated in ch3, ch4 and Ch5 to the extent they pertain to the 1.5C literature
17692	92	28	98	30	This paragraph is about uncertainty and, Although it is well-structured entirely, I hope that the characteristics of specific area need to be written [Republic of Korea]	Taken into account - Key methodological aspects driving/framing the assessment are now consolidated and explained at the beginning of Ch2. See section 2.1 and technical annex.
62130	92	28	92	41	The limitations of IAMs described precisely in this paragraph should be reflected in the SPM, which tends to take the IAMs as the definitive answer to the feasability issue [Antoine Bonduelle, France]	Noted - Key methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2. See section 2.1 and technical annex. Please note that it is beyond the mandate of Ch2 to know for sure if these issues will be finally considered in the SPM - let alone if they will endure Gov approval.
42654	92	29			drastic near, ===> drastically near [Egypt]	Noted - Text is taken from source (Riahi et al. 2017).
61778	92	29	93	18	There are very interesting and relevant issues related to real world recent changes not covered in the AR5 (e.g. CCS, nuclear, solar PV) totally invisible from the title of the section ("limitations of IAMs") which should be made more visible to the reader. These issues should be highlighted at the beginning of the chapter, showing the reality of recent changes (possibly compared to what was anticipated in the AR5), before turning to outcomes of models to explore pathways. Again, it is very difficult to understand the conclusions of this whole section, and their implications for the other sections of the chapter. [Valérie Masson-Delmotte, France]	Taken into account - Key methodological aspects driving/framing the assessment (including limitations) are now consolidated and explained at the beginning of Ch2. See section 2.1 and technical annex. In addition, technology issues in mitigation pathways are treated more extensively in sections 2.3 and 2.4.
51882	92	34	92	37	The actual prices need to be listed. Merely saying that solar is cheaper than was expected is misleading, it's still more expensive than nuclear power. What are the numbers for CCS? What's projected? [Jason Donev, Canada]	Rejected – Thanks for the suggestion but unfortunately it was not possible to include this in the revisions. Providing these numbers would also imply a requirement to carry out an additional assessment. However, note that a study by Creutzig et al (2017) explored the uncertainty in solar costs and its influence on prospective scenarios. We acknowledge this study in the chapter together with its implications for the energy system. Given the allocated time to develop this special report, we believe hat AR6 will be in much better position to address the issue raised the reviewer.
37226	92	35	92	35	This statement that real-world costs are higher than anticipated is highly misleading. It infers that CCS projects have higher costs than expected over and above any typical large-scale industrial infrastructure project. The Petra Nova CCS Project was completed on time and on-budget (Global CCS Institute, 2017 Global Status of CCS: 2017). Additionally, there is no indication that the Gorgon CCS part of the wider Gorgon LNG, currently under construction, has had higher costs than expected beyond normal variations. References for other CCS facilities in operation: SaskPower, 2015-2016 Annual Report, Mike Monea, March 2013 Presentation at SaskPower CCS Global Consortium; Forbes 2017.' Ambitious Texas Carbon Capture Project Turns Rocky For NRG At $50 Oil; U.S. DOE 2017, 'PETRA NOVA - W.A. PARISH PROJECT. Assumptions: AUD$ currency conversions by Global CCS Institute. [John Scowcroft, Belgium]	Noted - Key methodological aspects driving/framing the assessment are now consolidated and explained at the beginning of Ch2. See section 2.1 and technical annex. In addition, please note that aspects related to CDR are discussed explicitly in section 2.3 and Ch4, which also provides an assessment of evidence on CDR costs and 2050 deployment potentials.
4562	92	49	93	6	Making limitations transparent is commendable. In light of the enormous potential of scenraios that foresee a reduction in economic activity in the countries of the Global North, the problems of depicting such scenarios with equilibrium or cost minimisation model-based frameworks should be elaborated on further. [Kai Kuhnhenn, Germany]	Noted - It is important to stress that climate policy cost estimates under cost-effective analysis (i.e. DP-IAMs mitigation pathways) do not include benefits due to avoided climate change impacts or any co-benefits (e.g. health benefits from reduced air pollution). See cross chapter box 2.1. However, also note that additional policy costs due to adverse side effects of climate policy are not covered either. Avoided costs and co-impacts of climate policy are treated in Ch3 and Ch5.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
18198	93		95		Table 2.14 (showing different policy mixes) is interesting. However, in order to be more robust/credible it needs to be better explained (e.g. in the text) on what basis these pathways are compatible with 1.5°C (e.g. are they based on a 1.5°C carbon budget or emissions pathway?). Otherwise, it is difficult to see what differentiates the policy prescriptions in this table from the rest of the section's more general discourse on policy-technology-behavior interactions. [Andrea TILCHE, Belgium]	Noted - Table 2.14 has been reviewed to include benchmark indicators across the different studies and supported by the scenario assessment in sections 2.3. and 2.4. The studies assessed in Table 2.14 are grounded in published scenarios combined with expert judgment, including feasibility analysis for key sectors mainly at global scale. However, due to overlaps, please note that most of the contents were moved to Ch4, where the integrated pathway literature is confronted with 'reality checks'. For specific technologies, regional details and feasibility "in practice" see also Ch4.
47826	93	4	93	4	Kindly check: 'Grubb et al.'……..year missing in citation [Sarah Connors, France]	Accepted - REF has been updated in Mendeley library
47902	93	4	93	18	Please check the citations: Grubb et al.; IRENA 2017;……..incomplete; not available in reference section [Sarah Connors, France]	Accepted - REF has been updated in Mendeley library
900	93	12	93	12	Table 2.14' should be 'Figure 2.14' [Robert Shapiro, United States of America]	Noted - Tables are correctly (and automatically) labelled
39166	93	12	93	19	Please write this is clear and plain language, or the profound message your are conveying concerning governance is lost to many readers. [Lindsey Cook, Germany]	Noted - Language is constantly improved across the report
1770	93	12	94	1	Some of the findings/conclusions of studies presented in Table 2.14 are unrealistic (i.e. Rockström et al., 2017 - "coal exits the global energy mix by the end of 2020; by 2040, oil will be about to exit the global energy mix; polycentric power grids using superconductive cables will start supplying energy in developing countries"; Figueres et al., 2017 - "Electric Vehicles (EV) make up >15% of new car sales globally by 2020"). Such unrealistic references to 2020 should be omitted, or at least a comment on 2020 should be made before the table (in page 93). [Greece]	Noted - Table 2.14 has been reviewed to include benchmark indicators across the different studies and supported by the scenario assessment in sections 2.3. and 2.4. The studies assessed in Table 2.14 are grounded in published scenarios combined with expert judgment, including feasibility analysis for key sectors mainly at global scale. However, due to overlaps, please note that most of the contents were moved to Ch4, where the integrated pathway literature is confronted with 'reality checks'. For specific technologies, regional details and feasibility "in practice" see also Ch4.
11932	93	14	93	15	They indicate that the pace should be governed by novel governance schemes rather than by inertia imposed by incumbent (predictable) technologies (Rockström et al., 2017). - this needs explaining [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - This refers to new and stringent policy frameworks accelerating the transition. Aspects related to socio-technical change are elaborated in detail in Ch4.
51884	93	17	93	17	Is Climate Action Tracker an appropriate source of this information? [Jason Donev, Canada]	Noted - To ensure its quality and validity, the report "Climate Action Tracker, 2016: 10 steps - The ten most important short-term steps to limiting warming to 1.5°C" by NewClimate Institute, Ecofys and Climate Analytics has been assessed. The analyses for energy supply and end-use sectors in this report refer to the sector-specific results of (Rogelj et al. 2015a) and (Kuramochi and et al.) as the point of departure. Technology-specific assessments are based on various technical studies including the IPCC AR5 (IPCC 2014b), IEA Energy Perspectives 2016 (IEA 2016), and the Climate Action Tracker's own calculations. At all events, aspects related to socio-technical change are elaborated in detail in Ch4.
2386	94		95		Table 2.14 should include a reference to the Deadline 2020 report by C40 http://www.c40.org/researches/deadline-2020 [Debra Roberts, South Africa]	Noted - Table 2.14 has been reviewed to include benchmark indicators across the different studies and supported by the scenario assessment in sections 2.3. and 2.4. The studies assessed in Table 2.14 are grounded in published scenarios combined with expert judgment, including feasibility analysis for key sectors mainly at global scale. However, due to overlaps, please note that most of the contents were moved to Ch4, where the integrated pathway literature is confronted with 'reality checks'. For specific technologies, regional details and feasibility "in practice" see also Ch4.
18200	94		94		In table 1, Carbon Action Tracker row, Food System column: "Carbon efficient food production systems" should be added to the best practices [Andrea TILCHE, Belgium]	Noted - this table has been completely revised and most contents moved to Ch4 to avoid overlaps.
19574	94		95		Table 2.14 "Transitions and enabling conditions that need to take place in key sectors in the 1 short term for a 1.5°C pathway, based on available studies." Greenpeace Energy Revolution seems to be missing from this collection https://www.greenpeace.org/archive-international/en/publications/Campaign-reports/Climate-Reports/Energy-Revolution-2015/ [Jennifer Morgan, Netherlands]	Noted - Table 2.14 has been reviewed to include benchmark indicators across the different studies and supported by the scenario assessment in sections 2.3. and 2.4. The studies assessed in Table 2.14 are grounded in published scenarios combined with expert judgment, including feasibility analysis for key sectors mainly at global scale. However, due to overlaps, please note that most of the contents were moved to Ch4, where the integrated pathway literature is confronted with 'reality checks'. For specific technologies, regional details and feasibility "in practice" see also Ch4.
47056	94		94		Under Cities column, first row of table below the header: Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted - this table has been completely revised and most contents moved to Ch4 to avoid overlaps.
47060	94		94		Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted - this table has been completely revised and most contents moved to Ch4 to avoid overlaps.
21482	94	1	96	2	A table format only seems useful if comparable information is presented across different sudies which at this point does not seem to be the case. Given the large amount f (partly empty) space consumed by Table 2.14, I would suggest to cosider turning a discussion around the insights into text. [Volker Krey, Austria]	Noted - this table has been completely revised and most contents moved to Ch4 to avoid overlaps.
35512	94	1	94	2	In the (Rockstrom et al, 2017) paper, is coal really expected to make an exit by 2020? This is patently impossible! [Ashok Sreenivas, India]	Noted - Table 2.14 has been reviewed to include benchmark indicators across the different studies and supported by the scenario assessment in sections 2.3. and 2.4. The studies assessed in Table 2.14 are grounded in published scenarios combined with expert judgment, including feasibility analysis for key sectors mainly at global scale. However, due to overlaps, please note that most of the contents were moved to Ch4, where the integrated pathway literature is confronted with 'reality checks'. For specific technologies, regional details and feasibility "in practice" see also Ch4.
47904	94	1	94	1	Please check the citation in Table 2.14: IEA Energy Perspectives 2016 (IEA, 2016)……..not available in reference section [Sarah Connors, France]	Noted - this table has been completely revised and most contents moved to Ch4 to avoid overlaps.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
50234	94	1	96	2	The tables present interesting material on benchmarks for the transition to 1.5C consistent pathways. Why that only comes up in this part of the chapter is not clear to me, as the discussion in sections 2.3 and 2.4 would be the more logical place. Unfortunately the benchmarks differ for the various studies analysed. I suggest that an effort is done to harmonise the benchmark indicators across the different studies, looking at what is most policy relevant and available in terms of data. Then taking the numbers for the various indicators from the different studies could produce a very useful set of transition benchmarks (with a range) for 2030 and 2050 that would be very relevant for national governments, sectors and businesses in strenthening their targets and designing appropriate actions. Such a set of transition benchmarks is currently not available and so this Special Report could fill an important void that is now a barrier to the 2018/ 2020 UNFCCC process of strenthening NDCs. [Bert Metz, Netherlands]	Noted - Table 2.14 has been reviewed to include benchmark indicators across the different studies and supported by the scenario assessment in sections 2.3. and 2.4. The studies assessed in Table 2.14 are grounded in published scenarios combined with expert judgment, including feasibility analysis for key sectors mainly at global scale. However, due to overlaps, please note that most of the contents were moved to Ch4, where the integrated pathway literature is confronted with 'reality checks'. For specific technologies, regional details and feasibility "in practice" see also Ch4.
35844	95		95		Row 1; column 6. - In agriculture, multi-dimentional constraints slow down the adoption, thus the target is very ambitious. Moreover, most of the estimates are based on simple assumptions. [India]	Noted - Table 2.14 has been reviewed to include benchmark indicators across the different studies and supported by the scenario assessment in sections 2.3. and 2.4. The studies assessed in Table 2.14 are grounded in published scenarios combined with expert judgment, including feasibility analysis for key sectors mainly at global scale. However, due to overlaps, please note that most of the contents were moved to Ch4, where the integrated pathway literature is confronted with 'reality checks'. For specific technologies, regional details and feasibility "in practice" see also Ch4.
40826	95		95		Row 1; column 6. Reducing emissions by 50% from agriculture and LU by 2030 is ambitious and unrealistic target. Reducing N2O by increasing N-fertlizer use efficiency and reduction of enteric fermentation can lead to reduction in emission by certainly not by 50% by 2030...Instead, major reduction targets may be diverted to other sectors where technology can penetrate and make a change quickly. In agriculture, multi-dimentianal constranits slow down the adoption, thus the traget is unrealistic. Moreover, baseline estimate also are not well quantified and established in many regions of the world. Most of the estimates are based on simple assumptions. [NARESH KUMAR SOORA, India]	Noted - Table 2.14 has been reviewed to include benchmark indicators across the different studies and supported by the scenario assessment in sections 2.3. and 2.4. The studies assessed in Table 2.14 are grounded in published scenarios combined with expert judgment, including feasibility analysis for key sectors mainly at global scale. However, due to overlaps, please note that most of the contents were moved to Ch4, where the integrated pathway literature is confronted with 'reality checks'. For specific technologies, regional details and feasibility "in practice" see also Ch4.
35514	95	1	95	2	In (Figueres et al, 2017), it would be good to clarify if renewables form 30% of capacity or generation by 2020 [Ashok Sreenivas, India]	Noted - Table 2.14 has been reviewed to include benchmark indicators across the different studies and supported by the scenario assessment in sections 2.3. and 2.4. The studies assessed in Table 2.14 are grounded in published scenarios combined with expert judgment, including feasibility analysis for key sectors mainly at global scale. However, due to overlaps, please note that most of the contents were moved to Ch4, where the integrated pathway literature is confronted with 'reality checks'. For specific technologies, regional details and feasibility "in practice" see also Ch4.
35842	95	1	95	1	Replace- 'FOOTNOE' by 'FOOTNOTE' [India]	Editorial
42780	95	1	95	1	HFC mitigation was the number one solution in Drawdown; maybe fit this into the “buildings” and/or “industry” columns. [Kristin Campbell, United States of America]	Noted - Table 2.14 has been reviewed to include benchmark indicators across the different studies and supported by the scenario assessment in sections 2.3. and 2.4. The studies assessed in Table 2.14 are grounded in published scenarios combined with expert judgment, including feasibility analysis for key sectors mainly at global scale. However, due to overlaps, please note that most of the contents were moved to Ch4, where the integrated pathway literature is confronted with 'reality checks'. For specific technologies, regional details and feasibility "in practice" see also Ch4.
43010	95	1	95	1	HFC mitigation was the number one way; maybe fit this into the “buildings” and/or “industry” columns. [Durwood Zaelke, United States of America]	Noted - Table 2.14 has been reviewed to include benchmark indicators across the different studies and supported by the scenario assessment in sections 2.3. and 2.4. The studies assessed in Table 2.14 are grounded in published scenarios combined with expert judgment, including feasibility analysis for key sectors mainly at global scale. However, due to overlaps, please note that most of the contents were moved to Ch4, where the integrated pathway literature is confronted with 'reality checks'. For specific technologies, regional details and feasibility "in practice" see also Ch4.
51886	95	1	95	1	Is Drawdown an appropriate source of information? [Jason Donev, Canada]	Noted - Table 2.14 has been reviewed to include benchmark indicators across the different studies and supported by the scenario assessment in sections 2.3. and 2.4. The studies assessed in Table 2.14 are grounded in published scenarios combined with expert judgment, including feasibility analysis for key sectors mainly at global scale. However, due to overlaps, please note that most of the contents were moved to Ch4, where the integrated pathway literature is confronted with 'reality checks'. For specific technologies, regional details and feasibility "in practice" see also Ch4.
47072	96	1	96	1	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted - this table has been completely revised and most contents moved to Ch4 to avoid overlaps.
21514	96	4	96	11	interesting part about urban and food systems [Nathalie HILMI, France]	Noted
42656	96	4			modelling ===> modeling [Egypt]	Editorial
34706	96	8	96	11	Is not Improved livestock management a supply-side mitigation option? [Mexico]	Noted - Clarification: livestock management is treated as part of the agricultural (end use) sector in the energy system.
39168	96	9	96	22	This is an important point and what can the IPCC do? We unable to sufficiently brief policy makers because current modelling does not properly engage in consumption/demand mitigation potential as it does with techology, thus urgent attention is needed to improve modelling to sufficiently reflect these options, otherwise we fail to inform on effective policy options due to our own inadequate modelling. That is very serious and needs urgent reform. [Lindsey Cook, Germany]	Noted - Please note that that key methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2. This also includes limitations of IAMs. Several knowledge gaps are also identified (e.g. increase behavioural realism) in section 2.6.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
60198	96	12	96	15	This point should be given more emphasis in this report. [United States of America]	Noted - Please note that that key methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2. This also includes limitations of IAMs. See section 2.1. and technical annex. Several knowledge gaps are also identified (e.g. increase behavioural realism) in section 2.6.
60200	96	27	96	27	Please specify the nature of the "substantial uncertainties" in the mitigation potential of HFCs (i.e., technical, political, social, economic, etc.). The cited paper suggests that it is technically possible to reduce HFC emissions substantially so it would improve clarity if the specific types of uncertainties were articulated here. [United States of America]	Noted - Key methodological aspects driving/framing the assessment are now consolidated at the beginning of Ch2. See section 2.1 and technical annex. It is beyond the mandate of Ch2 to know for sure if these issues will be finally considered in the SPM - let alone whether they will endure Gov approval.
60202	96	30	96	30	Remove "almost entirely" and "hypothetical" to read as "... potential depends on reference emissions against which low emission scenarios ...". Rationale: Reference scenarios are by definition hypothetical, but based on reasonable assumptions of economic/technology trends. The current framing suggests the reference emission scenarios outlined in related studies are not realistic. [United States of America]	Accepted - we agree with the reviewer and the sentence was refined. However, please note that all methodological aspects are now consolidated in section 2.1. and technical annex.
60204	96	31	96	33	Some caveating is warranted here. There may be an income level above which this statement is historically true. At least to date, however, China and India – two of the world's largest emitting nations – are not characterized by this statement. [United States of America]	Noted - Please note that methodological aspects (including drivers such as economic growth [e.g. as depicted in SSPs]) are now consolidated in section 2.1. and technical annex.
60206	96	40	96	41	Remove the clause "..., particularly in the context of mitigation for HFCs and BC-rich sectors, ...". The points raised here regarding the importance of reference emissions in benefit-cost analysis apply to many or all sectors so there is no need to highlight a specific set of substances as that may detract from the essential point being communicated in this paragraph. [United States of America]	Accepted - We agree with the reviewer and the sentence was refined. However, please note that methodological aspects are now consolidated in section 2.1. and technical annex.
62132	96	44	98	30	This cross chapter box is based on the context of pricing GHG and balancing co over other scenarios is that of existence itself. This should not be balanced by economic costs but by the necessity of avoiding irreversible damage or disapearance of their Nations. This caveat should be developed at the start of the box (otherwise interesting). Without such mention, the box can become shocking in the context of UNFCCC. [Antoine Bonduelle, France]	Rejected - Unfortunately, it is not entirely clear what the comment is all about.
1772	96	45	98	30	Cross-Chapter Box 2.1 is too long and should be shortened. [Greece]	Noted - Text has been refined and length reduced whenever possible/needed.
38396	96	45	98	30	If, as it is said in the box 2.1, the SCC uncertainty is much higher that the carbon price to achieve the 1.5 or 2 C target, I wonder if we could just use the carbon price when assesing policies or in regulation instead of SCC. The carbon price unceratinty can be reduced with data from the market and tecnology develoment but with SCC the unceratainty is quite intrinsic and hardly will be reduced in the future at all. The problem with this huge uncertainty on SCC is that it can latter be used by policy-makers to select the number they want as it is happeing now in US. [Mikel González-Eguino, Spain]	Noted - We do not include this proposal in the text, as it would be policy prescriptive.
19170	96	45	97	30	Box 2.1: this box appears to be unnecessary in the context of a special report on 1.5°C, especially given the need to conserve space. In particular: * the framing of climate action in terms of a temperature goal (1.5°C or 2°C) pre-supposes that CEA is more relevant than CBA and SCC. A simple statement of this would be sufficient here (CBA & SCC could then be detailed more completely in AR6). * SCC has an important weakness, namely its reduction of (simplified, quantified) damages in terms of cost per tCO2(e). IPCC WG2 reports (and the impacts chapter of this report) are extremely reluctant to provide quantified damages per °C change due to inherent uncertainties. The fact that damage-based SCC estimates appear to go beyond the best available robust evidence regarding impacts is an important point that should be made if discussing the merits of SCC vs other approaches. [Andrea TILCHE, Belgium]	Reject - The box is important to explain the relationship of carbon prices reported in Chapter 2 (and tied to CEA) with other approaches in the literature, notably SCC and CBA, which is beyond the scope of Ch2. While being an important concept, SCC is closely related to anticipated future impacts and thus falls within the scope of Chapter 3.
57760	96	46	98	30	The box should also discuss the state of the art for social cost of carbon modeling. Before we start talking about what is missing, we should discuss how well we can model the social cost of carbon. See Rose et al (2017) for a detailed diagnostic analysis of current modeling. Also, it is useful to distinguish different types of SCCs. The box mentions CBA and CEA analysis, but given confusion about SCC values, there is another useful distinction - reference, policy, and optimal SCCs. There is also a need to think about the difficulty of identifying optimal pathways. To working papers in review might be useful on these last two points. Rose, S.K., D.B. Diaz, G.J. Blanford, 2017. Understanding the Social Cost of Carbon: A Model Diagnostic and Inter-Comparison Study, Climate Change Economics 8 (2). Rose, S.K., 2017. Managing Climate Damages: Exploring Trade-offs. EPRI, Palo Alto, CA. 3002009659. Rose, S.K., 2017. Carbon Pricing and the Social Cost of Carbon. EPRI, Palo Alto, CA. 3002011391. [Steven Rose, United States of America]	Noted - Thanks for the suggestion. The references to the state of the art are cited and form the starting point of the discussion. The box focuses on recent developments after AR5, part of which was intense debate about the SCC concept and estimates. The fact that SCC can be calculated independently of CBA is mentioned. The suggested literature is included. Note that no SCC quantifications were included in Chapter 2
39170	97	1	97	40	Very helpful to have these various transition pathways from various organizations [Lindsey Cook, Germany]	Noted
40386	97	4	97	8	In this part of the chapter a footnote should be added for a general explanation on how the distribution of damages between current and future generations can be valued. [Erick Pajares, Peru]	Rejected - Please note that climate damages are the domain of Chapter 3. for intra- and inter-general economic aspects of climate change see also AR5 WGIII Chapter 3.
47906	97	12	97	14	Please check the citations: Nordhaus 2007; National Academies of Sciences and Medicine 2016;……..not available in reference section [Sarah Connors, France]	Noted - REF are included in Ch2 Mendeley library. There seems to be a problem with SYNC word doc.
28106	97	27	97	28	Replace "the range of uncertainties in SCC estimates along an optimal trajectory determined by CBA is far higher than" with "the range of estimates for SCC along an optimal trajectory determined by CBA is far higher than .." Explanation: As is stated correctly in the next sentence, value judgments as source of differences in SCC estimates are different from "uncertainties". Value judgements are deterministic. They increase the range of estimates, but not the uncertainty. [Germany]	Taken into account - Thanks for this comment. Text was revised.
42658	97	29			combine ===> combined [Egypt]	Editorial
40388	97	43	97	54	If Social Carbon Cost (SCC) concept is underestimated –among other reasons– because of its limited treatment in addressing «the risks of catastrophic climate change for future generations» , then it would be advisable for this chapter to clarify the scope of future generations used to formulate the foresaid concept. [Erick Pajares, Peru]	Rejected - We appreciate the comment by the reviewer; however, the suggested topic is beyond the scope of Ch2. While being an important concept, SCC is closely related to anticipated future impacts and thus falls within the scope of Chapter 3. No SCC quantifications were included in Chapter 2.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
60208	97	43	97	46	In this sentence or earlier in the box, it should be clarified that SCC is developed using the same aggregate IAMs that have been used for CBA-based analyses. [United States of America]	Rejected - Cross-chapter Box 2.1. makes clear that CBA IAMs and Detailed Process IAMs (used for CEA) are two different model types. Since Chapter 2 does not develop SCC estimates, the comment is not clear. While being an important concept, SCC is closely related to anticipated future impacts and thus falls within the scope of Chapter 3. The carbon price estimates are CEA based.
42660	97	52			wellbeing ===> well-being [Egypt]	Editorial
42662	97	54			progress ===> progressing [Egypt]	Editorial
39172	98	1	103	48	What is missing here is recongition of research concernig the problem with the economic paradigm in which we function, which exacerbate the use of many root causes of climate change, and which are financiallyvery lucrative. [Lindsey Cook, Germany]	Noted - Framing and contextual aspects (including economic issues) are contained in Ch1.
21484	98	13	98	20	The sentence on SCC not being a theoretical concept is contradicted by the second half of the sentence that refers to a frictionless world without uncertainty. That in itself makes clear that the concepts are theoretical. [Volker Krey, Austria]	Taken into account - Wording adjusted. It is meant that SCC is used for regulation, not only discussed in textbooks.
1618	98	19	98	34	Different models could result to significantly different carbon price/marginal abtement cost due to different modeling apporaches, assumptions on availibity, cost, potentials of key mitigaiton technologies such as BECCS, assumptions on demand price/income elasticity, assumption on economic structure improvement and etc. It is suggested to add the reference (Chen W et al., 2016. Towards low carbon development in China: a comparison of national and global models. Climatic Change, 136:95-108) which attempts to compare and explain the the differences between different models. [Wenying Chen, China]	Noted - Methodological issues explaining differences across models are elaborated; including sampling bias.
61780	98	22	98	30	I suggest to avoid interpreting the text of the decision of COP21 and quote directly what is in paragraph 108 (social, economic and environmental value). The end of the box reads as quite prescriptive (is this based on an assessment of the literature?). What is the key finding from this cross-chapter box? Why are the findings of this cross-chapter box not captured in the executive summary of any chapter? [Valérie Masson-Delmotte, France]	Accepted - Text addressing 'Paragraph 108' was deleted
47062	98	25	98	25	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted - Policy language is under constant improvement
15794	98	27	98	28	It is not clear on what basis the claim is made that paragraph 108 of decision 1/CP.21 adopting the Paris Agreement mentions the concept of "Social Value of Mitigation Activities". Paragraph 108 simply notes the value of voluntary mitigation action and their many co-benefits. There is no indication that this was intended to be a reference to a specific concept or that it was intended to be limited to voluntary action to reduce non carbon dioxide polluntants. The reference to the Paris Agreement in this sentence should be deleted. [Australia]	Accepted - Text addressing 'Paragraph 108' was deleted
60210	98	27	98	28	While it uses some of those words, paragraph 98 of the COP decision adopting the Paris Agreement does not refer to SVMA as such nor does it refer to linking emissions of pollutants at the activity level. The reference to paragraph 98 makes an assumption or leap that is not evident in the decision text and goes beyond what was agreed by Parties, and thus should be omitted. [United States of America]	Accepted - Text addressing 'Paragraph 108' was deleted
1616	98	33	102	1	It is suggested to add add GDP loss/welfare loss in this section since these two indicators could be provided by most of the IAMs. And please add the marginal abatement cost from IEA-ETP studies for comparisons. [Wenying Chen, China]	Noted - We thank the reviewer for bringing up the important issue of GDP losses. Unfortunately, and given the complexities related to such an assessment, the allocated time for the development of this special report has not allowed the team to carry out the analysis. Instead of providing an examination with no vetted and robust numbers, the team believes that AR6 will be in a much better position to perform this assessment. We hope the reviewer understands the situation. All data reported by modelling teams (and accepted before cut off date) is included. Unfortunately, ETP did not submit any carbon price data.
50688	98	33	104	22	The discussion of economic impacts of mitigation limits itself basically to Carbon Prices and Investments. Broader economic implications of mitigation, such as the impact on non-energy consumption goods, or distributional impacts are not discussed in the context of 1.5 degree scenarios, which require enourmous macro-economic changes over the next decade. Some broader impacts are discussed generically in Box 2.2, but certainly not in depth for the implications of 1.5 degree scenarios [Bastiaan van Ruijven, Austria]	Noted - The aspects mentioned by the reviewer are beyond the scope of Ch2 and pertain to Ch3 (i.e. impacts) and Ch5 (e.g. distributional and ethical issues)
21488	98	35	101	38	The discussion of carbon prices in Section 2.5.2.1 does not add much to the corresponding section in the WGIII AR5 and could therefore be condensed substantially. I would suggest to focus in Section 2.5.2 on the more robust insights related to investments (see Section 2.5.3). [Volker Krey, Austria]	Noted - Thanks for the suggestion. Figures in section 2.5 are the latest submitted to the database and based on accepted/published studies. Figures are now presented for 2030-2100 (undiscounted) and average (5%) discounted for the same period. They explicitly touch upon a new category of scenarios, including 1.5C scenarios not presented in AR5. Note that while section on carbon pricing is based on multiple papers (already accepted/published), the section on investment is mostly based on one study. Given the allocated time to develop the special report, the team believes that AR6 will be in a much better position to expand the section on carbon pricing, including other metrics.
58138	98	35			The sub-section does not discuss findings of technology sensitivity reported in Bauer et al. (2017). Crucial here is that delayed BECCS availability (up until 2050) is more crucial than doubling the investment costs for Advanced Bioenergy Technologies. Also, non-availbility of BECCS is more important for the carbon price than a limited supply of bioenergy (100EJ/yr). [Nico Bauer, Germany]	Noted - Despite severe page limits, text about modelling/technology aspects affecting the price of emissions was expanded; including CDR issues. See also section 2.3.
58136	98	35			It appears to me that carbon prices are expressed in terms of present value prices rather than current value prices. This has a big potential for huge confusion. Carbon prices should be expressed in current value prices. Otherwise policy makers migh get the impression that relatively small caron prices in 2050 are sufficient to achieve the targets. This should not be buried in a technical appendix or a footnote. It must be transparent in a way that policy makers can get the information clearly and directly. Actually, I have not found a reference to the exact metric. [Nico Bauer, Germany]	Taken into account - Indeed, the values presented in the SOD were discounted. We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios.
21516	98	36	98	39	Are those macroeconomic effects of mitigation? [Nathalie HILMI, France]	Noted - Yes, they have been already treated in previous AR (see. Ch6 in AR5)

