**Table 5.2 | Mitigation – SDG table**
*Social-Demand*

**Industry – SDG 1**

| Measure | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|
| Accelerating Energy Efficiency Improvement | ↑ | [+2] | 📖 | ☺ | ★ | **Reduces Poverty**<br>% of people living below poverty line declines from 49% to 18% in South African context. | Altieri et al., 2016 |
| Low-carbon Fuel Switch | | [0] | | | | No direct interaction | |
| Decarbonization/CCS/CCU | | [0] | | | | No direct interaction | |

**Industry – SDG 2**

| Measure | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|
| Accelerating Energy Efficiency Improvement | | [0] | | | | No direct interaction | |
| Low-carbon Fuel Switch | | [0] | | | | No direct interaction | |
| Decarbonization/CCS/CCU | | [0] | | | | No direct interaction | |

**Industry – SDG 3**

| Measure | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|
| Accelerating Energy Efficiency Improvement | ↑ | [+2] | 📖📖 | ☺☺ | ★★ | **Air, Water Pollution Reduction and Better Health (3.9)**<br>People living in deprived communities feel positive and predict considerable financial savings. Efficiency changes in the industrial sector that lead to reduced energy demand can lead to reduced requirements on energy supply. As water is used to convert energy into useful forms, the reduction in industrial demand is anticipated to reduce water consumption and wastewater, resulting in more clean water for other sectors and the environment. In extractive industries there are trade-off unless strategically managed. Behavioural changes in the industrial sector that lead to reduced energy demand can lead to reduced requirements on energy supply. As water is used to convert energy into useful forms, the reduction in industrial demand is anticipated to reduce water consumption and wastewater, resulting in more clean water for other sectors and the environment. | Vassolo and Döll, 2005; Xi et al., 2013; Nguyen et al., 2014; Holland et al., 2015; Zhang et al., 2015; Fricko et al., 2016 |
| Low-carbon Fuel Switch | ↑ | [+2] | 📖📖 | ☺☺ | ★★ | **Water and Air Pollution Reduction and Better Health (3.9)**<br>Industries are becoming suppliers of energy, waste heat, water and roof tops for solar energy generation, and hence helping to improve air and water quality. | Vassolo and Döll, 2005; Nguyen et al., 2014; Holland et al., 2015; Karner et al., 2015; Fricko et al., 2016 |
| Decarbonization/CCS/CCU | ↓ | [-1] | 📖📖 | ☺☺☺ | ★★★ | **Disease and Mortality (3.1/3.2/3.3/3.4)**<br>There is a risk of $CO_2$ leakage both from geological formations as well as from the transportation infrastructure from source to sequestration locations. | Wang and Jaffe, 2004; Hertwich et al., 2008; Apps et al., 2010; Veltman et al., 2010; Koornneef et al., 2011; Singh et al., 2011; Siirila et al., 2012; Atchley et al., 2013; Corsten et al., 2013; IPCC, 2014 |

**Industry – SDG 4**

| Measure | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|
| Accelerating Energy Efficiency Improvement | ↑ | [+1] | 📖📖 | ☺☺ | ★★ | **Technical Education, Vocational Training, Education for Sustainability (4.3/4.4/4.5/4.7)**<br>Awareness, knowledge, technical and managerial capability are closely linked, energy audit, information for trade unions, product/appliance labeling help in sustainability education. | Apeaning and Thollander, 2013; Fernando and Evans, 2015; Roy et al., 2018 |
| Low-carbon Fuel Switch | ↑ | [+1] | 📖📖 | ☺☺ | ★★ | **Technical Education, Vocational Training, Education for Sustainability (4.b/4.7)**<br>New technology deployment creates demand for awareness and knowledge with technical and managerial capability; otherwise acts as barrier for rapid expansion. | Apeaning and Thollander, 2013; Fernando and Evans, 2015; Roy et al., 2018 |
| Decarbonization/CCS/CCU | | [0] | | | | No direct interaction | |

*Social-Demand (continued)*

| Sector | Option | 1 No Poverty (Interaction / Score / Evidence / Agreement / Confidence) | 2 Zero Hunger (Interaction / Score / Evidence / Agreement / Confidence) | 3 Good Health and Well-being (Interaction / Score / Evidence / Agreement / Confidence) | 4 Quality Education (Interaction / Score / Evidence / Agreement / Confidence) |
|---|---|---|---|---|---|
| **Buildings** | **Behavioural Response** | **Poverty Reduction via Financial Savings (1.1)**<br>↑ / [+2] / 📖 / ☺ / ★<br>People living in deprived communities feel positive and predict considerable financial savings.<br>Scott et al., 2014 | [0]<br>No direct interaction | **Improved Warmth and Comforts**<br>↑ / [+2] / 📖📖📖 / ☺☺☺ / ★★★<br>Home occupants reported warmth as the most important aspect of comfort which was largely temperature-related and low in energy costs. Residents living in deprived areas expect improved warmth in their properties after energy efficiency measures are employed.<br>Huebner et al., 2013; Yue et al., 2013; Scott et al., 2014; Zhao et al., 2017 | [0]<br>No direct interaction |
| | **Accelerating Energy Efficiency Improvement** | **Poverty and Development (1.1/1.2/1.3/1.4)**<br>↑ / ↓ / [+2,-1] / 📖📖📖 / ☺☺☺ / ★★★<br>Energy efficiency interventions lead to cost savings which are realized due to reduced energy bills that further lead to poverty reduction. Participants with low incomes experience greater benefits. 'Energy efficiency and biomass strategies benefitted the poor more than wind and solar, whose benefits are captured by industry. Carbon mitigation can increase or decrease inequalities. The distributional costs of new energy policies (e.g., supporting renewables and energy efficiency) are dependent on instrument design. If costs fall disproportionately on the poor, then this could impair progress towards universal energy access and, by extension, counteract the fight to eliminate poverty. (Quote from McCollum et al., 2018).<br>Casillas and Kammen, 2012; Hirth and Ueckerdt, 2013; Jakob and Steckel, 2014; Maidment et al., 2014; Scott et