Comment No	From Page	From Line	To Page	To Line	Comment	Response
40970	98	36	99	17	Carbon price should be more clearly defined taking into accounts of the policy debate. Carbon price is defined at the Glossary as “The price for avoided or released carbon dioxide ..” therefore all possible policy, including emission trading, tax and numerical standard, shall be included. Carbon price/carbon pricing is a crucial for reducing emission this is the reason its definition itself is an argument. I recommend that the difference of definition and its implication approach should be analyzed and introduced. An example of the definition is at P18 of the following document. https://www.belfercenter.org/sites/default/files/files/publication/harvard-project-east-asia.pdf Also amendment should be reflected on Glossary. [Takashi Hongo, Japan]	Noted - It is defined in Cross-chapter box 2.1 and previous assessment reports (e.g. see AR5 Ch6)
42664	98	37			macro- economic ===> macro-economic [Egypt]	Editorial
42666	98	48			exchange ===> the exchange [Egypt]	Editorial
62134	98	49	98	50	The GWP-100 metric is imposed by the frame as mentioned in chapter 1, but maybe it should be mentioned that size and duration of a temperature overshoot could be reduced if short lived gases are prioritized?. [Antoine Bonduelle, France]	Noted - Methodological issues are now consolidated in section in 2.1 and technical Annex. In addition, a new scenario classification is provided. Aspects regarding short-lived climate forcers are treated in section 2.2
21518	98	50	98	53	Please define clearly the concept of carbon price [Nathalie HILMI, France]	Noted - It is defined in Cross-chapter box 2.1 and previous assessment reports (e.g. see AR5 Ch6)
21520	98	52	98	52	social cost of carbon (box 2.1) is not in chapter 3 section 3,5,2. Maybe in 3,5,3? Probel of numbering? [Nathalie HILMI, France]	Noted - The outline of Chapters is under constant refinements/changes to accommodate various issues, let alone review comments.
60212	99	1	99	34	The point on page 2-99, lines 31-34, about sampling bias is very important and warrants more caution in reporting carbon price ranges for 1.5°C scenarios. There are also additional biases that may impact the results reported here. Assumptions about baseline emissions can dramatically alter carbon prices. Do the 1.5°C scenarios reported here reflect the full range of baseline uncertainty? Beyond the model selection sample bias discussed, do the results reported here reflect the range of technology sensitivities the models that are presented would normally explore? What about policy design sensitivities? Are all of these scenarios assuming a first best global climate policy? Given these concerns, the carbon price range for the 1.5°C scenarios presented on page 2-99, lines 6-9, is highly problematic. These lines state that, "For scenarios that can return global warming to 1.5°C with a greater than 50 and 66 percent probability, carbon prices range from 90-105 USD(2010)/tCO2 in 2050, respectively. Then, for scenarios that limit global warming below 1.5°C with a greater than 50 percent probability, carbon prices are estimated to be 240 USD(2010)/tCO2 in 2050 approximately." First off, these are median values of the set of scenarios included in this report, but this sentence could be misinterpreted as presenting the range of values across the scenarios instead of the range between the median value for the 50 percent probability scenario and the median value for the 66 percent probability scenario. More importantly, these values are necessarily biased downward by the issues discussed above. Excluding all scenarios where for whatever reason the 1.5°C target is infeasible, and only presenting carbon prices from optimistic scenarios where the target is achieved, creates a significant downward bias in the carbon prices reported here, and understates the extent of the challenge a 1.5°C target presents. [United States of America]	Taken into account - We have expanded the paragraph on sampling bias, adding more examples. This is despite serious word limits. In addition, we clearly introduced uncertainties regarding the impacts of chosen discount rates on the choice and timing of mitigation investments. See also section 2.6. Also note that, with the latest reported data, we now provide undiscounted and average discounted values for a longer period of time (2030-2100). Text was revised accordingly.
4478	99	2	99	17	1) Here are descriptions of absolute costs of carbon or MAC (median) for different target. From those figures I can not understand why carbon prices (MACs) differ by about 3 to 7 times. I understand "3" (difference between $30 and $90) but not "7" ($30 and $240?). 2) Please show not only carbon prices but also GDP or consumption loss as shown in Table SPM.2 (p. 15) and Figure 6.21 (p. 450) in AR5/WG3. In doing so please show figures in 2030, 2050 and 2100 so that policymaker can compare 2 degree and 1.5 degree world from cost aspect. 3) There are large differences between carbon price in this chapter and that in AR5. In figure 6.21 of AR5/WG3, median carbon price in 2050 for 2 degree (likely, i.e. >66%) is more than $100 in 2015 and more than $1000 in 2100 whereas it is $70 for 2 degree with greater than 66% probability. What are the reasons? Greater than 66% is different from likely in AR5 or difference of discount rate, or models are different? Clear explanation of this difference is absolutely necessary. Also we suspect GDP of consumption loss may also different from AR5 even for 2 degree target. In this sense, GDP and consumption loss in 2030, 2050 and 2100 for both 2 and 1.5 degree with differenct probability should be shown. If there is no such figures, please describe so. [Mitsutsune Yamaguchi, Japan]	Noted - The values presented in the SOD were discounted. With more data available, we now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. Note that unlike AR5, which only included cost-effective scenarios for estimating discounted average carbon prices for 2015-2100 (also using a 5% discount rate) (see Clarke et al., 2014, p.450), values shown in the chapter include delays or technology constraint cases (see Sections 2.1 and 2.3). Details about methodological aspects can also be found in the technical annex. When it comes to GDP/consumptions losses, and given the complexities related to such an assessment, the allocated time for the development of this special report has not allowed the team to carry out the analysis. Instead of providing an examination with no vetted and robust numbers, the team believes that AR6 will be in a much better position to perform this assessment. We hope the reviewer understands the situation.
21486	99	2	99	17	The discussion of median carbon prices in this paragraph does not make sense taking into account that for all of the scenario categories shown in Figure 2.29 span one to two orders of magnitue. [Volker Krey, Austria]	Taken into account - Values presented in the SOD were discounted. We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. The calculation of carbon price mark-ups in 1.5°C and 2°C-consistent pathways was based on direct scenario pairs from the same model and the same study. Those pairs generally assume a significantly smaller carbon budget for 1.5°C-consistent pathways in comparison to 2°C-consistent pathways (e.g. 600 GtCO2 smaller in the CD-LINKS and ADVANCE studies) which is the main driver behind the increase in the price of carbon.
37084	99	2	99	17	Line 3-4 is not consistent with Chapter 4 Line 21-24. On one hand, Chapter 2 states that carbon price for "below 2 degreee", "return to 1.5 degree" and "below 1.5 degree" is in the range of 30-70$, 90-105$ and 240$ respectively. Chapter 2 also states that "below carbon price between "below 1.5 degrees 50%" and "below 2 degrees 50% or 66%" scenarios differ by about a factor of three to seven by 2050. On the other hand, Chapter 4 states that worldwide marginal aatement cost for 2 degree target in AR5 was 130-260$/t-CO2 and the one for 1.5 degree is not yet available (page 70 line 23-24). It is bizarre that marginal abatement cost or carbon price for seeking below 2 degree (30-70$ in 2050) is much lower than the figure for seeking 2 degree in AR5 (130-260$). Why carbon prices for seeking more ambitious temperature "below 2 degree (30-70$ in 2050)" and "return to 1.5 degree (90-150$ in 2050)" are lower than AR5 figure aiming at 2 degree (130-260$)? Why carbon prices for 1.5 degree are presented in Chapter 2 while Chapter 4 states such figures are not yet avaiable? Readers will be very much confounded by such discrepancies. Since cost information is particularly crucial for policy makers, full consistency across the entire report should be secured. [Jun Arima, Japan]	Noted - The values presented in the SOD were discounted. We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. Please note that while Ch2 addresses the integrated pathway literature (i.e. ex-ante estimates of carbon prices), Ch4 deals with 'reality checks' and also addresses carbon prices seen in current carbon markets (i.e. ex-post values).

Comment No	From Page	From Line	To Page	To Line	Comment	Response
60214	99	2	99	17	Discussion of the economic impacts of 1.5°C scenarios does not reflect the current state of the literature and the uncertainty. The chapter cites ranges of carbon prices for 1.5 and 2°C scenarios that do not reflect the ranges of carbon prices reported in the literature, and appears to project more optimistic estimates of the costs that are not fully supported by the literature. [United States of America]	Rejected - The section on price of carbon is based on the latest data (accepted/published papers, until 15 May 2018) and reported by modelling teams. It focuses on cost-effective analysis (CEA). The social costs of carbon is outside the scope of Ch2 (as duly noted in cross-chapter box 2.1). While being an important concept, SCC is closely related to anticipated future impacts and thus falls within the scope of Chapter 3. Note that based on the latest submitted data, we now report undiscounted values (2030-2100) and average discounted values (5% discount rate) for the same period.
31422	99	3	99	17	1) In “carbon prices between ‘Below 1.5°C 50%’ and ‘Below 2°C 50% or 66% scenarios differ by about a factor of three to seven by 2050”, could you tell us where “seven” comes from? $30 is described as the carbon price for below 2°C with 50% probability and $240 is that for below 1.5°C with a greater than 50 percent. The correct number would be “eight” not “seven”. 2) Should add GDP or consumption loss in Table SPM.2 (p. 15) and Figure 6.21 (p. 450) in AR5WGIII for policy makers in order to easily compare 1.5 and 2°C world. 3) This carbon price value is different from that in figure 6.21 of AR5/WGIII. Please clarify it or explain the difference in procedures. For example, median carbon price in 2050 for 2 degree (likely, i.e. >66%) is more than $100 in 2015 in AR5/WGIII, whereas $70 for 2°C with greater than 66% probability in 2050 in this report. [Japan]	Noted - The values presented in the SOD were discounted. With more data available, we now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. Note that unlike AR5, which only included cost-effective scenarios for estimating discounted average carbon prices for 2015-2100 (also using a 5% discount rate) (see Clarke et al., 2014, p.450), values shown in the chapter include delays or technology constraint cases (see Sections 2.1 and 2.3). Details about methodological aspects can be found in the technical annex. When it comes to GDP/consumptions losses, and given the complexities related to such an assessment, the allocated time for the development of this special report has not allowed the team to carry out the analysis. Instead of providing an examination with no vetted and robust numbers, the team believes that AR6 will be in a much better position to perform this assessment. We hope the reviewer understands the situation.
37082	99	3	99	4	Carbon price range of 30-70$ for Below 2 degrees looks very low compared with the level presented in the Figure 6.21 of AR5. Since readers will read collating AR5 and SR1.5, there should be a clear explanation on methodology for calculating carbon price and dircrepancy between AR5 and SR1.5. [Jun Arima, Japan]	Taken into account - The values presented in the SOD were discounted. We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios.
60216	99	3	99	9	This section of text states that global carbon prices in Figure 2.29 are discounted from 2050 to 2020 using a 5% rate. Thirty years of discounting at 5% means that carbon prices are reduced by a factor of 4.3. This is very misleading and discounting is not appropriate here. This gives the mistaken impression that reaching 1.5 or 2°C targets is not expensive. For example, the median carbon price of US$30 per tCO2 in the "Below 2°C (50)" column is much too low to even cover the cost of capturing and storing 1 tCO2. Instead, the 2050 carbon prices should be presented as 2050 carbon prices without discounting. [United States of America]	Taken into account - The values presented in the SOD were discounted. Based on the latest data, we now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios.
60218	99	3	99	4	Based on carbon pricing data available for this special report (discounted to 2020 using a 5% rate). Have the 2050 carbon prices reported by the models been discounted back to 2020 at a 5% rate to produce the numbers reported here? Most models report carbon prices in real terms, so discounting in this manner would be inappropriate. Please check that these values have not been effectively discounted twice. Furthermore, the units used in page 2-99, line 5, are 2010 USD, this is inconsistent with the description of discounting to 2020. [United States of America]	Taken into account - The values presented in the SOD were discounted. Based on the latest data, we now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios.
28108	99	4	99	9	The 5% discounting over 30 years (2050 to 2020) is not properly explained, neither the reasons for doing it nor the consequences of doing it. The discounting leads to a reduction in nominal prices by 77% (1/1.05^30?0.23). If these prices are perceived by the readers as being nominal prices in 2050 - which is highly likely as the discounting is only mentioned once, afterwards prices are always labelled "in 2050" - the results may be misunderstood as being very low. Two suggestions: i) Either report prices for 2050 as returned by the models (undiscounted) and explain the difference between current prices and those in 2050. ii) Or report the 2050 prices as returned by the models first, then explain the reasons for and consequences of discounting, and then do the discounting. From then on, whenever you report discounted prices, make sure they are clearly marked as such ("prices 2050 discounted to 2020"). The difference between prices in 2050 and discounted to 2020 should also be well explained in figure 2.29. For example you could insert a second y-axis (on the right), where one y-axis shows prices in 2050 and the other one prices discounted to 2020. Both should be explained. Once you have made it clear that prices for 2050 are discounted to 2020, there is a need to explain why you don't report prices for 2020 as returned by the models. If there are good reasons not to state the price path over time (2020, 2030, 2040) explicitly, it would at least be helpful to describe it verbally, such that it becomes clear that GHG should also be priced in the years up to 2050, not only starting in 2050. [Germany]	Taken into account - The values presented in the SOD were discounted. We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. A 5% was chosen to make comparison with AR5 estimates. Please note that this is not the social discount rate applied in modelling frameworks. Values of social discount rates are explicitly mention; including uncertainties about impacts on the choice and timing of mitigation investments.
55640	99	4	99	4	why is a 5% discount rate used? [David Cooper, Canada]	Noted - A 5% was chosen to make comparison with AR5 estimates. Please note that this is not the social discount rate applied in modelling frameworks. Values of social discount rates are explicitly mention; including uncertainties about impacts on the choice and timing of mitigation investments. See also section 2.6.
28110	99	5	99	6	In this section carbon prices are discussed. In order to get available carbon price data comparable at a certain point in time a discounting approach is used and a reference to figure 2.29 is given. However the textual description might be confusing in this regard that the discrete likelihood categories 55%/66% chance for the temperature limits are here combined together with one price range (median values, i.e. USD30-70) instead of a discrete (median) price level for each likelihood level (i.e. USD 30 for 'below 2C'-50% and USD 70 for 'below 2C'-66%, and so on). [Germany]	Taken into account - The values (2050) presented in the SOD were discounted. We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. A 5% was chosen to make comparison with AR5 estimates. This is not to be confused with the social discount rate. Values are also reported in the section.
41564	99	5			Change "USD30–70USD" to "30–70 USD" [Czech Republic]	Editorial
466	99	6	99	9	this sentence is confused - please clarify as the 50 and 66% values don't seem to be stated consecutively as the text would indicate. [David Reay, United Kingdom (of Great Britain and Northern Ireland)]	Noted - The entire scenario categorisation was improved so new scenario categories are now used.
28112	99	6	99	8	The reason for the difference should be explained (increasing marginal costs when it comes to reach higher levels of mitigation). Please add. [Germany]	Taken into account - Text was revised.
22670	99	7		44	Please double check if "USDUSD2010" is a correct expression, I think that at least USD is duplicated and could be simplified (lines 7, 38, 39 and 44) [LUIS VALDES, Spain]	Editorial
41566	99	7			Change "90–105USDUSD" to "90–105 USD" [Czech Republic]	Editorial
41568	99	9			Change "240USDUSD" to "240 USD" [Czech Republic]	Editorial

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28114	99	12	99	12	Replace "three to seven" with "three to eight". The statement is based on comparing 30 USD/tCO2 with 240 USD/tCO2, which gives a factor of eight not seven. [Germany]	Noted - Figures have been updated based on the latest reported data; including a longer time period.
42668	99	13			give ===> gives [Egypt]	Editorial
46594	99	13	99	13	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Noted - IPCC uncertainty language is now explicitly used across Ch2.
47074	99	16	99	16	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted - Policy language is under constant improvement
11934	99	18	99	21	a mix of ambitious energy efficiency policies can reach a mitigation scenario in line with a 1.5°C target more cost-effectively than a carbon tax alone (Brown and Li, 2017). - why is this approach more cost effective? [United Kingdom (of Great Britain and Northern Ireland)]	Noted - Energy efficiency policies decrease fuel expenses and investments in installed capacity. It also triggers savings in transmission, fixed O&M costs, etc. This lowers utility resource costs significantly when EE policies are combined with tax compared to a carbon tax alone.
58064	99	23	99	23	There is a missing word "have" in the phrase "performance been shown" that should read "performance have been shown." [Siir KILKIS, Turkey]	Editorial
2480	99	36	99	56	USD are written "USDUSD" in several places. [Jared Woollacott, United States of America]	Editorial
21522	99	36	99	37	What is the role of financial markets in the fixation of carbon price? [Nathalie HILMI, France]	Noted - In this case there is no role of financial markets explicitly. However, for instance, it is assumed that access to finance for mitigation investment is available. See section 2.5.2.2. See also Ch4 for carbon markets and climate finance in practice.
41570	99	38			Change "10–17USDUSD" to "10–17 USD" [Czech Republic]	Editorial
41572	99	39			Change "45USDUSD" to "45 USD" [Czech Republic]	Editorial
41574	99	44			Change "27USDUSD" to "27 USD" [Czech Republic]	Editorial
54560	99	44	91	48	you could quote her Bertoldi P. "Are current policies promoting a change in behaviour, conservation and sufficiency? An analysis of existing policies and recommendations for new and effective policies", in Proceedings from eceee Summer Studies 2017. [Paolo BERTOLDI, Italy]	Noted - Many thanks for the suggestion. However, this is within the scope of Ch4. Behavioural aspects are left exclusively to that chapter.
4900	99	46	99	46	Change "absent" to "absence" [Michael MacCracken, United States of America]	Editorial
58066	99	46	99	46	The word "absent" should be "absence" in the phrase "absent of complementary policies" to read "absence of complementary policies." [Siir KILKIS, Turkey]	Editorial
42670	99	48			limited ===> the limited [Egypt]	Editorial
31034	100		101		Box on macroeconomic impacts shall be extended and turned into a chapter. Important issues such as effects of different carbon prices on GDP, disposal income, etc. must be discussed based on quantitative estimations. [Victoria Alexeeva, Austria]	Noted - We appreciate the suggestion by the reviewer and we take her/his remarks in a very positive manner. However, this is beyond the mandate of Ch2 - let alone severe page limits. Aspects related to 'economic impacts' are within the scope of Ch3.
47908	100	5	100	5	Please check the citation: Krey et al. 2014;……...not available in reference section [Sarah Connors, France]	Noted - This REF is included in Ch2 Mendeley library. There seems to be a problem with SYNC word doc.
21524	100	12	100	13	GDP=C+I+G+(X-M) in box 2,2 [Nathalie HILMI, France]	Noted - Due to numerous issues (e.g. overlaps with other chapters) this box was removed from Ch2.
47828	100	12	100	13	If GDP and consumption variations fall below the baseline, they are reported as losses or macro-economic costs…..…… Please check; citation needed, no reference [Sarah Connors, France]	Noted - Due to numerous issues (e.g. overlaps with other chapters) this box was removed from Ch2.
60220	100	12	100	13	The text should note that baseline setting very amenable to manipulation. [United States of America]	Reject - There is baseline uncertainty which should be clearly stated, but "manipulation" is not the right term to be used in this context.
60222	100	13	100	15	The slowing of economic activity in the long-run is typically not a result of macro-economic projections but a built-in assumption. That these model assume economies have a long-run equilbrium path they are generally on - but may have been knocked off it by a recent market shock. The effects of the shock will be most pronounced then in the short-run, and over time the economy adjusts and moves back to the long-run equilibrium path. [United States of America]	Noted - The slowdown of economic growth with increasing affluence is part of macro-economic projections (cf., Dellink et al. 2017 - GEC) which is empirically grounded. See also Mundaca and Markandya (2016)
18202	100	20	100	23	What does it mean "if marginal abatement cost is equated throughout the world"? If global action took place on a cost-minimising basis (i.e. equal marginal cost throughout the world), then it is difficult to see how developing/carbon intensive countries would be most affected. Surely they would have higher marginal abatement costs and therefore undertake less mitigation? [Andrea TILCHE, Belgium]	Noted - In this case it means all countries subject to a carbon pricing mechanism. It is via this policy that abatement (compliance) costs are equated. Carbon intensive countries are more impacted when such policy is implemented compared to a country that is less carbon intensive. Countries with high(er) abatement costs can benefit, however, from emission reductions elsewhere where abatement costs are lower (e.g. via CDM project in the real world). Then, a policy with a 'uniform' carbon pricing and no transfer payments can yield uneven distribution of policy costs. At all events, please note that this box no longer exist due its theoretical orientation and lack of linkages with other chapters and the available 1.5C literature.
42672	100	32			labour ===> labor [Egypt]	Editorial
19172	100	35	101	7	Box 2.2: This box appears unnecessary given that it has no direct connection to pathways of 1.5°C (in absolute terms or relative to other outcomes). Its messages are rather weak (if that's the best that can be argued from the peer-reviewed literature, so be it). [Andrea TILCHE, Belgium]	Taken into account - Due various reasons, including theoretical aspects and cross-chapter issues, this box is no longer in Ch2.
60224	100	35	100	45	This section of text describes ways that carbon tax revenues may be used to offset distortionary taxes in an economy, reducing the cost of a climate policy. This may be true during early years of carbon taxation, but net carbon tax revenues will peak and decline as the economy approaches carbon neutrality and offsetting subsidies are paid for carbon sequestration. For a discussion of this effect, see Sands, R. February 2018. "U.S. Carbon Tax Scenarios and Bioenergy," Climate Change Economics 9(1), in press. [United States of America]	Taken into account - Thanks for the reference. This issue was touched upon in SOD (p.91 L9-14). Text was revised.
31032	100	38	100	45	The literature mentioned here is to a large extent (if not exclusively) theoretical in nature, this refers in particular to the “double-dividend hypothesis” suggested by Bovenberg, van der Ploeg, Goulder and De Mooij. The empirical findings on to what extent the double-dividend has been realised is completely missing and must be added. [Victoria Alexeeva, Austria]	Rejected - Empirical policy aspects (e.g. policy choice, policy implementation) are within the scope of Ch4 that are pertinent to the 1.5C subject. Ch2 looks into the Integrated Pathways Mitigation literature.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
45958	100	50	100	50	Please also see the OECD/IEA and IRENA, 2017 study on this topic (already cited in this chapter of the report). [Deger Saygin, Turkey]	Taken into account - The literature has been reviewed and included to extent that pertains to the scope of the chapter.
4480	101	9	101	11	Very important point. Keep this. [Mitsutsune Yamaguchi, Japan]	Noted - Further details about policy in practice are also found in Ch4
31424	101	9	101	11	As this sentence is important, please keep it included in the report. [Japan]	Noted - Further details about policy in practice are also found in Ch4
51888	101	9	101	11	This point about politically feasible carbon price is really important (I live in a jurisdiction where the carbon price has been INCREDIBLY unpopular). It should be made more promenently. [Jason Donev, Canada]	Noted - Further details about policy in practice are also found in Ch4
22672	101	11			Insert a space between "level.Carbon" [LUIS VALDES, Spain]	Editorial
51890	101	11	101	11	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Editorial
60226	101	12	101	13	Suggest adding a table that lists these policies by country along with the affected sectors and the carbon price (or price range). This would be very helpful and informative to readers. [United States of America]	Rejected - Thanks for the suggestion. However, this is within the scope of Ch4 that deals with empirical ('reality checks') aspects; including policy choice. Due to overlaps, this material has been moved to Ch4.
28116	101	13	101	23	Please ensure that a clear and detailed explanation of barriers to implement more carbon tax systems and to reach adequate price levels are included either here or in Ch 4. As this will be an important factor to reach high mitigation levels, it is important that this report provides information on how these barriers can be overcome. Explanation in l 21-23 is rather superficial, and Ch 4 does not provide a clear overview of this matter either. [Germany]	Rejected - Thanks for the suggestion. However, this is within the scope of Ch4 that deals with empirical ('reality checks') aspects; including policy choice. Due to overlaps, this material has been moved to Ch4.
1774	101	15	101	16	The value of the EU-ETS should also be included here, given that at present it is the most important carbon market worldwide. [Greece]	Noted - Due to numerous issues (e.g. overlaps with other chapters) this paragraph was removed from Ch2 and it is now included in Ch4. Aspects about the EU-ETS are treated in Ch4.
51892	101	15	101	15	Can 1USD/t really be considered carbon pricing, or is it just greenwashing at this level? I realize that you may need to include it, but framing it is important too. [Jason Donev, Canada]	Noted - This is why it is mentioned mention that "an optimal carbon price of the magnitude estimated by in modelled mitigation pathways needs to be compared with what is politically feasible ". The aspect mentioned by the reviewer is within the scope of Ch4 that deals with empirical ('reality checks') aspects, including carbon prices in actual carbon markets.
11936	101	18	101	21	The discussion on carbon prices needed here refers to much higher prices than those reported on p99 lines 3 - 9, e.g. the 2030 prices are already above the 2050 one quoted earlier. Needs to be integrated and made consistent. [United Kingdom (of Great Britain and Northern Ireland)]	Taken into account - Indeed, the values presented in the SOD are discounted. We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. Methodological aspects about IAMs are now consolidated in section 2.1. and technical annex.
41576	101	18			Change "USD52 billion USD" to "52 billion USD" [Czech Republic]	Noted - Due to numerous issues (e.g. overlaps with other chapters) this paragraph was removed from Ch2 and it is now included in ch4.
51894	101	18	101	18	USD?? [Jason Donev, Canada]	Editorial
28118	101	19	101	21	It would be helpful to insert a remark here how these figures relate to the results on p 99. If you stick to the presentation of discounted rather than undiscounted prices for 2050, the figures may be understood to mean that Stiglitz et al find higher prices for 2020 than this report finds for 2050. Depending on changes in the presentation of the results on p 99 (as commented on there), the remark could be limited to a short reference. It could also be helpful to insert a table with i) prices for 2050 (undiscounted) , ii) prices for 2050 discounted to 2020 iii) prices from the Stiglitz et al paper, iv) prices observed in 2017 (ETS, Chinese, Swedish tax etc.). [Germany]	Taken into account - Indeed, the values presented in the SOD are discounted. We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. For prices in real carbon markets please see Ch4.
22674	101	20			Insert a space between "80USD" [LUIS VALDES, Spain]	Noted - Due to numerous issues (e.g. overlaps with other chapters) this paragraph was removed from Ch2 and it is now included in ch4.
41578	101	20			Change "40–80USDtCO" to "40–80 USD tCO" [Czech Republic]	Noted - Due to numerous issues (e.g. overlaps with other chapters) this paragraph was removed from Ch2 and it is now included in ch4.
22676	101	21			Insert a space between "100USD" [LUIS VALDES, Spain]	Noted - Due to numerous issues (e.g. overlaps with other chapters) this paragraph was removed from Ch2 and it is now included in ch4.
41580	101	21			Change "50–100USDtCO" to "50–100 USD tCO" [Czech Republic]	Noted - Due to numerous issues (e.g. overlaps with other chapters) this paragraph was removed from Ch2 and it is now included in ch4.
21528	101	27	101	27	Definition of carbn markets. Are they financial markets? [Nathalie HILMI, France]	Noted - Due to numerous issues (e.g. overlaps with other chapters) this paragraph was removed from Ch2 and it is now included in Ch4. Aspects about carbon markets are confined to Ch4.
31426	101	27	101	29	IPCC should add voluntary initiatives as well because it is as important action as others. It is expected to change the sentence into "In practice, carbon markets also operate simultaneously with pre-existing taxes and other policy options such as tradable green certificates, feed-in-tariffs, energy efficiency obligations, emissions standards, voluntary initiatives and early retirement of fossil-fuel installations." [Japan]	Noted - Please note that voluntary actions are within the scope of Ch4.
14100	101	28	101	28	There is missing any policy option in the enumeration or there is an extra comma on it? [Meimalin Moreno, Venezuela]	Editorial
22678	101	28			Remove double "," [LUIS VALDES, Spain]	Editorial
44878	101	28	101	28	.. certificates,, feed-in-tariffs.. --> duplicated comma [Hiroaki Kondo, Japan]	Editorial
51896	101	28	101	28	Extra comma [Jason Donev, Canada]	Editorial
58068	101	28	101	28	The extra punctuation in the phrase "certificates, , feed-in" should be addressed. [Siir KILKIS, Turkey]	Editorial
54640	102				Figure 2.29. Axis labels and titles are too small. Not easily readable. [Qudsia Zafar, Pakistan]	Taken into account - New figures are provided (based on the latest data point contained in the database). Thus, a new figure has emerged (with two panels).
5376	102		102		Suggest to make "x" mark in contras between the colour. [Sulistyawati Sulistyawati, Indonesia]	Noted - Figure has been improved/updated

Comment No	From Page	From Line	To Page	To Line	Comment	Response
31428	102		102	5	Please make it clear in the figure 2.29 that there are many "infeasible" (i.e. infinite price!) scenarios. And please delete the average (Median values in floating black dash), as the average excluding infeasible does not make any sence. Also, please show the carbon price in 2020, 2030 and 2100, as these are indicated in AR5 in Chapter 6, and describe this information precisely in SPM because this is very relevant information for policy makers to decide policy for short and long terms. In addition, it should be clearly mentioned that this assessment is gained under idealized policy conditions in Figure 2.29 as explained in the page 85 line 19-23.Also, please show the results for 2020 and 2030, this information is very relevant to policy makers. [Japan]	Taken into account - The values presented in the SOD were discounted. We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. A 5% was chosen to make comparison with AR5 estimates. Carbon prices values from real markets (i.e. ex-post estimates) are the foci of Ch4. Ch2 deals with values from the integrated pathway literature.
1622	102	1	102	1	It is suggested to add MAC from IEA ETP-B2DS for comparisons. [Wenying Chen, China]	Noted - All data reported by modelling teams (and accepted before cut off date) is included.
4482	102	1	102	1	Please show carbon price in 2100 as well as mitigation cost per GDP or consumption both in 2050 and 2100. [Mitsutsune Yamaguchi, Japan]	Noted - We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. Unfortunately, and given the complexities related to the assessment of GDP/consumptions losses, the allocated time for the development of this special report has not allowed the team to carry out the analysis. Instead of providing an examination with no vetted and robust numbers, the team believes that AR6 will be in a much better position to perform this assessment. We hope the reviewer understand the situation.
28120	102	1	102	4	The figure should contain two y-axes, one with undiscounted prices for 2050, one with prices discounted to 2020. Both kinds of prices should be well explained in the sub-title of the figure, see comment regarding result presentation on p 99. [Germany]	Taken into account - Indeed, the values presented in the SOD are discounted. We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. Methodological aspects about IAMs are now consolidated in section 2.1. and technical annex.
31430	102	1	102	1	Adding mitigation cost per GDP or consumption to this figure is informative for Policy Makers. We would request to indicate the carbon price at 2100, too, as these are indicated in Ar5 in Chapter 6, [Japan]	Noted – We thank the reviewer for bringing up the important issue of GDP consumption losses. Unfortunately, and given the complexities related to such an assessment, the allocated time for the development of this special report has not allowed the team to carry out the analysis. Instead of providing an examination with no vetted and robust numbers, the team believes that AR6 will be in a much better position to perform this assessment. We hope the reviewer understand the situation.
51898	102	1	102	1	This graph makes no sense to me. [Jason Donev, Canada]	Noted - A new figure with new (available) data has been produced. It contains two panels (undiscounted and average discounted data).
60228	102	1	102	1	If this figure is included, the caption needs to discuss the sampling bias inherent in this set of model runs. [United States of America]	Taken into account - Sampling bias is discussed in main text and, despite severe word limits, further examples have been added.
13918	102	2	102	2	Figure 2.29: looks like an effective figure, but too much white area. [Natalie MAHOWALD, United States of America]	Noted - A new figure was produced with the latest data. Design has been improved and includes two panels (undiscounted and average discounted carbon prices).
37086	102	2	102	5	Carbon prices should be presented not only for 2050, but also 2020, 2030 and 2100. For the sake of comparability, the same format of figures with AR5 Figure 6.21 should be presented adding 1.5 degree scenarios. [Jun Arima, Japan]	Taken into account - We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. These make the figures more comparable (including 5% discount rate as used in AR5). We also tried to replicate the layout used in AR5. Methodological aspects about IAMs are now consolidated in section 2.1. and Annex.
37088	102	2	102	5	Since this Figure could be often cited, its context should be clearly understood by readers. First of all, it should be made clear that there are many infeasible scenarios with infinite carbon price, in particular for 1.5 degrees scenario. This reflects extremely challenging nature of 1.5 degrees scenairo. In this regard, it is questionable and misleading to present "median value" only calculating feasible scenarios.With a view to avoiding misunderstanding, median values in floating black dash should be removed from FIgure 2.29. At least, there should be a note that there are scenarios with infinite carbon prices and such scenarios have not been included in the calculation of "median price". [Jun Arima, Japan]	Noted - no 'infinite' carbon values were reported to the database. The bias due to infeasible model runs is already discussed in AR5 (Section 6.2.3 and page 449 last paragraph). It is also explicitly reported that "none of the IAMs contained in the SR1.5 database could produce a 1.5°C scenario under SSP3-SPA3 assumptions". Other than this, the entire figure has been updated based on the latest (accepted) papers. We now provide undiscounted figures (2030-2100) and average discounted figures (2030-2100) for a range of 1.5C and 2C scenarios. Methodological aspects about IAMs are now consolidated in section 2.1. and technical annex.
2482	102	7	104	8	This section would be improved with reference to the current or projected dollar value of global investment for scale. [Jared Woollacott, United States of America]	Accepted - Added a note that in addition to being approximately 2.2% of global GDP, total global energy investments in 2016 also amounted to about 10% of gross capital formation.
8344	102	7	104	21	Section 2.5.2.2 reviews literature on investment in mitigating climate change. It is suggested that the long textual paragraph stating the amounts of investment obtained by various research studies be tabulated into a single form in order to more clearly display the differences and categories. [China]	Noted - There is only one study to date (McCollum et al., accepted) that has compiled investment estimates from different models and discussed the associated uncertainties. It is not the purpose of this IPCC report section to repeat those discussions; rather, the task is to simply specify the ranges identified by those other studies. And this can be done most effectively and compactly without a table.
18204	102	7			The investment discussion is mainly related to investments needed on the supply side. There is no coverage of the investments needed for transforming the demand side, even though other parts of the chapter stress its imporance. e.g., within transport sector a large amount of investments are needed to transform public transport, freight, non motorised transport, etc which can trigger a transformation to sustainable mobility [Andrea TILCHE, Belgium]	Taken into account - The literature on demand-side investments is very limited for integrated pathways in line with 1.5°C. It is telling that, while expressing a desire to see more specific numbers, no reference was provided where such estimates could be found. Furthermore, demand-side measures also suffer from definitional issues as it is difficult to determine the system boundaries of such investments. We have included aggregate demand-side estimates based on the literature available and have highlighted the demand-side as low to medium confidence given the known uncertainties surrounding this issue.
28122	102	8	104	23	It should be explained more clearly (as far as possible): What is the difference as for investment between reaching 1.5°C and 2°C? [Germany]	Taken into account - This 'incremental effort' insight is what the figure in this section intends to show.
60230	102	8	102	9	Date for reference missing. [United States of America]	Noted - This paper was under review at the time the SOD was submitted. All references are being updated across the chapter.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
21526	102	9	102	23	How is fixed the price for carbon emissions? If several ways to fix it, what will be the policy implication of such a price? [Nathalie HILMI, France]	Noted - We are not sure what the reviewer means. Is this related to imposing a "emission cap" or temperature target (?). As stated in the cross-chapter Box 2.1 "In CEA, the marginal abatement cost of carbon is determined by the climate goal under consideration. It equals the shadow price of carbon associated with the goal which in turn can be interpreted as the willingness to pay for imposing the goal as a political constraint"
47830	102	9	102	9	Kindly check: 'McCollum et al.'……year missing in citation [Sarah Connors, France]	Noted - This paper was under review at the time the SOD was submitted. All references are being updated across the chapter.
47910	102	9	104	13	Please check the citations: McCollum et al.;……incomplete; no year; not available in reference section and Iyer et al. 2015; International Energy Agency (IEA) 2016;……..not available in reference section [Sarah Connors, France]	Noted - Ch2 common library needs to be checked. Some of these studies were already included. Deleted by mistake?
54644	102	9	102	9	(McCollum et al.) reference needs correction. [Qudsia Zafar, Pakistan]	Noted - Paper was under review at the time the SOD was produced. It is now accepted and REF information was updated.
58312	102	9	102	9	Remember to put the date on "(MoCollum et al)" perhaps 2018? [Peter Marcotullio, United States of America]	Noted - This paper was under review at the time the SOD was submitted. All references are being updated across the chapter.
24110	102	13	102	16	The following statement seems misplaced: "There is some uncertainty surrounding this number because not all entities making investments report them publicly, and model-based estimates show an uncertainty range of about ± 15% (McCollum et al.)" There is some uncertainty around the 2017 IEA number, but not for reasons that can be found in the 2013 McCollum paper. The IEA estimate is a backward-looking accounting of all new energy supply and energy efficiency assets coming online in the given year. It is not a modelled result. I do not think that this statement should come between two setences on the IEA numbers. While you have identified some interesting conclusions of the IEA World Energy Investment analysis, I think it may also be worth mentioning that the recent decline in investment is mostly due to the 2014 oil price collapse and that electricity-sector investments have remained relatively robust, with renewables overtaking fossil fuel-fired generation by a considerable margin in the last ten years. Oil and gas sector investment in 2016 was in line with the annual investment requirements in that sector in the IEA Sustainable Development Scenario, which follows a 2C CO2 budget, i.e. if maintained at this level the problem of stranded assets in oil and gas production may vanish. [Simon Bennett, France]	Taken into account - The note about the uncertainty of estimates for global energy investments was added after the receiving comments on the first-order draft. To address those comments, we added the statement to the text to clarify that historical investment numbers are not entirely certain. This is a common misconception: that investment "data" are as certain as new capacity installations or energy flows. For some sectors, the data is known, but for others it is not. Much data is not reported publically by companies, and therefore has to be estimated ex-post. This is what the both the IEA and the global models do. See the "Methodology Annex" to the IEA's "World Energy Investment 2017" report for a brief discussion. Yes, it's true that the IEA WEI-2017 report does not do modeling per se, but it does do some analysis, based on a variety of assumptions, to calculate the investment numbers. This is not altogether different from how the models calculate investments in their historical periods. The McCollum et al. (accepted) paper discusses these issues a bit; the McCollum et al. (2013) paper does not discuss this. Accepted - We have added a note explaining that the recent decline in global energy investments followed the 2014 oil price collapse.
51900	102	13	102	15	This is a poor way to express these numbers. Could a chart be included? Could this be re-phrased? Two fifths is a bit strange here. [Jason Donev, Canada]	Accepted - The part of the sentence with the two-fifths statistic for oil and gas has been removed.
34242	102	14	102	14	Notes that oil and gas make up two fifths of global energy investment. Puzzling that coal investment was not included in this factoid. If one includes coal investment too, total fossil fuel investment amounts to 49.3% of total global energy investments in 2017. Arguably a more comprehensive and useful statistic. [Joe Thwaites, United States of America]	Noted - The part of the sentence with the two-fifths statistic for oil and gas has been removed due to previous comments.
51902	102	14	102	14	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Editorial
47832	102	16	12	16	Kindly check: 'McCollum et al.'……year missing in citation [Sarah Connors, France]	Noted - This paper was under review at the time the SOD was submitted. All references are being updated across the chapter.
54648	102	16	102	16	(McCollum et al.) reference needs correction. [Qudsia Zafar, Pakistan]	Noted - Paper was under review at the time the SOD was produced. It is not accepted and REF information was updated.
58070	102	16	102	45	The reference "(McCollum et al.)" is missing the year of publication. There are instances in lines 16, 18, 30 and 45. [Siir KILKIS, Turkey]	Noted - This paper was under review at the time the SOD was submitted. All references are being updated across the chapter.
60232	102	16	102	19	In addition to the IEA, Bloomberg New Energy Finance has well-regarded information on global clean energy investment trends and would be a useful source. [United States of America]	Noted - We continued reviewing the scientific (accepted) literature that pertains to the 1.5C-2C topic.
24112	102	19	102	29	Estimates of demand-side investments are more uncertain, mainly due to a lack of reliable statistics and definitional issues about what exactly is counted towards a demand-side investment (McCollum et al., 2013) I think you need to be clearer about what you are discussing here. Demand-side investments could encompass any investment that has an impact on the outlook for energy demand (all appliances, roads, vehicles, pedestrianisation schemes, factories etc. etc. I think you rather mean climate change mitigation investments related to energy end-use, which is a noble categorisation but has not been estimated by anyone to my knowledge. The IEA estimates energy efficiency spending to have reached $231bn in 2016 based on a definition of incremental spending to acquire more energy efficient end-use assets than would ordinarily have been selected by consumers. This definition is described in World Energy Investment 2017. I think that Charlie Wilson's paper about the lack of attention to the demand side is important. I also think it is worth noting the methodological challenges in modelling future energy efficiency investments in relation to the need for a counterfactual. An energy efficiency investment is always made in relation to a less efficient alternative and modelling the "compared to what?" element is problematic. In a scenario where governments apply strict efficiency standards that remove inefficient goods from the market, we might have to ask if anyone is actually investing in efficiency? Numerous studies have found that standards do not generally cause prices to rise, in which case any "investment" is either be a loss of manufacturers' profits or a loss of utility by consumers who are getting fewer additional (non-energy) functionalities but are getting a more energy efficient good for the same price. In a long-term model, how do you adjust the baseline year over time for the calculation of any "incremental" efficiency investment. These seem like worthy issues to raise in the context of investment in 1.5C. [Simon Bennett, France]	Accepted - These very astute comments have been incorporated into the paragraph.
58478	102	19	102	19	Could add (drawing on same IEA reference): "this decline in total investment is partly driven by capital cost reductions meaning more capacity can be installed for the same financial investment; though declines in oil and gas capacity investment is also a factor" [Andrew Prag, France]	Accepted - Text revised

Comment No	From Page	From Line	To Page	To Line	Comment	Response
34244	102	22	102	23	Sentence describes how definitions differ in which components are counted towards being relevant to the energy part of demand-side investments. If not too long or burdensome, it might be good to briefly describe these definitional differences. [Joe Thwaites, United States of America]	Accepted - The definitional differences are now better described.
58480	102	26	102	26	Could add: IEA estimate that the subset of energy demand -side investments that can be considered energy efficiency investments totalled around USD 0.23 trillion in 2016 (IEA 2017x [World Energy Investment]) [Andrew Prag, France]	Accepted - Text added earlier in the section
18206	102	31	103	9	This paragraph makes a number of points that could be stated more explicitly: i) the need for supply-side investments in a 1.5°C pathway could be lower than under BAU; but ii) this is because demand is likely to be lower and; iii) strong limitations on demand growth do not happen by magic, meaning; iv) substantial demand-side investment (not necessarily financial) is needed for 1.5°C. IAM scenarios imply this - even if they do not capture it explicitly; v) decarbonisation is more a question of qualitative shifts in investment (investing in different things) than massive increases (or decreases) in the amount of capital required (as discussed in the following paragraph and impli in Fig 2.30). [Andrea TILCHE, Belgium]	Noted - This is an accurate, lay-person's summary of the more scientific text written in the paragraph. The language provided by the reviewer should be incorporated elsewhere in the report.
58072	102	31	102	32	The link "www.cd32links.org/" should be provided as a reference. [Siir KILKIS, Turkey]	Rejected - this is website address and it is unclear which report/paper (if any) should be considered for review. Reviewer does not motivate his comment.
47834	102	34	102	34	Kindly check: 'McCollum et al.'……year missing in citation [Sarah Connors, France]	Noted - The paper was recently accepted. REF info is being updated
44880	102	36	102	36	in this report)-->Left parenthesis is missing. [Hiroaki Kondo, Japan]	Editorial
192	103	4	103	28	Please indicate the year of USD in line 4,19,21,22,25,28. [Mingshah Su, China]	Editorial
11938	103	4	103	5	How does much hinge on energy demand growth and energy efficiency investment? [United Kingdom (of Great Britain and Northern Ireland)]	Rejected - Reviewer comment is not entirely clear, unfortunately.
47836	103	6	103	6	Kindly check: 'McCollum et al.'……year missing in citation [Sarah Connors, France]	Noted - This paper was under review at the time the SOD was submitted. All references are being updated across the chapter.
54652	103	6	103	6	(McCollum et al.) reference needs correction. [Qudsia Zafar, Pakistan]	Noted - Paper was under review at the time the SOD was produced. It is now accepted and REF information was updated.
58482	103	9	103	9	Suggest to add: "Some scenarios for "well-below 2C" suggest that while demand-side investments need to increase dramatically to achieve the scenarios, supply-side investment needs to be significantly reallocated (away from fossil-fuels and towards renewables) but do not necessarily see an overall increase in total invesment (IEA 2017x, [World Energy Outlook 2017]" [Andrew Prag, France]	Taken into account - Reference to IEA publication is duly included in the section (as done in previous sections, e.g. 2.4)
45962	103	11	103	41	Is it possible to give some additional insights into the investments in the energy end-use sectors like buildings, industry, transport? [Deger Saygin, Turkey]	Rejected - Unfortunately, the literature that Chapter 2 draws upon does not provide such estimates at present. A detailed sectoral assessment goes beyond the scope of this Special Report. AR6 may have the possibility to address these issues.
46596	103	13	103	13	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Noted - IPCC uncertainty language is now explicitly used across Ch2.
902	103	15	103	15	more will needed' should be 'more will be needed' [Robert Shapiro, United States of America]	Editorial
47076	103	15	103	15	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted
58074	103	15	103	15	There is a missing word "be" in the phrase "will needed" so that it should read "will be needed." [Siir KILKIS, Turkey]	Editorial
11940	103	18	103	19	Low-carbon supply-side investments are projected to average 0.8–2.9 trillion USD yr–1 globally to 2050 - under 1.5°C, or current policy/baseline? [United Kingdom (of Great Britain and Northern Ireland)]	Noted - Under 1.5C pathways
39478	103	18	103	18	Between 1.5°Cpathways there must be a free space: 1.5°C pathways [Olga Alcaraz, Spain]	Editorial
47838	103	18	103	18	Kindly check: 'McCollum et al.'……year missing in citation [Sarah Connors, France]	Noted - This paper was under review at the time the SOD was submitted. All references are being updated across the chapter.
54656	103	18	103	18	(McCollum et al.) reference needs correction. Also at line 30. It should be corrected through rest of the text. [Qudsia Zafar, Pakistan]	Noted - Paper was under review at the time the SOD was produced. It is now accepted and REF information was updated.
58076	103	18	103	18	There is missing spacing and missing year of publication for the reference in the phrase "1.5°Cpathways (McCollum et al.)" [Siir KILKIS, Turkey]	Noted - This paper was under review at the time the SOD was submitted. All references are being updated across the chapter.
19580	103	19	103	22	Under middle-of-the-road assumptions of future socioeconomic and technological development (Fricko et al., 2017), the bulk of these investments are projected to be for clean electricity generation, particularly solar and wind power (0.09–1 trillion USD yr–1 and 0.1–0.4 trillion USD yr–1, respectively) as well as nuclear power (0.1–0.23 trillion USD yr–1). 2016 nuclear investments were 26 Bn USD. The SOD does not justify why these would grow to 100-230 Bn USD especially "under middle-of-the-road assumptions". Also considering that renewable electricity investments were again above 300 Bn USD in 2017 and above 200 Bn USD annually during each of the last 10 years - what justifies 90 Bn USD/annual investments on the lower end in the future, e.g. 2050? Source BNEF, 2018: https://data.bloomberglp.com/bnef/sites/14/2018/01/BNEF-Clean-Energy-Investment-Investment-Trends-2017.pdf or in case the report still wishes to use fossil industry funded IEA documents: https://www.iea.org/publications/wei2017/ [Jennifer Morgan, Netherlands]	Accepted - The language 'middle-of-the-road assumptions' seems to have been confusing. Importantly, this does not mean a BAU-type baseline future. Rather, it refers to a continuation of population, GDP growth, and techno-economic development trends; then, layered on top of that scenario storyline is the set of mitigation measures needed for achieving the 1.5C target. The 'middle-of-the-road assumptions' language has been moved elsewhere to avoid this confusion. This hopefully explains why models show potentially increased investment needs for nuclear power in a 1.5C future vs. today. After all, the last years have not seen investment patterns consistent with 1.5C, either for renewables or nuclear (which the models do show disagreements on). Please see sections 2.3 and 2.4 for discussions about energy supply choices in modeled pathways.
46540	103	25	103	25	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Noted - IPCC uncertainty language is now explicitly used across Ch2.
24114	103	27	103	28	1.5°C pathways see a reduction in annual investments for fossil-fuel extraction and unabated fossil electricity generation (to 0.2–0.7 trillion USD yr–1 in total over the 2016–2050 period). IEA data shows investment in these areas in 2016 was only $0.8billion, so this is hardly portraying a disastrous loss of investment in these sectors in a 1.5C world. There are some who think that oil and gas investments will rise over the coming decade, but I think it is worth taking another look at the investment needs in a 1.5C scenario. I would imagine a much bigger collapse of investment in fossil fuels. [Simon Bennett, France]	Taken into account - This comment prompted us to discuss a larger issue in the text, namely that the future investment results presented in the section are from IAM investment analyses of 1.5 °C pathways that have focused only on middle-of-the-road socioeconomic and technological development futures, namely the SSP2 storyline. However, other development futures (i.e., as envisioned by the SSPs) are of course possible.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
47840	103	30	103	30	Kindly check: 'McCollum et al.'……year missing in citation [Sarah Connors, France]	Noted - This paper was under review at the time the SOD was submitted. All references are being updated across the chapter.
22680	103	31			Insert space between "4).Furthermore" [LUIS VALDES, Spain]	Editorial - Space was added
24116	103	31	103	34	It is interesting to look at stranded assets as you define them here, especially as it is an indication of the waste of capital through misalignment with climate objectives. I think a broader point is that there will be more capital assets in a 1.5C scenario (compared with a 2C scenario or reference scenario) that will be threatened with closure or severe loss of revenue long before the end of their operational lives (even if they have paid off the capital) and this will give rise to political and economic dynamics that will likely impede the speed of the transition away from fossil fuels (and other technologies that find themselves "out of the money") . This dynamic is not well captured in the models summarised in this report and shoudl perhaps be highlighted to temper optimism and raise policy attention. [Simon Bennett, France]	Accepted - Text revised.
39480	103	31	103	31	Between (see Chapter 4).Furthermore there must be a free space: (see Chapter 4). Furthermore [Olga Alcaraz, Spain]	Editorial
60234	103	31	103	34	Stranded investments are a certainty when meeting the goal of 1.5°C. The statement implies that it is a risk, but not necessarily inevitable. The value of fossil fuel assets will inevitably fall on a path to 2°C or less. This point needs to be conveyed. [United States of America]	Accepted - Text revised.
22682	103	34			Insert a space between "investment)(Bertram" [LUIS VALDES, Spain]	Editorial - Space was added
51904	103	34	103	34	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Editorial
29642	103	38	103	38	Please insert after "low-carbon investments": (Michaelowa et al. 2018) Reference: Michaelowa, Axel; Allen, Myles; Fu Sha (2018): Policy instruments for limiting global temperature rise to 1.5°C – can humanity rise to the challenge?, in: Climate Policy, 18, p. 275-286 [Mareike Blum, Germany]	Rejected - Paper was reviewed and, in this particular case, no explicit links with the integrated pathway literature were possible to find.
3350	103	41	103	41	Reference to 2017 OECD report (investing in cliate, investing in growth [Kamel Bennaceur, United Arab Emirates]	Noted
21530	103	43	103	43	Why are low-carbon investment needs projected to be larger in OCDE countries and developing Asia? Any reference to support that statement? [Nathalie HILMI, France]	Noted - This entire section has been revised based on the latest figures provided by modelling teams.
22684	103	45			add "year" in citation or delete the reference (one case in this line) [LUIS VALDES, Spain]	Editorial - Space was added
47842	103	45	103	45	Kindly check: 'McCollum et al.'……year missing in citation [Sarah Connors, France]	Noted - This paper was under review at the time the SOD was submitted. All references are being updated across the chapter.
51906	103	45	103	46	Broken exponent [Jason Donev, Canada]	Editorial
39174	103	50	103	57	This is a really important point that should get strong highlighting. [Lindsey Cook, Germany]	Noted
47078	103	51	103	54	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted - Policy language is under constant improvement
29644	103	56	103	56	Please insert after "long term": (Michaelowa et al. 2018) Reference: Michaelowa, Axel; Allen, Myles; Fu Sha (2018): Policy instruments for limiting global temperature rise to 1.5°C – can humanity rise to the challenge?, in: Climate Policy, 18, p. 275-286 [Mareike Blum, Germany]	Taken into account - Paper was reviewed and explicit links with statements/arguments were found.
21532	103	57	104	21	climate finance is not in 4,4,2. Problem of numbering? [Nathalie HILMI, France]	Noted - Cross reference with all chapters will take place once final versions are exchanged among Ch teams.
4266	104				Figure 2.30. It is wrong and missleading when coupling "Nuclear and CCS" in the same colour and category. There are obviously totally different technologies and they have been discussed differently in the whole report and in this Chapter 2. Is CCS investment including BECCS?. If yes, how can be BECCS mixed up wiht nuclear under the same colour category?. Are these figures consistent with scenarions reporting the need for negative emissions to reach 1.5ºC in previous sections?. It is probably better to delete these figures if they cannot be re-drawn to distinguish between these two important categories of technologies. [Abanades Carlos, Spain]	Noted - BECCS and Nuclear are energy supply options. This is why they belong to Supply box. Figure has been revised based on multiple comments. Please note that figure is based on assessment carried out in Ch5.
11942	104	1	104	8	This section doesn't have references to studies to back it up, e.g. the high confidence statements [United Kingdom (of Great Britain and Northern Ireland)]	Noted - Text has been revised.
34246	104	1	104	3	Sentence discusses studies but has no citation. It makes important claims, so would be good to reference. [Joe Thwaites, United States of America]	Noted - Text has been revised.
51908	104	2	104	2	Define bankable. [Jason Donev, Canada]	Accepted - a brief definition is provided. Please note that financial aspects (beyond the Integrated Pathway literature) are treated in ch4.
47080	104	3	104	4	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted - IPCC uncertainty language is now explicitly used across Ch2.
62136	104	4	104	4	The mention of "financial stress tests" is of great importance, but maybe mention this also in the context of existing large scale assets, with the need for financial instruments to take into account the existing stranded assets [Antoine Bonduelle, France]	Noted - See also Chapter 4 (Section 4.4.2) for details of climate finance in practice.
46598	104	6	104	8	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Noted - IPCC uncertainty language is now explicitly used across Ch2.
193	104	9	104	11	It is USD 2015 in figure 2.30 a while it is USD 2010 in figure 2.30 b and c. IT is better to use the USD in the same year. [Mingshah Su, China]	Noted - Figure has been improved/updated
46640	104	9	104	22	Colourblind check for this figure. Please avoid using greens and reds together in figures as they are hard to distinguish between. [Sarah Connors, France]	Taken into account - Colours have been adjusted in line with guidance received from the TSU.
58484	104	11	104	11	Figure 2.3: this is a striking figure but is a bit confusing. What is being compared in panel (a), are these projections of investments or comparisons in the base-year? What is the IEA reference, is it World Energy Investment 2016? For panels b) and c), suggest including IEA numbers from World Energy Outlook (Sustainable Development Scenario and Faster Transition Scenario) as point of comparison. [Andrew Prag, France]	Accepted - Clarifications have been made and comparisons to the 2C scenarios of IEA have been added to part of the figure. It is only possible to do this for panel 'b', however, since that panel deals with the time period 2016-2050 and IEA only reports cumulative values over this time interval, which we then convert to an annual average. For this reason, we cannot compute 2016-2030 values for panel 'c' in the figure. We draw the IEA numbers from the 2017 IEA and IRENA report "Perspectives for the energy transition – investment needs for a low-carbon energy system" since that report focuses explicitly on energy investment needs under different scenarios.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
47844	104	12	104	12	Kindly check: 'McCollum et al.'……year missing in citation [Sarah Connors, France]	Noted - This paper was under review at the time the SOD was submitted. All references are being updated across the chapter.
45960	104	25	104	26	It is not entirely clear why the text refers to the year 2005. [Deger Saygin, Turkey]	Noted - Text has been revised.
4228	104	26	105	1	For example, Nunes et al. (2016) identify health-related SDGs and synergies between health and well-being, and other goals within the SDGs by sector.Furthermore, Nunes et al. (2016) set out the synergies between health and well-being (SDG 3), and other SDGs, and the various sectors relevant to each. Once synergies across the SDGs and sectors are identified, highlighting the interdependencies between health and well-being and other SDGs, there is a need to operationalise this approach through the identification of specific objectives, and measures or indicators, to monitor their achievement. The authors seek to overcome the specificity of the SDGs by illustrating how it is possible to identify synergies among them, their targets and indicators with current health and well-being concerns (eg, malnutrition, respiratory diseases, obesity). By doing this, we argue that, despite the considerations above, it is possible to reconcile the tensions between a more focused health and well-being framework to the SDGs, and a wider integrated approach that considers the interdependences among goals, targets and indicators across the sweep of sustainable development. http://gh.bmj.com/content/1/3/e000068 [Ana Raquel Nunes, United Kingdom (of Great Britain and Northern Ireland)]	Noted- The assessment in 2.5.3 is a synthesis based on the detailed assessment carried out in Chapter 5 (see Table 5.1) The suggested literature is referred to Ch5 authors for assessment.
39176	104	26	105	18	Really helpful and empowering collation of analysis. [Lindsey Cook, Germany]	Noted - Thank you
61782	104	26	105	57	Vague statements to be removed and replaced by more precise items (e.g. "and so on" : give examples; "see details in Chapter 5": where?). What is the conclusion of this section? Why is there no use of any calibrated IPCC language? The section reads more like a review than an assessment. [Valérie Masson-Delmotte, France]	Taken into account - Language of assessment improved, using IPCC calibrated language.
46442	104	28	104	28	I cannit find Epstein et al 2017 and Wustemann et al 2017 in the reference list. [Göran Finnveden, Sweden]	Noted - The content has been revised and that literature is no longer part of the references for this section.
47912	104	28	104	29	Please check the citations: Epstein et al. 2017; Wüstemann et al. 2017;……..not available in reference section [Sarah Connors, France]	Noted - The content has been revised and that literature is no longer part of the references for this section.
18208	104	44	104	45	food security should be replaced by "food and nutrition security", a more comprehensive and inclusive definition [Andrea TILCHE, Belgium]	Noted - Text is consistent with assessment carried out in Ch5.
18210	105		106		There is a need to ensure coherence between sections such as this one on 'choices' consistent with a sustainable 1.5°C pathway and other sections (e.g. 2.3) that set out the extent of transformation required in starker terms (energy transformation, land use requirements, need for negative emissions etc.) [Andrea TILCHE, Belgium]	Noted - Consistency across sections (and chapters) is a constant exercise.
12958	105	1	105	7	The statement "Trade-offs often arise from the large-scale deployment or restrictions of certain mitigation technologies and their related risks (e.g., nuclear or CCS)" requires a reference to support such a statement. As already stated in the first round of comments, it is unclear from the text what risks are being referred to with regard to nuclear energy and the basis for this statement. [Jessica Callen, Austria]	Taken into account - Text revised and edited. Section 2.5.3 focuses on discussing the relative SDG synergies identified across scenarios. For in depth assessment on SDG synergies and trade-offs, see Ch5.
21534	105	9	105	41	interesting link with chapter 5 [Nathalie HILMI, France]	Noted - Thank you
31432	105	11	105	13	The SSP1 'sustainability' scenario is an example of a scenario in which climate policy is implemented alongside other goals such as a focus on providing sufficient food, providing modern energy, avoiding deforestation and reducing local air pollution' The LED scenario by Grubler is also an example of a scenario including sustainable development goals such as access decent living standards. [Japan]	Taken into account - Text revised.
3352	105	18	105	18	The 2016 IEA WEO looked at the Energy-Water inter-relation [Kamel Bennaceur, United Arab Emirates]	Noted- The assessment in 2.5.3 is a synthesis based on the detailed assessment carried out in Chapter 5 (see Table 5.1) The suggested literature will be referred to Ch5 authors for assessment.
38392	105	20	105	30	Together with the paper from Bertram et al 2017, I think you could mention a recent paper from Markandya et al 2018 that compares the extra co-benefits in terms of health with the extra-cost of mitigation.TThe study shows that the extra effort of trying to pursue the 1.5ºC objective instead of the 2ºC would generate a substantial net benefit in India (7-15 trillion US$) and China (0.6-3.5 trillion US$) under diferent criteris for effort sharing. These co-benefit are remarkable and indicate that the statement in the Paris Agreement to “pursue efforts” to limit temperature increase to 1.5ºC would make economic sense in some scenarios and countries if health co-benefits are considered. Markandya et al 2018 Health co-benefits and mitigation costs of the Paris Agreement: a modelling study, The Lancet (Planetary Health), Volume 2 ,3e64 - e73. [Mikel González-Eguino, Spain]	Noted - The assessment in 2.5.3 is a synthesis based on the detailed assessment carried out in Chapter 5 (see Table 5.1) The suggested literature will be referred to Ch5 authors for assessment.
47914	105	22	105	25	Please check the citations: Kennel, F. et al. 2012; Peters and Tanner, 2016; Nilsson et al. 2016; …….not available in reference section [Sarah Connors, France]	Noted - The content has been revised and that literature is no longer part of the references for this section.
63222	105	23	103	25	Integrating development and climate policies can contribute to achieve 2030 goals more effectively, efficiently and sustainably, if synergies are enhanced and trade-offs minimized (Nilsson et al. 2016; Peters and Tanner, 2016). This report should be about achieving climate goals in way that do no impacting SDGs. Instead climate goals here are being held hostage to SDG achievement by 2030. Please show evidence that such (unrealistic) demands can indeed result in limiting warming to 1.5degC by 2100 (or ever). [Greg Rau, United States of America]	Taken into account - Text revised and edited. Section 2.5.3 focuses on discussing the relative SDG synergies identified across scenarios. For in depth assessment on SDG synergies and trade-offs, see Ch5.
3354	105	32	105	32	should include air quality [Kamel Bennaceur, United Arab Emirates]	Taken into account - air quality issues are more explicit across the entire section
7190	105	32	105	41	This comes as a surprise here: why would Ch2 synthesize the qualitative work on synergies and trade-offs carried out in Ch5, with explicit focus on the SDGs? This synthesis, incl. Fig 2.31, should be in Chapter 5, in 5.4.3 'Sustainable Development Implications of 1.5°C and 2°C Mitigation Pathways'. Implications of mitigation options and linkages with the SDGs is part of the plenary-approved outline of Ch5, not Ch2. Structurally, it makes more sense if Ch2 focused on the development implications of 1.5C emissions pathways through the lens of the SSPs and SPAs which is not done anywhere else in this SR, and/or further mine the literature on IAMs and links to achieving sustainability and sustainable development objectives (e.g. van Vuuren et al. 2015) in alignment with 1.5C compatible pathways, following the plenary-approved outline bullet 'Characteristics of mitigation and development pathways compatible with 1.5°C compared with 2°C'. [Petra Tschakert, Australia]	Rejected - The very title of Chapter 2 is "Mitigation pathways compatible with 1.5°C in the Context of Sustainable Development". Chapter 2 is of the opinion that it hence has a clear mandate to present the insights from the pathway literature in the context of the sustainable development assessment that Chapter 5 has carried out. This should not come as a surprise as this very integration table was discussed and decided in a Chapter 2-Chapter 5 coordination meeting during LAM2 in the presence of CLAs and LAs from both chapters.
42674	105	35			supply side ===> supply-side [Egypt]	Editorial
42676	105	35			land based ===> land-based [Egypt]	Editorial
46400	105	37	105	37	Need to replace SGD with SDG. [Ijaz Ahmad, Pakistan]	Editorial
22686	105	38			Remove dot after "say" [LUIS VALDES, Spain]	Editorial

Comment No	From Page	From Line	To Page	To Line	Comment	Response
44882	105	38	105	38	- that is to say. --> Period may not be necessary. [Hiroaki Kondo, Japan]	Editorial
58486	105	43	105	43	Suggest to add: The IEA has developed a combined "Sustainable Development Scenario" and finds that, with the right policies, achieving universal energy access can be achieved while reducing air pollution and simultaneously making progress on ambitous climate change goals (IEA 2017, World Energy Outlook 2017)" [Andrew Prag, France]	Noted- The assessment in 2.5.3 is a synthesis based on the detailed assessment carried out in Chapter 5 (see Table 5.1) The suggested literature will be referred to Ch5 authors for assessment.
30968	105	51	105	53	the implication here is that Fricko is SSP1. However, Fricko is described elsewhere as the middle-of-the-road scenario, and so is SSP2. The brackets here should more clearly set out which reference applies to which scenario. [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Noted - Illustrative scenarios have been reviewed. Ch2 use a new set of illustrative scenarios, described at the beginning of the chapter and consistently used along the chapter, including section 2.5.3
4268	106				Figure 2.31. In line with the previous comment, I doubt how/if all the colour codes reflect scientific consensus. I guess the figure requires scrutiny perhaps by a larger group of LA in this report, in order to reflect better consensus and nonconsensus areas. For example, in my area of expertise (CCS) it is odd that CCS gets a red mark (i.e. with high confidence¡) on health and wellbeing (like Nuclear ??¡¡) while it gets no mark on the "planet" aspects. I would expect a red mark on the "responsible consumption and production" because CCS is recognised to be an end pipe solution that could delay the energy system transformation towards more sustainable sytems. In contrast, it does not deserve a red mark on the "prosperity" side, as CCS deployment is a industry-driven mitigation option with large oportunities to generate economic activity. [Abanades Carlos, Spain]	Taken into account - As highlighted in the figure's caption, all colour codes and symbols are transparently and mechanistically linked to the detailed assessment of SDG-mitigation measure interactions discussed in detail in Section 5.4 and accompanying tables. The interaction assessment was updated for the FGD based on the updated assessment of SDG-mitigation interactions in Chapter 5.
29672	106		106		Fig 2.31. With the 4 illustrative scenarios (square, circle, cross, diamond) what is missing is an indication of the economic costs of each. This is crutial for policy-makers to use this for guidance. [Tim Dixon, United Kingdom (of Great Britain and Northern Ireland)]	Rejected - Unfortunately the estimation of economic costs is very convoluted and no robust estimates are available across all scenarios. It would be no problem to provide energy supply system costs, but these are only a limited contribution to the entire economic costs. Demand-side costs are much more difficult to adequately estimate due to issue highlighted in section 2.5.2.2. Given the lack of literature to provide comparable economic costs for all scenarios, and the absence of valuations of the benefits, no such costs have been included here.
54660	106				Figure 2.31. Figure text is not clear. High quality figure with larger font size sould be used [Qudsia Zafar, Pakistan]	Accepted - The authors agree. Figure has been improved.
7678	106	1	106	14	The aggregation of the mitigation measures in the case of land does not allow for a proper assesement of the intections with the SDGs. Measures need to be better defined. [Maria Jose Sanz Sanchez, Spain]	Rejected - While the aggregation does indeed provide a coarse view, the reviewer's comment does not provide any workable, useful or improved suggestion either.
30970	106	1	106	14	the “cross” scenario appears to be considerably more risky for SDG goals than other scenarios, and the “diamond” scenario the best performing. Should this analysis feed more into an assessment of relative desirability of the scenario in earlier pages of this chapter? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Accepted - The use and comparison of scenarios has been better streamlined throughout the chapter, with the scenarios being introduced in Section 2.1 and also better used in the ES.
22688	106	3			Insert space between "4).Only" [LUIS VALDES, Spain]	Editorial
39482	106	3	106	3	Between (Section 5.4).Only there must be a free space: (Section 5.4).O nly [Olga Alcaraz, Spain]	Editorial
58472	106	3	106	4	Suggestion to cite: IEA-2017 (Energy Access Outlook 2017) which explores te interactions between multiple societal objectives in depth - in particular the impacts of achieving three SDGs via the Sustainable Development Scenario on greenhouse gas emissions and energy sector investment. [Andrew Prag, France]	Noted - The assessment in 2.5.3 is a synthesis based on the detailed assessment carried out in Chapter 5 (see Table 5.1) The suggested literature will be referred to Ch5 authors for assessment.
22690	106	4			Insert space between "depth(Clarke" [LUIS VALDES, Spain]	Editorial
39484	106	4	106	4	Between depth(Clarke there must be a free space: depth (Clarke [Olga Alcaraz, Spain]	Editorial
39178	106	7	106	10	This should be highlighted, very important point [Lindsey Cook, Germany]	Noted - key aspects of this assessment are also contained in the Executive Summary
1776	106	10	106	11	Graph 2.31 is very complicated and hard to understand. Please make it simpler. [Greece]	Taken into account - Figure has been improved/updated
8346	106	10	106	14	What is the relationship between the scenarios of four categories in the table and the mitigation scenarios considered in Chapter 2? Which scenarios are included in a given category? How to relate the SDGs to different mitigation measures? It is suggested to give them a clearer expression. The existing figures and tables are too complicated for policymakers. It is suggested that the core messages to be disclosed in the figure be illustrated in the legend. [China]	Taken into account - Illustrative scenarios have been reviewed. Ch2 use a new set of illustrative scenarios, described at the beginning of the chapter and consistently used along the chapter, including section 2.5.3.
14102	106	10	106	11	It is is difficult to understand the last part on figure 2.3.1. At first part, the synergies or trade-offs between different mitigation measures and the all 17 SDGs are indicated, but in the second part, synergies and trade-offs between four different portfolios and just 16 SDGs are shown? Are these 16 squares in this part corresponding to other aspects of the discussion different from the previous 17 SDGs? This is not clear neither in the figure nor in the legend [Meimalin Moreno, Venezuela]	Taken into account - Figure has been improved/updated
49064	106	10	106	14	In Figure 2.31, it is unclear why reducing (or, perhaps, shifting) demand for conventional building and transport would necessarily lead to negative outcomes for SDG 8 involving decent work. It is possible that such shifts could lead to new employment and economic opportunities such as those involving alternative local economies or more compact cities. In addition, it is unclear why non-biomass renewables necessarily result in negative outcomes for SDG 15, life on land; in many cases, solar and wind power (e.g. distributed) can be pursued in ways that do not negatively affect land-use patterns. [David Waskow, United States of America]	Noted - The interactions reflected in the centre of this overview table are based on the synthesized assessment of Chapter 5, section 5.4. This central part of this table provides a reflection of the literature addressed in Chapter 5
7192	106	11	106	14	Fig 2.31 would sit much better in Ch5 as the entire synthesis for it is based on work done in and for Ch5 - best at the end of 5.4.3. Sustainable Development Implications of 1.5°C and 2°C Mitigation Pathways. [Petra Tschakert, Australia]	Rejected - We consider the figure a perfect illustration of the pathway consequences in the context of sustainable development, as mandated by the title of our chapter
44884	106	11	106	11	Does the difference of thickness of symbol (+, - etc.) have some meaning? [Hiroaki Kondo, Japan]	Editorial - No, please see legend at the top of the figure
51910	106	11	106	11	Text in picture is impossible to read, please resize. [Jason Donev, Canada]	Taken into account - Figure has been improved/updated
55642	106	11	106	14	can the five scenarios introduced earlier (fig 2.7) be used for cosnistency, or some help provided to match them to improve understanding. [David Cooper, Canada]	Taken into account - Illustrative scenarios have been reviewed. Ch2 use a new set of illustrative scenarios, described at the beginning of the chapter and consistently used along the chapter, including section 2.5.3.
55644	106	11	106	14	Figure 2.31: This figure is problematic in a few ways. First need to be very clear that figure is portraying gross impacts of mitigation measures (not net of reduced negative impacts of cliamte change itself.). [David Cooper, Canada]	Accepted - This important feature is now highlighted in the accompanying text.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
55646	106	11	106	14	Figure 2.31: This figure is problematic in a few ways. (continued). Second a number of the assessments for implications of measures on particualr SDGs are highly questionable -- often probably as a result of the level of aggregation. Eg: impact of renewables on biodiversity is shown as nehative with high confidence. there would indeed be negative impacts of eg hydropwer on freshwater bodiversity (though many impacts coudl be mitigated). Yet the total impact on biodiversity overall is likley to be much more significant for biomass (and BECCS) -induced land change effects yet this is assesed as both negative/positive with only medium confidence! This cannot be correct. [David Cooper, Canada]	Taken into account - As highlighted in the figure's caption, all colour codes and symbols are transparently and mechanistically linked to the detailed assessment of SDG-mitigation measure interactions discussed in detail in Section 5.4 and accompanying tables. The interaction assessment was updated for the FGD based on the updated assessment of SDG-mitigation interactions in Chapter 5.
55648	106	11	106	14	Figure 2.31: This figure is problematic in a few ways. (continued). Third the scale on the right (being strecthed over the full range) suggests that renewables measnure in circle scenarios is "low". I think that this can be misleading (even with the heading "relative"). [David Cooper, Canada]	Rejected - While the reviewer's observation is correct we have not found a way in which this could be avoided, and neither did the reviewer provide a suggestion here.
55650	106	11	106	14	Figure 2.31: Suggest that the measure behavioural response: diets and food waste be more logicaly listed under demand box. [David Cooper, Canada]	Taken into account - The specific measure is now included in the demand box.
51912	106	14	106	14	The footnote is both confusing and too out of the way for such an important point. [Jason Donev, Canada]	Noted
21432	107	1	113	28	Given that Chapter 2 is over length, I would suggest to consider moving at least the IAM and geophysical tool subsections of Section 2.6 to an annex of CHapter 2 or the entire report (see, e.g., Annex II in the WGIII AR5). In a paper, this is the material that would end up in the SI and there is plenty of opportunities to connect/cross-reference to that material from the more insight-oriented parts of the chapter. In this context, I would suggest to also include documentation of the scenario set assessed in CHapter 2 (and elsewhere in the report) into such an annex. If, inaddition, the discussion of the socio-technical transitions literature would be woven into the main text, probably best into Section 2.3 in the debate surrounding Table 2.8, complementing the more technical mitigation measures by a behavioral/societal dimension, then Section 2.6 could be turned on a short section on knowledge gaps. [Volker Krey, Austria]	Taken into account - Significant sections describing tools and methods have been moved to the Technical Annex during this revision round.
61784	107	1	113	28	See overarching comment for the whole chapter. This assessment of tools comes too late and is needed upfront to inform the readers of the chapter on methods and their fit for purpose upfront. [Valérie Masson-Delmotte, France]	Take into account - The assessment of tools has been included in Section 2.3, and is introduced in Section 2.1.
42678	107	6			strength and limitations ===> strength, and limitations [Egypt]	Text now deleted
11946	107	19	108	52	This section (in first or last para) should make some comment on extent to which IAMs fail to capture effects of climate change on economic growth rates (as referenced for example in IMF's October 2017 World Economic Outlook), and what that implies for analysis in this report. Link also to commentary in ch 3.5 [United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3. This is now covered in new 2.1 and detailed in the Annex
11944	107	19	107	19	Not sure if it would be best here on in the relevant feasibility section of chapter 4 (have left a similar comment there), but I would be interested if somewhere in the report a critical discussion of the issues raised in Wigley et al on spontaneous decarbonisation still hold https://www.nature.com/articles/452531a. It's an old paper now, but related more recent work has raised similar issues https://www.sciencedirect.com/science/article/pii/S0360544217311155. I think a critical discussion of these points would be important somewhere in the SR. [United Kingdom (of Great Britain and Northern Ireland)]	Section deleted to reduce length and avoid overlap. However, the chapter avoids the Wigley issue by assigning baselines with no additional policy measures compared to present
14048	107	19	107	19	This section 2.6.1 would be better placed above the sections above that compare the IAMs with IEA ETP model etc since the IAMs are described here after they have been discussed above [Ralph Sims, New Zealand]	We agree, section now removed and merged with 2.1 and 2.3
55480	107	19	108	52	It is notable that this section does not even touch upon agriculture sector models that are not part of IAM architectures, and thus exhibits a significant blindness towards relevant literature. A key example is the absence of a reference to the FAO GLEAM model (Gerber et al 2013, 2011, Opio et al 2013) which has been used to systematically evaluate cost-effective mitigation options from livestock systems across a range of regions and individual countries. [Andy Reisinger, New Zealand]	Section now removed and merged with 2.1 and 2.3. This sectorial analysis is too detailed for the scope of this report
56918	107	21	107	25	Some key elements io the methdological discussion in section 2.6.1 could have been introduced very early in the chapter to allow readers to consider what they wnt to draw from modelling results [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	We agree, section now removed and merged with 2.1 and 2.3
42680	107	24			cover ===> covers [Egypt]	Text now deleted
47916	107	27	108	41	Please check the citations: Kriegler et al. 2017;……..not available in reference section and Pietzcker et al.; ……..incomplete citation; no year; not available in reference section [Sarah Connors, France]	reference updated
9706	107	34	107	35	What body of literature othr than Jacobson et al, 2017 does suggest a 100% renewable energy? Please add citation of any other study. [Mustafa BABIKER, Sudan]	Section now removed and merged with 2.1 and 2.3>However, other references are now added in support of this
51914	107	34	107	35	Jacobson is not a growing body of literature. Even if one believes Jacobson, and I don't, he's hardly a 'growing body of literature', it's one poorly written paper. [Jason Donev, Canada]	Section now removed and merged with 2.1 and 2.3. Other references now added in support of this
57898	107	34	107	35	The statement "A growing body of literature on 100% renewable energy scenarios has emerged (Jacobson et al., 2017)" is a very important statement. At the same time, the reference as provided may be supported with multiple other references from the literature as needed, including 1) Deason, W., Comparison of 100% renewable energy system scenarios with a focus on flexibility and cost, Renewable and Sustainable Energy Reviews, Volume 82, Part 3, pp. 3168-3178, 2018; 2) Connolly, D., Lund, H., Mathiesen, B.V., Smart Energy Europe: The technical and economic impact of one potential 100% renewable energy scenario for the European Union, Renewable and Sustainable Energy Reviews, Volume 60, pp. 1634-1653, 2016; 3) Kraja?i?, G., Dui?, N., Zmijarevi?, Z., Mathiesen, B.V., da Graça Carvalho, M., Planning for a 100% independent energy system based on smart energy storage for integration of renewables and CO2 emissions reduction, Applied Thermal Engineering, Vol. 31, Issue 13, pp. 2073-2083 (September 2011). [Siir KILKIS, Turkey]	Section now removed and merged with 2.1 and 2.3. Thank you, some of these additional references are now used
62284	107	35			Mark Jacobson is cited as the only example for the 100% renewables literature. Please note that many energy economists and analysts find that his work lacks credibility. I suggest it should not be cited here. Alternatively, critiques of the work must be acknowledged, for example https://doi.org/10.1073/pnas.1610381114 [Edgar Hertwich, United States of America]	Taken into account - also the critiques on this work have been included.
47846	107	38	107	38	Kindly check: 'Pietzcker et al.' ……year missing in citation [Sarah Connors, France]	Text now deleted
22692	107	41			Insert space between "IAMs(UNEP" [LUIS VALDES, Spain]	Text now deleted
51916	107	41	107	41	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Text now deleted
14192	107	43	107	43	missing space before 'pathways' [Roger Bodman, Australia]	Text now deleted
22694	107	43			Insert space between "1.5ºCpathways" [LUIS VALDES, Spain]	Text now deleted

Comment No	From Page	From Line	To Page	To Line	Comment	Response
51918	107	43	107	43	This line (or lines) is missing a space (or more than one). There seems to have been some sort of problem in converting this document to pdf. [Jason Donev, Canada]	Text now deleted
18212	108	9	108	10	This strong statement should be qualified. IAMs are rather crude, in particular in their treatment of land use (in general) and its linkes to energy (notably bioenergy). E.g., Erb et al. 2018. (Unexpectedly large impact of forest management and grazing on global vegetation biomass. Nature, 553, 73-76 doi: 10.1038) show that half of the land use emissions are very likely neglected because land management effects beyond deforestation are almost never taken into account when assessing the C effects of land-use changes. Haberl et al. 2012. (Correcting a fundamental error in greenhouse gas accounting related to bioenergy. Energy policy, Vol: 45-222, Issue: 5, Page: 18-23) point out that the usual assumptions related to the mitigation impacts of bioenergy (namely that combustion emission can be ignored) are incorrect, but there is no indication that this has been corrected in the IAMs. To the extent IAMs are "process-based", they should meaningfully internalise the land sector in their treatment of the energy system (as it relatesto bioenergy). [Andrea TILCHE, Belgium]	Section now removed and merged with 2.1 and 2.3. Bioenergy is covered in a separate report in detail. These analyses are too detailed for this one
11948	108	14	108	16	could you be more explicit about this as it seems significant to the question about model reliance on large scale CDR. Is it effectively that the discount rate is such that the models are happy to rely on cdr later in the century? does adding CDR into the models drive the economics that prioritises their use? What alternatives are there to this? [United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3. CDR modelling is covered in chapter 4, references are now added
56920	108	14	108	21	This important point could usefully have been made earlier [Skea Jim, United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3. CDR now addressed in 2.3
58078	108	36	108	36	The phrase "from models with to models" may be revised to read "from models to models" with the deletion of "with." [Siir KILKIS, Turkey]	Corrected as suggested
42682	108	39			modelling ===> modeling [Egypt]	English spelling is used
53190	108	40	108	52	this paragraph would be better represented in a table, as the 15 line sentence is basically unreadable. Suggest a table with two columns--update type since AR5 (col 1), citation (col 2), short description of update (col 3) [Christopher Weber, United States of America]	text now deleted
47848	108	41	108	41	Kindly check: 'Pietzcker et al.' ……year missing in citation [Sarah Connors, France]	reference corrected
44886	108	47	108	47	for example. --> for example, [Hiroaki Kondo, Japan]	text now deleted
51920	108	52	108	52	The ADVANCE project is an odd source to cite here. [Jason Donev, Canada]	Section now removed and merged with 2.1 and 2.3. Reference now removed
58080	108	52	108	52	The link "http://themasites.pbl.nl/models/advance/index.php/ADVANCE_wiki" should be given as a reference. [Siir KILKIS, Turkey]	text now deleted
33568	109	1	111	40	Several feedback machanisms are listed here. However, one missing tool is the soil carbon-climate change feedback, which is often mediated by soil microorganisms. Recently, a wide variety of soil C models have been proposed that can capture these feedback mechanisms. See Sihi etal-2018-Merging a mechanistic enzymatic model of soil heterotrophic respiration into an ecosystem model in two AmeriFlux sites of northeastern USA, Agricultural and Forest Meteorology-252-155-166; Sihi etal-2016-Comparing models of microbial–substrate interactions and their response to warming, Biogeosciences, 13, 1733-1752, https://doi.org/10.5194/bg-13-1733-2016 and Wieder etal-2013-Global soil carbon projections are improved by modelling microbial processes, Nature Clim. Change, 3, 909–912, doi:10.1038/nclimate1951 for more information. Given soil store a significant fraction of terrestrial C and the microbial processing of soil organic matter may enhance the loss of soil C as CO2 to atmosphere under perturbed condition (which can further increase global temperature), consideration of these feedback mechanisms are URGENT to identify strategies for achieving the COP 21 target of 1.5 degree C temperature increase by 2100. [Debjani Sihi, United States of America]	Section now removed and merged with 2.1 and 2.3. This is now addressed in 2.2
35846	109	6			Delete one "or", has been used twice [India]	text now deleted
42684	109	6			or or ===> or [Egypt]	text now deleted
58082	109	6	109	6	There is an extra word "or" in the phrase "and/or or." [Siir KILKIS, Turkey]	text now deleted
42686	109	9			are the principal method ===> are the principal methods [Egypt]	text now deleted
42688	109	9			traceability ===> traceability, [Egypt]	text now deleted
42690	109	11			simulations ===> simulations, [Egypt]	text now deleted
44888	109	12	109	12	WGIII-->WG3? The forms to refer these working groups are not unified in entire repott. [Hiroaki Kondo, Japan]	now unified
56682	109	24	109	24	Here and in other parts of this chapter equilibrium climate sensitivity is used as the metric for physical climate feedbacks. I think that for the scenarios explored in this chapter (particularly overshoot scenarios) the transient climate response is a more pertinent metric. [Kirsten ZICKFELD, Canada]	This is not necessarily the case for high ambition scenarios, so ECS remains the appropriate metric. Section now removed and merged with 2.1 and 2.3
5880	109	25			There was no CMIP4. I assume the authors mean CMIP3 here? [Peter Thorne, Ireland]	text now deleted
61786	109	25	109	25	What is meant by CMIP4 here? [Valérie Masson-Delmotte, France]	text now deleted
46542	109	28	109	28	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	text now deleted
42692	109	37			publication ===> the publication [Egypt]	text now deleted
904	109	43	109	43	temperature and less important' should be 'temperature are less important' [Robert Shapiro, United States of America]	text now deleted
13826	109	43			Change "and less important and" to "are less important than" [MacDougall Andrew, Canada]	text now deleted
35848	109	43	109	43	Replace "and less important" with "are less important" [India]	text now deleted
55770	109	43			Regarding the statement that carbon cycle feedbacks are less important in low emissions scenarios: The permafrost carbon feedback is the exception to this, as seen in Burke et al (2017), MacDougall et al (2012) [references already included in this chapter]. I suggest “carbon-cycle feedbacks on temperature are less important (with the possible exception of the permafrost carbon feedback, Burke et al (2017); MacDougall et al (2012)) …” [Sarah Chadburn, United Kingdom (of Great Britain and Northern Ireland)]	This section has been thoroughly revised and the permafrost related part in section 2.2 now reads "Schädel et al. (2014) suggest an upper bound of 24.4 PgC (90 GtCO2) emitted from carbon release from permafrost over the next forty years for a RCP4.5 scenario. Burke et al. (2017) use a single model to estimate permafrost emissions between 0.3 and 0.6 GtCO2 y-1 from the point of 1.5°C stabilization, which would reduce the budget by around 20 GtCO2 by 2100. Comyn-Platt et al. (2018) include methane emissions from permafrost and suggest the 1.5°C remaining carbon budget is reduced by 180 GtCO2."

Comment No	From Page	From Line	To Page	To Line	Comment	Response
2092	109	47	109	57	Ignores tipping points, carbon cycle feedbacks, etc. - eg permafrost outgassing (near certain http://iopscience.iop.org/article/10.1088/1748-9326/9/8/085003/meta), anoxic methanogenesis https://www.sciencedirect.com/science/article/pii/S1877343514000372 eg in dead zones (more speculative) [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3. Earth system feedbacks now added in section 2.2
13374	109	47	110	8	Additional literature of relevance includes Kellar et al (in review) Current Climate Change Reports The Effects of Carbon Dioxide Removal on the Carbon Cycle, which reviews current knowledge; Kellar et al (accepted) The Carbon Dioxide Removal Model Intercomparison Project (CDR-MIP): Rationale and experimental design Geosci. Model Dev discusses questions of C-cycle response to NETs and initial results in framing the CDR-MIP project, [Scott Vivian, United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3. These references are considered in 2.2
13828	109	48			Zickfeld and MacDougall, 2016 should be "Zickfeld et al. 2016" [MacDougall Andrew, Canada]	text now deleted
51922	109	49	109	49	Define TCRE [Jason Donev, Canada]	now defined
60236	109	50	109	54	The 7% figure is nothing more than a guess. Hence the text discussing it is pointless. [United States of America]	Section now removed and merged with 2.1 and 2.3. This 7% is no longer used
13830	109	51			Zickfeld and MacDougall, 2016 should be "Zickfeld et al. 2016" [MacDougall Andrew, Canada]	text now deleted
56684	109	52	109	54	This is very interesting and merits further exploration. [Kirsten ZICKFELD, Canada]	Section now removed and merged with 2.1 and 2.3. Detailed analysis now in section 2.2
36900	109	54	109	57	The path dependence of surface warming may be understood via single equation (Goodwin et al., 2015; Williams et al., 2017a,b; Goodwin et al., 2018): the surface warming depends on a thermal response involving climate feedback and the ratio of ocean heat uptake and radiative forcing, and a carbon response involving ocean and terrestrial carbon uptake and carbon emissions. Thus, the effects of different factors can be understood and formally compared with each other via this equation. See Goodwin, P., R.G. Williams and A. Ridgwell, 2015. Sensitivity of climate to cumulative carbon emissions due to compensation of ocean heat and carbon uptake. Nature Geoscience, 8, 29-34, doi:10.1038/ngeo2304. Williams, R.G., V. Roussenov, P. Goodwin, L. Resplandy and L. Bopp, 2017. Sensitivity of global warming to carbon emissions: effects of heat and carbon uptake in a suite of Earth system models. Journal of Climate, 30, 9343-9363, doi: 10.1175/JCLI-D-16-0468.1. Williams, R.G., V. Roussenov, T.L. Froelicher and P. Goodwin, 2017. Drivers of continued surface warming after cessation of carbon emissions. Geophysical Research Letters, 44, doi.org/10.1002/2017GL07508. Goodwin. P., A. Katavouta, V.M. Roussenov, G.L. Foster, E.J. Rohling and R.G. Williams, (2018) Pathways to 1.5 and 2 °C warming based on observational and geological constraints, Nature Geoscience, doi:10.1038/s41561-017-0054-8. [Richard Williams, United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3. Citations added in 2.2
56686	109	57	109	57	Cite Zickfeld et al., 2016 [Kirsten ZICKFELD, Canada]	text now deleted
56454	110	1	111	40	This section is about modeling, but the text indicates that, Given the indicated uncertainty how much CO2 and methane is released from thawed permafrost, and it s very large potential, this factor need much more attention, integral attention, because a new type of land use is required to recapture CO2 by introducing new plants (seeding from the air?) Obviously this needs support from Russia and Canada, where Norway, Canada and Alaska may be a good place to develop this. Getting Russia deploying activities to create CO2 uptake may be a diplomatic opportunity for many countries [Henk Daalder, Netherlands]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2
46544	110	2	110	2	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	text now deleted
42694	110	4			asymmetrical ===> the asymmetrical [Egypt]	text now deleted
56688	110	7	110	7	Which scenario is used for the CNRM-ESM1 simulations? [Kirsten ZICKFELD, Canada]	text now deleted
51924	110	10	110	10	This picture doesn't make a lot of sense to me. [Jason Donev, Canada]	text now deleted
59	110	11	110	15	The figure caption needs clarification. What an individual line presents? Is it a single scenario? What does "cumulative emissions relative to 2016" mean? (Perhaps "after" or "from", rather than "relative to".) [Tommi Ekholm, Finland]	text now deleted
11954	110	17	110	19	Is it possible to quantify the counterbalancing effecting of C uptake from vegetation gains? Is there are reference that can be used here. Would be interesting to know what the balance is likely to be. [United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3. References added in 2.2
34234	110	17	113	57	A lot of emphasis has been given to permafrost C feedback in this section. While it is true that permafrost thaw pose a severe risk of losing a big chunk of C currently stored in these frozen soils. It should also be noted that warmer tropical/subtropical soils, particularly wetlands, also vulnerable to losing its stored C, in the form of CH4 (which is of several magnitude higher than those emitted from permafrost soils) and should be kept in mind. For more information, see Megonigal etal-2005-Anaerobic metabolism:linkages to trace gases and aerobic processes. Biogeochemistry, 8, 317–424. More so, CH4 emission from these warmer wetlands often results from complex interaction of soil characteristics and temperature. For example, Sihi etal-2016-Carbon quality and nutrient status drive the temperature sensitivity of organic matter decomposition in subtropical peat soils-Biogeochemistry-131-103-119. [Debjani Sihi, United States of America]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2
39180	110	17	111	21	As the AR5 did not address permafrost melting effectively, and this section talks also of the post 2100 effects in addition to short term effects, please find a way to highlight this in the summary, so that policy makers are aware of the connection between greater warming and release of greater GHG from permafrost loss. [Lindsey Cook, Germany]	text now deleted
42782	110	17	111	26	Permafrost has already warmed by about half a degree, and the depth of summer thaw has increased. Arctic Monitoring and Assessment Programme (AMAP) (2017) SNOW, WATER, ICE, AND PERMAFROST IN THE ARCTIC: SUMMARY FOR POLICYMAKERS, 4 (“Near-surface permafrost in the High Arctic and other very cold areas has warmed by more than 0.5°C since 2007–2009, and the layer of the ground that thaws in summer has deepened in most areas where permafrost is monitored.”). [Kristin Campbell, United States of America]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2
43012	110	17	111	26	Permafrost has already warmed by about half a degree, and the depth of summer thaw has increased. Also, the potential future impact of permafrost is not always fully encapsulated in the carbon-cycle feedback modeling. Arctic Monitoring and Assessment Programme (AMAP) (2017) SNOW, WATER, ICE, AND PERMAFROST IN THE ARCTIC: SUMMARY FOR POLICYMAKERS, 4 (“Near-surface permafrost in the High Arctic and other very cold areas has warmed by more than 0.5°C since 2007–2009, and the layer of the ground that thaws in summer has deepened in most areas where permafrost is monitored.”); Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1618481114. [Durwood Zaelke, United States of America]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2

Comment No	From Page	From Line	To Page	To Line	Comment	Response
50670	110	17	111	26	We would like to draw the attention of the Chapter Lead Authors and Lead Authors to the paper by Comyn-Platt et al., "Permafrost and natural methane feedbacks limit emission budgets to 1.5 or 2.0°C of warming", which is in review for publication in Nature Geosciences. Copies of the submitted paper were provided to the Chapter Lead Authors for Chapter 2. In our paper, we extend the permafrost thaw modelling of Burke et al. (2017, cited paper in second order draft) by allowing for some of the carbon to be released as methane. We also take account of methane (CH4) emissions from natural wetlands and implement updated descriptions of these processes into the JULES global land surface model. Uniquely, we use JULES within a novel inverted version of the IMOGEN intermediate complexity climate model (Huntingford et al., IMOGEN: an intermediate complexity model to evaluate terrestrial impacts of a changing climate. Geoscientific Model Development 3, 679-687, doi:10.5194/gmd-3-679-2010) to follow prescribed global warming pathways that stabilise at 1.5°C or 2.0°C above pre-industrial levels by year 2100. Our summary findings suggest that these feedback processes respond faster at temperatures below 1.5°C, and that the differences between the 1.5°C and 2°C targets are disproportionately smaller. We find the feedbacks to be substantial, causing anthropogenic CO2 emission budgets to be reduced by 24% for stabilisation at 1.5°C, and 14% for 2.0°C stabilisation. [Garry Hayman, United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2. these refs are used
55968	110	17	111	11	These citations (in particular, Schuur et al 2015) and manner in which permafrost thaw is disucssed -- especially, mention of a decreased carbon budget due to decreased permafrost thaw -- needs to be reflected in other sections, especially Chaper 3 and to a lesser degree Chapter 1. Currently, only total area of permafrost loss is noted in most mentions of permafrost in this SR, but related carbon release estimates are a more important associated impact. Permafrost may for example continue to exist at deeper layers when upper layers have thawed and released carbon. Therefore, area of total loss is not a complete measure of impact. [Pamela Pearson, United States of America]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2
55772	110	18			I suggest removing the word 'more' as it is not clear what that relates to (what is it more than?) and if misinterpreted can change the meaning of that sentence. [Sarah Chadburn, United Kingdom (of Great Britain and Northern Ireland)]	text now deleted
42784	110	21	110	23	The amount of carbon in permafrost is roughly double the amount of carbon presently held in the atmosphere. World Bank & International Cryosphere Climate Initiative (ICCI) (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 44 ("The earth's total permafrost holds an estimated 1,700 Gt of carbon, compared to 850 Gt currently in the atmosphere. Much of that below-ground carbon, however, exists at deep levels that will take more time to thaw and reach the surface."). [Kristin Campbell, United States of America]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2
43014	110	21	110	23	The amount of carbon in permafrost is roughly double the amount of carbon presently held in the atmosphere. World Bank & International Cryosphere Climate Initiative (ICCI) (2013) ON THIN ICE: HOW CUTTING POLLUTION CAN SLOW WARMING AND SAVE LIVES, 44 ("The earth's total permafrost holds an estimated 1,700 Gt of carbon, compared to 850 Gt currently in the atmosphere. Much of that below-ground carbon, however, exists at deep levels that will take more time to thaw and reach the surface."). [Durwood Zaelke, United States of America]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2
55774	110	21			Size of permafrost carbon pool is quoted. 'Permafrost carbon pool' should be defined, as this given pool is the total soil carbon pool in all permafrost-affected regions, and the reader may assume that it means the permanently frozen carbon, when in fact the quoted numbers also include carbon in the active layer and non-permafrost soils in discontinuous permafrost regions. I suggest changing this sentence to read: " Given the size of the permafrost carbon pool (1460 to 1600 Gt total soil carbon in permafrost-affected regions ..." or similar. [Sarah Chadburn, United Kingdom (of Great Britain and Northern Ireland)]	Section 2.6 has been reduced and these aspects are now discussed upfront in Section 2.2. However, this particular wording has been removed during the revisions.
55776	110	28			Useful to add an additional reference in this paragraph: Eleanor J Burke et al 2018 Environ. Res. Lett. 13 024024 "CO2 loss by permafrost thawing implies additional emissions reductions to limit warming to 1.5 or 2 °C" https://doi.org/10.1088/1748-9326/aaa138 There is 60-100 Gt less carbon vulnerable to release in a 1.5°C warmer world compared with 2°C. [Sarah Chadburn, United Kingdom (of Great Britain and Northern Ireland)]	This permafrost related part in section 2.2 reads "Schädel et al. (2014) suggest an upper bound of 24.4 PgC (90 GtCO2) emitted from carbon release from permafrost over the next forty years for a RCP4.5 scenario. Burke et al. (2017) use a single model to estimate permafrost emissions between 0.3 and 0.6 GtCO2 y-1 from the point of 1.5°C stabilization, which would reduce the budget by around 20 GtCO2 by 2100. Comyn-Platt et al. (2018) include methane emissions from permafrost and suggest the 1.5°C remaining carbon budget is reduced by 180 GtCO2." The comparison between 1.5°C and 2°C has not been included here.
55778	111	2			Use of the word 'inert' is not clear. I suggest 'latency in the system' instead of 'inert system'? [Sarah Chadburn, United Kingdom (of Great Britain and Northern Ireland)]	text now deleted
55780	111	5	111	11	Permafrost methane emissions are simulated in a paper that is currently in review undergoing revisions. The paper is titled "Permafrost and natural methane feedbacks limit emission budgets 1 to 1.5 or 2.0°C of warming", Comyn-Platt et al, in review for Nature Geoscience. Exact values might change during revision so should be added after final publication of this paper. [Sarah Chadburn, United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2. Reference is used
46402	111	6	111	9	The statement "…….because of maximum thermokarst lake extent by mid-century……." is not clear. [Ijaz Ahmad, Pakistan]	text now deleted
51926	111	9	111	9	Thermokarst? [Jason Donev, Canada]	This is a real word
44890	111	10	111	10	CO2-->CO2 [Hiroaki Kondo, Japan]	corrected
47850	111	10	111	10	Kindly use CO2 [Sarah Connors, France]	corrected
51928	111	11	111	11	Stating a confidence here would help. [Jason Donev, Canada]	Section now removed and merged with 2.1 and 2.3. Where confidence is given
13832	111	14	111	15	Duplicate citation of MacDougall 2012 [MacDougall Andrew, Canada]	text now deleted
22696	111	14		15	Remove one MacDougall et al (it is duplicated). Put 2012 in brackets (there is one missed) [LUIS VALDES, Spain]	text now deleted
47852	111	14	111	15	Please use MacDougall et al. (2012) [Sarah Connors, France]	text now deleted
18214	111	15	111	17	The "transition of the terrestrial land surface from a carbon sink to a carbon source" should be clarified. Does it relate to the boreal zone (affected by permafrost) only? If not (but it is global land surface), then how can it be reconciled with the assertions in other parts of the text that land use would transition from a carbon source to a carbon sink? [Andrea TILCHE, Belgium]	Section now removed and merged with 2.1 and 2.3. Text clarified in 2.2
35850	111	15			MacDougall et al 2012 cited twice [India]	text now deleted
51930	111	16	111	16	What is (2013-2078)?? If it's years, that's already in the past? [Jason Donev, Canada]	text now deleted

Comment No	From Page	From Line	To Page	To Line	Comment	Response
29504	111	19	111	19	Suggested addition here or elsewhere in the text (bold red): Given the difference in estimating the "anthropogenic" sink between countries and the global carbon modelling community (Grassi et al. 2017), the land-related emission estimates included here are not necessarily directly comparable with countries' estimates at global level . [Giacomo GRASSI, Italy]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2
11950	111	21	111	26	There is another Burke et al paper that is relevant here and is missing - http://iopscience.iop.org/article/10.1088/1748-9326/aaa138 [United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2
11952	111	21	111	26	It feels like you are somewhat downplaying the importance of these uncertainties. 200 gt is a lot in this context. It's not small! [United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2. We have changed our assessment
38388	111	21	111	26	Although as you say permafrost carbon feedback could be seen as small in terms future temperature change (<0.1ºC), its implications in terms of mitigation in a RCP2.6 context (1.5ºC) will be significant from an economic point of view. This needs also to be mentioned as emissions from permafrost will peak when global emissions should be aproching to zero. Gonzalez-Eguino and Neumann 2016 show these dynamics in an emission pathway consistent with the paper from Scheneider Von Deimling et al 2015 and in an RCP2.6 scenario. According to this paper CO2 emissions will need to peak 5-10 year earlier, depending on the uncertainty in emissions, and carbon price will need to 6-21% higher compared to a situation where emissions from permafrost are not accounted for. González-Eguino, M and Neumann, M. (2016) Significant implications of permafrost thawing for climate change control, Climatic Change 136:381–3885 Also, Hope, C, and Schaefer.K 2015 show that the exta-damage coming from permafrost thawing is also quite relevant: an increase in damages of 13%, 43 trillions US$. Gand Hope, C, and Schaefer.K (2015). "Economic Impacts of Carbon Dioxide and Methane Released from Thawing Permafrost." Nature Climate Change, 6, pages 56–59 (2016) [Mikel González-Eguino, Spain]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2. We have changed our assessment
55782	111	21	111	26	Possible addition at the end of this paragraph: "However, Burke et al (2017) do not include thermokarst formation or methane emissions which provide up to 40% additional radiative forcing in Schneider von Deimling et al (2015). Nonetheless, including this would still lead to a relatively small temperature bias of [estimate via same method as the value in the preceding sentence?]" [Sarah Chadburn, United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3.Permafrost and methane release now expanded on in 2.2. We have changed our assessment
46546	111	24	111	25	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	text now deleted
36666	111	28	111	35	I think it's important to point out the ESMs can be used to evaluate the potential impacts of land-based mitigation strategies like BECCS and afforestation/reforestation. In this way we can investigate the potential earth system impacts of a mitigation strategy and test their effectiveness (e.g. Krause et al. 2017; Boysen et al. 2017: "The limits to global-warming mitigaiton by terrestrial carbon removal" doi:10.1002/2016EF000469; Harper et al. in review). For example, Harper et al. showed that certain mitigation options that appear to work in an IAM might not make sense when tested in an ESM modelling framework (that study used offline dynamic global vegetation models forced with climate change patterns from 34 CMIP5 GCMs). [Anna Harper, United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3. This discussion is too detailed for this section
43016	111	28	111	40	Because these feedbacks are not always included, the resulting uncertainty contributes to the potentially catastrophic and existential warming that is still possible in the "fat tail" of probability of warming. Xu and Ramanathan (2017) Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes, Proc. Natl. Acad. Sci., doi: 10.1073/pnas.1618481114. [Durwood Zaelke, United States of America]	Assessment now changed in section 2.2 and these feedbacks are included
13894	111	31	111	31	Nutrient limitation due to change in reactive nitrogen or phosphorus deposition over land and ocean (Duce et al., 2008; Mahowald et al., 2017),, also include iron deposition, as this is likely to be one of the most important perturbation to ocean productivitty (also included in Mahowald et la., 2017, so no need to change citation). note that the radiative forcing from anthropogenic aerosol biogeochemical effects is likely to be the same size as the radiative forcing from anthropgenic aerosols overall. The latter is given one whole paragraph, while the former is given 1/3 of a sentence. Perhaps this should e unpacked a bit more equally? [Natalie MAHOWALD, United States of America]	This is now discussed in section 2.2
36658	111	31	111	32	Above reference is relevant here too. [Anna Harper, United Kingdom (of Great Britain and Northern Ireland)]	references are used in section 2.2
58084	111	33	111	33	The authors' name is used in the sentence so that only the year of publication should be included in the parenthesis. The phrase "Voigt et al. (Voigt et al., 2017a, 2017b)" may be instead Voigt et al. (2017a, 2017b)." [Siir KILKIS, Turkey]	citations corrected
55970	111	42	112	2	Add line 43, "uncertainty, especially when attempts are made to average this forcing at a long-term and global level." See earlier comments on treatment of "aerosols." Suggest better clarity, for example referring to specific aerosols (SO2, black carbon etc) or even sources. Perhaps consider beginning this paragraph simply with line 45, "Partitioning..." [Pamela Pearson, United States of America]	Section now removed and merged with 2.1 and 2.3. Section 2.2 revises these
39182	111	50	111	57	Could you write this so lay-people can understand what you are saying, policy option wise? [Lindsey Cook, Germany]	text now deleted
42696	112	6			As a result ===> As a result, [Egypt]	comma added
46600	112	7	112	7	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	text now deleted
46602	112	7	112	9	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	text now deleted
32938	112	13	112	29	Consider to include the following references: Goodwin et al 2018 (https://doi.org/10.1038/s41561-017-0054-8), Cox et al. 2018 (http://www.nature.com/doifinder/10.1038/nature25450) and Marvel et al. 2018 (DOI: 10.1002/2017GL076468) [Ragnhild Skeie, Norway]	Section now removed and merged with 2.1 and 2.3. Reference added in 2.2

Comment No	From Page	From Line	To Page	To Line	Comment	Response
35640	112	13	112	29	There are two recent papers evaluating the Equilibrium Climate Sensitivity (ECS) that are highly relevant to this section, and provide consistent constraints on the ECS from very different lines of evidence. “Cox, P.M., C. Huntingford, and M.S, Williamson (2018) Emergent constraint on equilibrium climate sensitivity from global temperature variability, Nature, 553, 319–322, doi:10.1038/nature25450” and “Goodwin. P., A. Katavouta, V.M. Roussenov, G.L. Foster, E.J. Rohling and R.G. Williams, (2018) Pathways to 1.5 and 2 °C warming based on observational and geological constraints, Nature Geoscience, 11, 102 – 107, doi:10.1038/s41561-017-0054-8.” The Cox et al (2018) study in Nature uses the variability of surface temperature on annual timescales (and not considering the trend in surface warming) to find that the ECS has a best estimate of 2.8 °C with a 66% confidence limit ‘likely range’ from 2.2 to 3.4 °C. The Goodwin et al. (2018) study in Nature Geoscience does not consider evidence from the inter-annual variability but instead uses a combination of geological evidence for climate sensitivity from the last 65 million years along with additional constraints from the trends in surface warming and ocean heat uptake during the instrumental era to find a best estimate of ECS of 2.6°C, with a 66% confidence limit ‘likely range’ from 2.2 to 3.5 °C. This uncertainty range in ECS from Goodwin et al (2018) study can be seen both in Figure 3 therein and in the supplementary data file for that publication, and encompasses the results of 10 numerical experiments used to generate the probability density function with different initial assumptions. The 95% confidence limit ‘very likely’ range for ECS in the Goodwin et al (2018) study is from 2 to 4.3 °C. Both the Cox et al (2018) and Goodwin et al (2018) studies represent ‘post-AR5’ science in terms of their constraints on the Equilibrium Climate Sensitivity, and the similarities in the 66% confidence limit ‘likely range’ estimates for ECS, even though the results are from different independent lines of evidence (interannual variability for Cox et al and longer term trends + geological evidence in Goodwin et al), does suggest that their findings are highly relevant to this section, and should be included in the discussion in this paragraph about the implications of the ECS distribution on the results. [Philip Goodwin, United Kingdom (of Great Britain and Northern Ireland)]	Section now removed and merged with 2.1 and 2.3. Reference added in 2.2
60238	112	13	112	52	The carbon budget needed to achieve the 1.5°C goal, in reality, is likely tighter, perhaps significantly so, than the carbon budget used in the analysis presented in this chapter. This point should be made clear in the introductory section of this chapter and in the Executive Summary. [United States of America]	Not necessarily true. Knowledge gap explains in more detail. Section now removed and merged with 2.1 and 2.3. Carbon budgets revised with and without feedbacks in 2.2 - both are presented
46548	112	14	112	14	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	text now deleted
35852	112	15	112	15	Delete the word 'lower' [India]	text now deleted
32934	112	20	112	20	Specify that 2xCO2 sensitivity is based on climate models [Ragnhild Skeie, Norway]	too detailed for here
56690	112	20	112	20	What are these "known reasons"? [Kirsten ZICKFELD, Canada]	text now deleted
32936	112	22	112	22	Delete "uncorrected". Historical estimates are not necessary uncorrect, but as written above these estimates are generally lower than estimates based on doubling of CO2 in climate models for known reasons. In the next sentece "revised interpretation" is written, and hence "uncorrected" can be deleted. [Ragnhild Skeie, Norway]	text revised
21434	112	36	112	52	In Section 2.6.2 on the geophysical tools the last paragraph on the MAGICC setup has quite some overlap with the second paragraph, which provides some potential for shortening. [Volker Krey, Austria]	overlap removed
46550	112	39	112	39	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	text now deleted
46604	112	42	112	42	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	text now deleted
46552	112	47	112	47	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	text now deleted
46606	112	51	112	51	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	text now deleted
14136	112	55	113	28	2.6.3 Sociotechnical transitions literature puts primary attention to the role of different stakeholders in shaping mitigation pathways. However, the description doesn't mention how citizens, businesses and other stakeholder groups can get involved into the actions and pathways. The suggested actions here include: civic power plant, consumer behavior, carbon disclosure project, internal carbon pricing etc. [Yi-Chieh Chan, China]	Section now removed and merged with 2.1 and 2.3. This is now discussed in 2.5
21436	112	55	113	26	The socio-technical transitions literature could be woven into the main text, probably best into Section 2.3 in the debate surrounding Table 2.8, complementing the more technical mitigation measures by a behavioral/societal dimension. [Volker Krey, Austria]	sections are now merged
28124	112	55	113	28	This chapter on "Sociotechnical transitions literature" is much too short and superficial. Here only the existence of literature, its importance and main strands of content is described. Please elaborate and add major results relevant for 1.5 SR. (this is even more important as the main conclusions of the SR are so far based on IAM-results), and add a reference to the relevant sections in Ch 4 and Ch 5, where this discussion should have more space. [Germany]	Section now removed and merged with 2.1 and 2.3. This is now discussed in 2.5
42698	112	55			Sociotechnical ===> Socio-technical [Egypt]	hyphen added
58212	112	55	113	28	There are only two paragraphs dedicated to this important sub-section. I would recommend to include some further discussions and references here. Carbon mitigation is not only about costs, but also about social changes, policy and cultural issues, etc. See for example, the positive trade-offs between lower consumption of meat, climate mitigation and health recently assessed by Vineis et al. (2016) “Co-benefits of food policies: climate and health”: https://ehp.niehs.nih.gov/isee/2016-o-035-3305/ [Alexandre Strapasson, Brazil]	Section now removed and merged with 2.1 and 2.3. This is now discussed in 2.5
21438	112	57	113	12	One aspects missing in Section 2.6.3 is the fact that IAM developments are moving into the direction of including behavioral components (e.g., technology adoption in LDVs) which would be relevant to mention here. See, for example, McCollum DL, Wilson C, Pettifor H, Ramea K, Krey V, Riahi K, Bertram C, Lin Z, Edelenbosch OY, Fujisawa S (2017) Improving the behavioral realism of global integrated assessment models: An application to consumers’ vehicle choices. Transportation Research Part D: Transport and Environment 55:322-342. [Volker Krey, Austria]	Section now removed and merged with 2.1 and 2.3. This is now discussed in 2.5

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24126	112	57	113	28	I find that this section really underplays the relevance of social, political and behavioural considerations in the 1.5C discussion. It appears to say that insights from behavioural literature are vey important, but because they can't be quanitified they can compfortably be ignored in this report. I strongly disagree. If the quantitative scenarios do not unfold as described in this report (and they will not), it will be largely because of social, political and behavioural considerations, many of which fall far outside teh energy and climate realm. It shoudl at least be acknowledged that very high-level IAM modelling of 1.5C is only scratching the surface of what would need to be done to understand the challenge at hand, and most of what needs to be done relates to humans and not machines. [Simon Bennett, France]	Section now removed and merged with 2.1 and 2.3. This is now discussed in 2.5
38390	113	1	113	10	I would like to raise you attetion to this paper from van de Ven et al (2018) wchich is being recently published covering many behavioural options food, mobility, housing and waste and captures both their direct and indirect implications in terms of greenhouse gas emissions for UE. The results indicate that modest to rigorous behavioural change could reduce per capita footprint emissions by 6 to 16%, out of which one fourth will take place outside the EU, predominantly by reducing land use change. The domestic emission savings would contribute to reduce the costs of achieving the internationally agreed climate goal of the EU by 13.5 to 30%. van de Ven, DJ., González-Eguino, M., Arto, I. (2018) The potential of behavioral change for climate change mitigation: a case study for the European Union, Mitigation and Adaptation Strategies for Global Change, [Mikel González-Eguino, Spain]	Covered in earlier sections. Section is now removed
42700	113	2			Sociotechnical ===> Socio-technical [Egypt]	text now deleted
30852	113	5	113	6	The literature - not specifically tied to 1.5C - is large here, why only these 2 and somewhat old references? Also, these ref [Érika Mata, Sweden]	Section now removed and merged with 2.1 and 2.3. literature is updated
42702	113	5			Sociotechnical ===> Socio-technical [Egypt]	text now deleted
39184	113	11	113	13	This is a very important point, since humanity is currently living with unprecedented consumption levels that are not sustainable for the planet. Could you please ensure that this finding is it clearly shown in models throughout the SR1.5C, so that policy makers can appreciate the finding. [Lindsey Cook, Germany]	this is now made in the main chapter
18216	113	31			This section should include the need to improve the representation of land, in particular management effects over and beyond land-use changes. These are currently poorly or not at all represented. [Andrea TILCHE, Belgium]	Now covered in CDR knowledge gap 2.6.3
18218	113	31			This section should include the need to better (more completely and realistically) capture the relationship between bioenergy and land use, including the right attribution of benefits and impacts. [Andrea TILCHE, Belgium]	Now covered in CDR knowledge gap 2.6.3
18220	113	31			This section should include the need to consider the non-energy and non-food uses of biomass, including for mitigation purposes (to replace other, more emission-intensive products and/or to sequester carbon directly, without energy use). These are important alternatives to BECCS and ready to deploy. [Andrea TILCHE, Belgium]	Now covered in CDR knowledge gap 2.6.3
55652	113	31	115	28	Knowledge gaps: Real carbon saving potential of biofuels (given uncertainty over indirect land use change effects, among others, acknowledged in AR5) - link to chapter 4 [David Cooper, Canada]	CDR gap added
39186	113	33	113	46	As land use and meat/diary diets are critical elements of mitigation, what does the IPCC propose to do about reducing the knowledge gaps? Suggest urgent research and near future model revision? For now, will these gaps, and potential for sustainable agriculture and diet, be made clear in the mitigation models presented? [Lindsey Cook, Germany]	Section now removed and merged with 2.1 and 2.3. Knowledge gaps now discussed
55546	113	33	114	28	Another gap, especially for the studies at national or local levels, is political: to convince decision-makers that they must reach a zero (or even negative) emission future, and not only reach what they consider as a "fair" distribution of mitigation efforts. [Maryse Labriet, Spain]	too political for a knowledge gap
3244	113	34	113	35	It is true that the role of land use change in 1.5C scenarios is still a major uncertainty, but recent IAM studies are paving the way forward in improving this. It is worth mentioning that here (Doelman et al 2018). Link to paper: https://www.sciencedirect.com/science/article/pii/S0959378016306392?via%3Dihub [Vassilis Daioglou, Netherlands]	Citations removed from knowledge gap
29506	113	34	113	35	Suggested addition here or elsewhere in the text (bold red): In particular, given the difference in estimating the "anthropogenic" sink between countries and the global carbon modelling community (Grassi et al. 2017), the land-related estimates included here are not necessarily directly comparable with countries' estimates at global level. [Giacomo GRASSI, Italy]	Too detailed for this knowledge gap
3702	113	35	113	35	agricultural emissions and also livestock farming uncertainty, I guess [Castor Muñoz Sobrino, Spain]	Too detailed for this knowledge gap
18222	113	38	113	38	Clarify what is meant by "carbon-neutral liquid fuel" or (preferably) avoid the term and use a more precise descrption. [Andrea TILCHE, Belgium]	Section now deleted. Term not used
42704	113	48			aerosol cloud ===> aerosol-cloud [Egypt]	text now deleted
13920	113	49	113	50	It is also important to better quantify the potential co-benefits of mitigating air pollutants and how the reduction in air pollution may affect the carbon sink by modifying diffuse radiation and ozone levels (Section 2.5). much more important than diffuse radiation is the changes in tempertaure, precipitation and fertilization effects from aerosols (Mahowald et al., 2011, BGS, Mahowald, 2011, Science; Mahowald et al., 2017). Please rephrase: "It is also important to better quantify the potential co-benefits of mitigation air pollutants and how the reduction in air pollution may affect the land and ocean carbon uptake." [Natalie MAHOWALD, United States of America]	Too detailed - text removed for brevity. Covered and reference used in 2.2
35854	113	52	113	53	More clarity is needed on meaning of "less important", e.g. compared to what. [India]	Section now deleted and reworded in 2.2
61788	113	53	113	53	climate sensitivity and carbon cycle responses… are less important than they would be in high emissions scenarios. This should be compared to the size of the associated carbon budgets. Do you assess that the relative uncertainty (implication for the percentage of associated carbon budget metrics) is significantly smaller here than for other levels of warming? This is not fully supported by aspects of the previous section, including the implications of Fig. 2.32. [Valérie Masson-Delmotte, France]	Too detailed - we are making a general point but text is clarified
68	114	9	114	41	The paragraph is too a winding. Please restructure. [Tommi Ekholm, Finland]	text now deleted
61790	114	9	114	57	I am not sure that the final section on "key knowledge gaps" is the place for an assessment of the limterature associated with important aspects such as IAMs or rebound effects. I suggest to move these discussions to earlier parts of the chapter or to other chapters where they would fit, and keep the final section concise, summarizing the knowledge gaps coming from the earlier sections of the chapter. [Valérie Masson-Delmotte, France]	We agree - section on IAMs are shortened
46608	114	13	114	13	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	text now deleted
14194	114	15	114	15	replace 'what is' with 'that' [Roger Bodman, Australia]	text now deleted

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42706	114	22			under ===> in [Egypt]	text now deleted
42708	114	25			Also ==> Also, [Egypt]	text now deleted
42710	114	25			socioeconomic ===> socio-economic [Egypt]	text now deleted
42712	114	26			Socioeconomic ===> Socio-economic [Egypt]	text now deleted
58086	114	33	114	33	There is missing spacing between words in the phrase "pathways(Schultes et al., 2017)." [Siir KILKIS, Turkey]	text now deleted
44892	114	40	114	40	1/3rd --> 1/3? [Hiroaki Kondo, Japan]	text now deleted
58088	114	40	114	40	The usage of 1/3rd may be written as one third so that the phrase "mitigation costs by up to 1/3rd" may be read as "mitigation costs by up to one third." [Siir KILKIS, Turkey]	text now deleted
18224	114	43			In this paragraph, reference should be made to: Plevin, R. J., Delucchi, M. A. and Creutzig, F. (2014), Using Attributional Life Cycle Assessment to Estimate Climate-Change Mitigation Benefits Misleads Policy Makers. Journal of Industrial Ecology, 18: 73–83. doi:10.1111/jiec.12074 Mark A. Delucchi. "Estimating the Climate Impact of Transportation Fuels: Moving Beyond Conventional Lifecycle Analysis Toward Integrated Modeling Systems Scenario Analysis." Journal of the Washington Academy of Sciences, vol. 99, no. 3, 2013, pp. 43–66. JSTOR, JSTOR, www.jstor.org/stable/jwashacadscie.99.3.0043. [Andrea TILCHE, Belgium]	references are removed from text
54562	114	43	115	1	for an overview of the rebound effect you could also quote Ruzzenenti and Bertoldi, 2017 F. Ruzzenenti, P. Bertoldi Energy conservation policies in the light of the energetics of evolution N. Labanca (Ed.), Complex Systems and Social Practices in Energy Transitions. Framing Energy Sustainability in the Time of Renewables., Springer (2017) (ISBN 978-3-319-33753-1) [Paolo BERTOLDI, Italy]	no references used here but used in section
60240	114	43	114	48	Not clear how "rebound" is defined or measured in this context. Is the implication that increased energy efficiency would lead to higher economic output and therefore a smaller reduction in energy use then otherwise expected due to efficiency improvements? [United States of America]	Text clarified to be more explicit
47082	115	3	115	28	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	text now deleted
42714	115	4			global ===> globally [Egypt]	text now deleted
42716	115	8			decision making ===> decision-making [Egypt]	text now deleted
69	115	17	115	28	The paragraph presents a topic that is perhaps underrepresented in scenarios studies. Please try to add some references, as they lack completely. See e.g. (Ekholm et al, Energy Policy 59, 2013) and (McCollum, Climate Change Economics 4, 2013). [Tommi Ekholm, Finland]	text now deleted
58090	115	18	115	18	The use of subsequent plural words in the phrase "needed investments resources" may be "needed investment resources" or "needed investments and resources." [Siir KILKIS, Turkey]	text now deleted
70	115	20	115	20	Why a "better representation of financial crises" is needed? Crises will come and go, but what is their relation to mitigation? Please justify this claim or revise the sentence. [Tommi Ekholm, Finland]	text now deleted
62138	115	27	115	28	Mention should be made of large lending bodies that have to adapt to the replacement of stranded assets by low or neutral carbon infrastructure. [Antoine Bonduelle, France]	Too detailed for this section but covered in section 2.5
21440	116	1	118	28	The current FAQs in my mind don't fulfill the role of such a section. Currently two questions with answers of 1 and 1.5 pages respectively are included which misses the point of having an FAQ. Breaking the current overarching questions (which are in a way the two overarching questions of the chapter) down into questions that can be answered in a more compact way, would be useful. Practically, one could just answer the current question in a much more compact way, leaving out many of the subtleties, and complement them by additional questions that then discuss the conditionalities (e.g., political feasibility of scenarios). [Volker Krey, Austria]	Taken into account - The FAQ section has been significantly revised so that they are less technical and more easily accessible.
28126	116	1	118	29	The FAQ section needs significant improvement. It is way too long (i.e., 2 questions are answered on 1.5 pages) and somewhat chunkily written. Please see also our general comment on the FAQ on the entire report. [Germany]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
44896	116	1	118	28	There are many 'CO2's which should be corrected 'CO2's. [Hiroaki Kondo, Japan]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
55972	116	1	118	25	Here again, EXCELLENT FAQs. Suggest however adding phrases such as "extremely difficult and expensive to achieve," following the word, "unlikely" in places such as line p. 116 line 52. Such phrases emphasize that this is less an issue of blind probability and more a result of human action and policy choices. [Pamela Pearson, United States of America]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
61792	116	1	116	57	I suggest to add in this FAQ the outcome of one section of chapter 1 (what happens if we stop emissions today). Please explain what is meant by "models" (which models, used for which purpose). The order of arguments should be modified starting by what does it take to be on track with climate stabilization and where NDC stand compared to what is needed. The end of the FAQ is different, as it is linked to the feasibility issue. A smoother transition and an introduction to the feasibility issues in the first paragraph would help. Again, subscripts for CO2. Rather than "scientists estimate", I suggest to explain by which method this result is obtained (as such, it reads as expert judgement rather than the outcome of quantified projections). An alternative option could be to explain under which conditions 1.5°C cannot be achieved. I suggest to be explicit at the beginning of the FAQ about the root causes of global warming (combustion of fossil fuels for energy, transport, heating, cooking, deforestation, intensive agriculture, cement) before describing the track that would be needed and reporting where current pledges stand. [Valérie Masson-Delmotte, France]	Taken into account - The revised FAQs now better link to Chapter 1 discussion of pathways.

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3290	116	3	116	57	Emission by 2016 or 2017 should be presented, and compared with emission pathway for 1.5?. UNEP EGR2017 is better to be referred. [Xiu Yang, China]	Taken into account - The FAQ section has been significantly revised so that they are less technical and more easily accessible. Precise numerical information has been removed, as this is better placed in the main body of the chapter, ES, or SPM:
5882	116	5			The number given here is at odds with … Section 1.2 [0.85 +/-0.1], FAQ1.1 [0.87] and earlier in this chapter [0.95]. Important that the report as a whole characterizes this number consistently given its central role in SR15. [Peter Thorne, Ireland]	Accepted - Interchapter consistency has been ensured throughout the report.
22760	116	5			In Chapter 1, P58 L49-50 describes that temperature rise is 'about' 1 degree, while here 'around'. Eather will do but uniform word is better. [Shuzo Nishioka, Japan]	Taken into account - cross-chapter consistency has been checked.
24086	116	5			In Chapter1 P58 L49-50 discribes that temperature rise is 'about' 1 degree, while here 'around' .Eather will do but uniform word is better. [Shuzo Nishioka, Japan]	Taken into account - cross-chapter consistency has been checked.
50678	116	5	116	6	…which means *that we are already two thirds of the way to *1.5°C of warming. [Jasmin Irisha Jim Ilham, Malaysia]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
13542	116	6	116	6	correct 1.5oC [Sergio Aquino, Canada]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
14196	116	6	116	6	degre symbol needs raising [Roger Bodman, Australia]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
22698	116	6			Note that 1.5oC should be written as in line 7 (1.5ºC) [LUIS VALDES, Spain]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
35856	116	6			Degree symbol be in superscript [India]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
39486	116	6	116	6	1.5oC must be 1.5°C [Olga Alcaraz, Spain]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
39488	116	6	116	6	mid-centur-y must be 1.5°C mid-century [Olga Alcaraz, Spain]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
44894	116	6	116	6	1.5oC-->1.5oC [Hiroaki Kondo, Japan]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
47854	116	6	116	6	Kindly use 1.5°C [Sarah Connors, France]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51268	116	6	116	6	In the statement " 1.5oC of warming." needs to be replaced with "1.5oC of warming." [Muhammad Latif, Pakistan]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
4300	116	17	116	20	More recent studies project global greenhouse gas emissions resulting from NDCs at a significantly higher level than this range. See for instance Benveniste et al. (2018) which projects global emissions of 56.8-66.5 Gt Co2eq/yr in 2030 (90% confidence interval), both a higher estimate than currently indicated in the SOD, and one with a larger uncertainty range. Indeed, in order to properly estimate the uncertainty it is relevant to consider a range of socio-economic scenarios rather than one given projection. Furthermore, let us not confuse emissions projections resulting from NDCs and emissions projections impacted by current policies - such differentiated estimates are necessary to signal a needed update of corresponding NDCs. Full reference: Benveniste, H., Boucher, O., Guivarch, C., Le Treut, H., and Criqui, P. (2018). Impacts of nationally determined contributions on 2030 global greenhouse gas emissions: uncertainty analysis and distribution of emissions. Environmental Research Letters 13, 014022. doi:10.1088/1748-9326/aaa0b9. [Hélène Benveniste, United States of America]	Taken into account - The FAQ section has been significantly revised so that they are less technical and more easily accessible. The quantitative discussion of NDCs is presented in the cross-chapter box on NDCs in Chapter 4, which now also includes this new study. Although this study indeed suggests higher emissions in 2030, it only considers emissions targets and doesn't consider any of the renewable energy targets included in the NDCs. It is thus expected that its estimates are biased high.
47856	116	20	116	22	Kindly use CO2e [Sarah Connors, France]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
55974	116	23	116	23	Add, 'Such overshoot has the potential to substantially worsen human and ecosystem impacts, especially if overshoot persists for more than a few decades, and substantially increases the risk of triggering essentially irreversible dynamics such as ice sheet loss and related long-term sea-level rise." [Pamela Pearson, United States of America]	Taken into account - The revised FAQ now reads: "For example, the larger and longer an 'overshoot', the greater the reliance on practices or technologies that remove CO2 from the atmosphere, on top of reducing the sources of emissions (mitigation). Such ideas for CO2 removal have not been proven to work at scale and, therefore, run the risk of being less practical, effective or economical than assumed. There is also the risk that the use of CO2 removal techniques ends up competing for land and water and if these trade-offs are not appropriately managed, they can adversely affect sustainable development. Additionally, a larger and longer overshoot increases the risk for irreversible climate impacts, such as the onset of the collapse of polar ice shelves and accelerated sea level rise."
46554	116	26	116	26	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
18226	116	30	116	32	This is just one interepretation of "carbon neutrality". Other, very difference interpretations exist, most notably in the context of bioenergy. It would be preferable not to use this term at all, or to better define it. E.g., in this instance it is not clear whether it refers to overall net emissions to the atmosphere (including natural sinks), or just the anthropogenic part, and how the two can be separaed. [Andrea TILCHE, Belgium]	Taken into account - The revised FAQs do not include this term anymore as they focus more on the general evolution of emissions and pathways. The concept is still used elsewhere in the report but is in that case dully defined.
40828	116	30	116	36	Above comment is in hormony with this paragraph. [NARESH KUMAR SOORA, India]	Unclear what is meant here by the reviewer - no particular action taken.
14198	116	31	116	31	extra hyphen in 'mid-centur-y' [Roger Bodman, Australia]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
22700	116	31			remove "-" in "centur-y" [LUIS VALDES, Spain]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
22762	116	31			century [Shuzo Nishioka, Japan]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
42718	116	31			mid-centur-y ===> mid-century [Egypt]	Noted. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
44898	116	31	116	31	mid-centur-y --> mid-century [Hiroaki Kondo, Japan]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
47858	116	31	116	31	Please use CO2 and 'mid-century' [Sarah Connors, France]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51932	116	31	116	31	centur --y [Jason Donev, Canada]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
58092	116	31	116	31	The word that is written as "mid-centur–y" should be "mid-century." [Siir KILKIS, Turkey]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
13544	116	34	116	34	omit: however [Sergio Aquino, Canada]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
13922	116	38	116	40	Known as non-CO2 climate forcers, this group includes methane, nitrous oxide, black carbon and hydrofluorocarbons. It seem that here one should add one more sentence, talkinga bout tradeoffs a bit more. One should also be honest and mention that cutting aerosols (not just BC) for air quality improvements, which should happen we hope, is going to make the cliamte problem worse, as it will raise temperatures, as well as reduce the uptake of anthropogenic carbon in the land and ocean, which will also cause an increase in temperatures. [Natalie MAHOWALD, United States of America]	Taken into account - This point has been included in the discussion of the chapter (Section 2.2) but now falls outside the scope of the revised FAQ.
47860	116	38	116	39	Kindly use CO2 [Sarah Connors, France]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51934	116	42	116	52	This is another place where the results must be stated boldly, clearly and with no ambiguity. This is more important than most, since the FAQs serve as a summary (whether we want to think of them that way or not). [Jason Donev, Canada]	Taken into account - The FAQs have been revised to provide more of a lay-man introduction into the topic rather than clear quantitative information. The key findings and insights are communicated clearly and in general terms, while the detailed assessment is provided in the chapter, as well as the ES and SPM.
46556	116	52	116	52	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
47862	116	54	116	54	Kindly use CO2 [Sarah Connors, France]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
5884	117	1	118	25	FAQ are supposed to be accessible. This FAQ feels a little technical and heavy on numbers. I would urge efforts to simplify the text and remove numbers wherever possible with instead text that says the same thing effectively. [Peter Thorne, Ireland]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
61794	117	1	117	57	The FAQ is in fact about the notion of carbon budget, CDR (about half of the FAQ), then implications of stringent mitigation (sectors, scenarios not compatible etc). There are probably too many ideas for a single FAQ, and it reads as quite abstract. I suggest to avoid "The scientific literature discusses" and replace it with an explanation of the methods. Do not use "models" or "pathways" without explaining what they are. [Valérie Masson-Delmotte, France]	Taken into account - The FAQs have been revised significantly so that a clearer and more accessible storyline is provided. Pathways and other concepts are defined in the chapter, and have thus not been repeated here.
47864	117	3	117	57	Kindly use CO2 [Sarah Connors, France]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
58094	117	4	117	5	The phrasing in "Scenarios that achieve this see coal phased out, renewables become the dominant source of energy by 2050 and rapid cuts to non-CO2 drivers of warming" may be "Scenarios that achieve this see coal being phased out, renewables becoming the dominant source of energy by 2050 and non-CO2 drivers of warming being cut rapidly" with better verb agreement. [Siir KILKIS, Turkey]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
8348	117	10	117	10	With regard to the linear relationship between carbon concentration and warming as stated in the report – "Since warming is directly proportional to total cumulative carbon dioxide (CO2) emissions" (Page117, line 10), it is suggested to add the non-linear relationship between the two mentioned by some researchers. “the temperature change (?T) versus cumulative CO2 emissions (CE) relationship is nonlinear during periods of net negative emissions” References: 1. Dana, E. and Z. Kirsten (2017). "What determines the warming commitment after cessation of CO2 emissions?" Environmental Research Letters 12(1): 015002?2. Good, P., J. A. Lowe, T. Andrews, A. Wiltshire, R. Chadwick, J. K. Ridley, M. B. Menary, N. Bouttes, J. L. Dufresne and J. M. Gregory (2015). "Nonlinear regional warming with increasing CO2 concentrations." Nature Climate Change 5(2): 138-142. [China]	Taken into account - The FAQs have been significantly revised to provide a more lay man introduction into the topic of pathways and NDCs. This detailed, more technical information has thus been included in the chapter assessment, and Section 2.2. in particular.
30972	117	11	117	11	defines a carbon budget as “the maximum total carbon that can be emitted as CO2” – does this not need to make clear that it is a net figure, of carbon emitted, minus carbon caused to be absorbed? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
44900	117	24	117	24	emission --> emission reduction? [Hiroaki Kondo, Japan]	Taken into account - The FAQ section has been significantly revised so that they are less technical and more easily accessible.
62140	117	28	117	28	Maybe replace "most model pathways" by "existing IAM pathways" to reflect the low number of modelling and also the previous criticism of the IAMs. [Antoine Bonduelle, France]	Taken into account - The FAQ section has been significantly revised so that they are less technical and more easily accessible. This particular wording does not feature in the revised FAQ.
2094	117	32	117	37	as above ignores carbon cycle feedbacks and carbon-specific tipping points [Andrew Lockley, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The FAQs have been significantly revised to provide a more lay man introduction into the topic of pathways and NDCs. This detailed, more technical information has thus been included in the chapter assessment, and Section 2.2. in particular.
42720	117	32			global ===> the global [Egypt]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51130	117	43	117	54	Quoting from Cross-Chapter Box 3.1: "Indeed, scenarios that limit end-of-century warming to below 1.5°C are available that use no (Grubler et al.; van Vuuren et al.) or annual amounts of less than 1.5 GtCO2 yr-1 (Bertram et al.; van Vuuren et al.) – the lower end of the assessed potential range (...)." See Holz et al. 2017, van Vuuren et al. 2017, Grubler et al. 2017 for 1.5°C pathways that do not rely on CDR, and in the case of Bertram et al. and Holz et al.'s limCDR scenario, that require limited amounts of CO2 drawn from the atmosphere. [Linda Schneider, Germany]	Noted, yet unclear which precise action the reviewer is suggesting. The revised FAQs now more clearly make the geophysical connection between overshoot and net CDR, which highlights the dependence on early action.
22702	117	45			Insert ° in 1.5C [LUIS VALDES, Spain]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
42722	117	46			temperature ===> the temperature [Egypt]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
30974	117	47	117	47	when you say “require stringent reductions in substances other than CO2”, how much? [Simon Bullock, United Kingdom (of Great Britain and Northern Ireland)]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
13546	117	48	117	48	there needs to be one convention for commas with multiple items in the paper: black carbon and hydrofluorocarbons. [Sergio Aquino, Canada]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
51132	117	50	118	1	If you speak of the uncertainties around permanency of CO2 removals via ecosystem restoration, you should also mention the fact that CCS is not technologically developed and available at scale, lacks societal support (Vaughan, N.E. & Gough, C. (2016) Expert assessment concludes negative emissions scenarios may not deliver, ERL) and that the potential and stability of geological storage is disputed. Also, since any method of drawing CO2 from the atmosphere is inherently fraught with uncertainties, removals should not be counted towards the same target as emissions reductions, i.e. not be used to offset or compensate for fossil or industrial emissions. [Linda Schneider, Germany]	Taken into account - The FAQ section has been significantly revised so that they are less technical and more easily accessible. This particular discussion does not feature in the revised FAQs anymore.
13924	117	52	117	52	The total amount of CDR in 1.5°C pathways is of the 52 order of 380–1130 GtCO2 over the 21st century, with BECCS deployed in some scenarios as early as 2020. please describe the amount of land and water required to maintain this level of BECCS and/or describe that this level of BECCS may have profound environmental consequences that will make it socially undesireable. [Natalie MAHOWALD, United States of America]	Taken into account - The FAQ section has been significantly revised so that they are less technical and more easily accessible. This particular discussion does not feature in the revised FAQs anymore. Instead it is covered in Section 2.4.4.
34214	117	54	118	1	Restoration of wetlands and mangroves also can be an adaptation measure, in addition to removing CO2 and enhancing biodiversity. Furthermore, restoring wetlands can prohibit large amounts of CO2-emissions, which can be caused by human intervention and utilization. Please consider to include these two aspects of wetland and mangrove restoration. [Norway]	Noted. However, the revised FAQs do not include this discussion anymore.
18228	117	55	117	55	It is good that the restoration of these systems is considered here, but they are not even mentioned in the body of the Chapter. [Andrea TILCHE, Belgium]	Noted. The revised FAQs do not include this discussion anymore.
4560	118	3	118	4	What is meant by economic development? Economic growth? If so, does it need be lower to hold warming to 1.5°? [Kai Kuhnhenn, Germany]	Taken into account - economic development and the evolution of inequalities is one of the drivers that can facilitate or frustrate climate change mitigation. This discussion, however, does not feature anymore in the revised FAQs. Instead, it is discussed at the beginning of section 2.3.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
57158	118	3	118	4	Holding warming to 1.5°C strongly depends on future population growth: This is not evident because population growth does not have an instantaneous effect (= short term), and it would have little long-term effect in a zero-emissions world. This chapter itself suggests that the effect occurs trough land-use emissions. The SSP scenario database at IIASA indeed confirms that there is a significant link between population and land-use related emissions, but as far as I could find, it is hard to say that population has a "strong" effect on total emissions. Total emissions become larger only for the highest population growth scenarios. Please check and consider rephrasing (just deleting the word "strongly" would perhaps be valid for all the features that are cited?) [Philippe Marbaix, Belgium]	Taken into account - This discussion doesn't feature anymore in the revised FAQs. However, it is still touched upon in Section 2.3. Still, an in-depth assessment of this issues lies outside the scope of this special report, as it is equally (and probably even more) applicable to baseline emission development.
22704	118	4			I think that in this list "science and technology development" should be considered as a key element. Please consider its insertion (perhaps preceding "international cooperation") [LUIS VALDES, Spain]	Taken into account - However, this discussion does not feature anymore in the significantly revised FAQs.
42724	118	5			phase out ===> phase-out [Egypt]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
46558	118	16	118	16	Check use of IPCC uncertainty language. Text should be highlighted in italic font when used. Please use alternative wording if not meant to be official IPCC uncertainty language. [Sarah Connors, France]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
906	118	22	118	22	need to consider complex' should be 'needs to consider complex' [Robert Shapiro, United States of America]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
47084	118	22	118	22	Avoid policy prescriptive language like should / must / need. Replace with alternative terms such as 'would need to', 'could' etc. [Sarah Connors, France]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
47866	118	27	118	27	Kindly use CO2 [Sarah Connors, France]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
58468	119		143		References seem to be in alphabetical but not chronological order. [Andrew Prag, France]	Noted. The FAQs have been thoroughly revised as a result of the review comments on substance. The entire chapter will be edited by the TSU for consistent use of punctuation and spelling.
238	120	13	120	15	Add a refrence after doi:10.1504/IJGEI.2017.080766 [Herve Nifenecker, France]	Noted. Any issues with the references have been checked and remediated where possible.
239	120	16	120	18	Int. J. of Global Energy Issues, 2017 Vol.40, No.3/4, pp.240 - 254 Berger(2) et al. [Herve Nifenecker, France]	Noted. Any issues with the references have been checked and remediated where possible.
240	120	16	120	18	DOI: 10.1504/IJGEI.2017.10007761 Berger (2) et al. [Herve Nifenecker, France]	Noted. Any issues with the references have been checked and remediated where possible.
241	120	16	120	18	Title: Nuclear energy and bio energy carbon capture and storage, keys for obtaining 1.5°C mean surface temperature limit Authors: André Berger; Tom Blees; Francois-Marie Breon; Barry W. Brook; Marc Deffrennes; Bernard Durand; Philippe Hansen; Elisabeth Huffer; Ravi B. Grover; Claude Guet; Weiping Liu; Frederic Livet; Herve Nifenecker; Michel Petit; Gérard Pierre; Henri Prévot; Sébastien Richet; Henri Safa; Massimo Salvatores; Michael Schneeberger; Bob Wornan; Suyan Zh [Herve Nifenecker, France]	Noted. Any suggested references have been considered.
5230	122	1	122	5	It is because of the difficulties mentioned here that SRM is considered necessary and I'd urge it be mentioned some here. [Michael MacCracken, United States of America]	Incorrect reference. The reviewer comments refers to a page which is part of the list of references. No action undertaken.
5228	122	2	122	3	The problem is that sole reliance on CDR to help meet the required amount of cooling seems likely to take a significant time, thus prolonging the overshoot and worsening the impacts. [Michael MacCracken, United States of America]	Incorrect reference. The reviewer comments refers to a page which is part of the list of references. No action undertaken.
5232	122	15	122	16	Some say high cost, others object and say much lower cost. This sounds as if it has taken only the high estimates as credible. [Michael MacCracken, United States of America]	Incorrect reference. The reviewer comments refers to a page which is part of the list of references. No action undertaken.
5234	122	21	122	23	Well, strictly speaking this is true; however, volcanic eruptions are a close natual analog, ship tracks are observed and human-emitted aerosols and aerosol precurosr certinaly do also provide analogs. So, controlled injection may not have been done, but uncontrolled emissions certainly provide clear examples. In my view, the statement here really fails to understand that the approaches being proposed are really quite well understood. [Michael MacCracken, United States of America]	Incorrect reference. The reviewer comments refers to a page which is part of the list of references. No action undertaken.
5236	122	25	122	26	Needs editorial work. [Michael MacCracken, United States of America]	All references to be corrected and put in IPCC style in final editing.
5238	122	26	122	28	The phrasing here shows no understanding of what is done--SAI creates a haze, not a cloud. And the aerosols themselves are not shot into the atmosphere--they are, with most approached, formed there based on gaseous precursors that are lofted to the stratosphere, most likely by aircraft. [Michael MacCracken, United States of America]	Incorrect reference. The reviewer comments refers to a page which is part of the list of references. No action undertaken.
5240	122	32	122	36	This is a very unbalanced summary of SRM: Regarding ethics, for example, the most important issue, namely the ethical implications of the great potential benefits SRM being withheld and not being used to greatly reduce impacts on those in the developing world, is not even addressed. Similarly regarding justice and equity issues. Of course, SRM introduction affects a larger region--that is the intent, to offset climate change for all. While governance is an issue, it is not really clear it is controversial--the issue needs to be explained, not demagoged. Yes, there is much discussion and it seems to me the expectation is that IPCC would present the points being raised and fairly describing all expert perspectives and not be as one-sided as the discussionis presented here. And just because SRM will not significantly affect ocean acidification is not a reason for it not to be a complement to the other approaches to dealing which also have serious shortcomings (and there are geoengineering approaches that have been proposed for dealing with ocean acidification, but they would not do anything on temperature). [Michael MacCracken, United States of America]	Incorrect reference. The reviewer comments refers to a page which is part of the list of references. No action undertaken.

Comment No	From Page	From Line	To Page	To Line	Comment	Response
5242	122	37	122	40	This summary makes no mention of the problem with mitigation and CDR, namely that they will take a long time to have a significant effect, especially at the pace that countries are acting (or really failing to act). Only SRM seems to be an option for preventing overshoots and keeping temperature from rising significantly--that is just not something cost effectively possible in the near-term. Again, context and balance really is needed. [Michael MacCracken, United States of America]	Incorrect reference. The reviewer comments refers to a page which is part of the list of references. No action undertaken.
5244	123	6	123	6	Paleoclimatic evidence suggests that the equilibrium sea level sensitivity is of order 20 meters per degree rise in the global average temperature. This may take time, but the commitment gets made and paleoevidence also indicates that loss of glacial ice occurs much, much more rapidly than build up. In the answer to this question, mention needs to be made of how warming can initiate long term effects, how the peak/overshoot value is likely the primary determinant of impacts to biodiversity and initiating sea level rise. That is, it will be critical to make the point here that some impacts just cannot be adapted to and there will needs to be ongoing and very significant retreat from coastlines--and levees will not be an answer. [Michael MacCracken, United States of America]	Incorrect reference. The reviewer comments refers to a page which is part of the list of references. No action undertaken.
46312	126	46	126	49	48-49 is an incomplete version of 46-47 [Henry Shue, United Kingdom (of Great Britain and Northern Ireland)]	All references to be corrected and put in IPCC style in final editing.
56568	126	48	126	49	Duplicate citation of the paper cited on lines 46-47 [Eleanor Johnston, United States of America]	All references to be corrected and put in IPCC style in final editing.
58464	127	15	127	20	IEA (2017). World Energy Investment should become IEA (2017b) [Andrew Prag, France]	All references to be corrected and put in IPCC style in final editing.
58466	127	15	127	20	Suggest adding source: IEA (2017c). World Energy Outlook-2017. Paris, France [Andrew Prag, France]	All references to be corrected and put in IPCC style in final editing.
58462	127	25	127	25	Consistency of references: "IEA (2017a)" instead of International Energy Agency (IEA) (2017) [Andrew Prag, France]	All references to be corrected and put in IPCC style in final editing.
1590	127	55	127	57	Please update reference to Jacobson, M.Z., M.A. Delucchi, Z.A.F. Bauer, S.C. Goodman, W.E. Chapman, M.A. Cameron, Alphabetical: C. Bozonnat, L. Chobadi, H.A. Clonts, P. Enevoldsen, J.R. Erwin, S.N. Fobi, O.K. Goldstrom, E.M. Hennessy, J. Liu, J. Lo, C.B. Meyer, S.B. Morris, K.R. Moy, P.L. O'Neill, I. Petkov, S. Redfern, R. Schucker, M.A. Sontag, J. Wang, E. Weiner, A.S. Yachanin, 100% clean and renewable wind, water, and sunlight (WWS) all-sector energy roadmaps for 139 countries of the world, Joule, 1, 108-121, doi:10.1016/j.joule.2017.07.005, 2017 [Mark Jacobson, United States of America]	Accepted - References have been updated to the latest available versions of the papers.
46444	135	24	135	27	The references Revesz et al 2014a and b seem to be the same. [Göran Finnveden, Sweden]	All references to be corrected and put in IPCC style in final editing.
46314	141	6	141	13	van Vuuren 2017c and van Vuuren 2017d are the same [Henry Shue, United Kingdom (of Great Britain and Northern Ireland)]	All references to be corrected and put in IPCC style in final editing.
13834	142	59	142	63	Zickfeld and MacDougall, 2016 and Zickfeld, MacDougall and Matthews, 2016" are the same paper. Please fix. [MacDougall Andrew, Canada]	All references to be corrected and put in IPCC style in final editing.
22712	142	59	142	60	It looks like this reference is a duplicate of the one below, also its author list is incomplete. [Katarzyna B Tokarska, United Kingdom (of Great Britain and Northern Ireland)]	All references to be corrected and put in IPCC style in final editing.
3246	143	1	144	25	This is an extremely important question, and one that non-scientists across the world are struggling with (and scientists are struggling to answer).I don't think the text here adequately answers FAQ 2.2. The text is very vague, it sounds like an abstract to an IAM paper, focuses a lot on CDR (is that all we have to do?) and largely repeats what is said in FAQ 2.1. It would be more useful, for a lay audience if specific actions/technologies/targets were mapped out here. Preferrably for different demand and supply sectors. Furthermore specific policy tools could be mapped and important social/personal choices should be hilighted (population growth, food demand, consumption rates, etc.). It seems to me that much of the answer to FAQ 4.1 would be more relevant here. And FAQ 4.1 can focus more on institutional and social aspects in order to make these actions realisable. [Vassilis Daioglou, Netherlands]	Taken into account - The FAQs have been significantly revised and now answer the questions "What kind of pathways limit warming to 1.5°C and are we on track?" and "What do energy supply and demand have to do with limiting warming to 1.5°C?". They now provide a much more accessible introduction to the answers to these questions.
54484	143	10	143	10	Replace 'consumer' with 'consumption'. The term consumer is role constructed in a certain kind of society. It is not appropriate as an ahistorical, a cultural term. The list of sciences shedding light on consumption behaviour should include anthropology and sociology, where the social dimensions of consumption are well developed. [Thomas Thornton, United Kingdom (of Great Britain and Northern Ireland)]	This comment refers to a page and line numbers that do not exist in the Chapter 2 SOD. No action taken.
54486	143	25	143	27	This is an important point. There is an assumption that quantification can increase our understanding of transition through certain kinds of (optimization and equalibrium assumptions). Just how is not explained. Are alternative methods available? [Thomas Thornton, United Kingdom (of Great Britain and Northern Ireland)]	This comment refers to a page and line numbers that do not exist in the Chapter 2 SOD. No action taken.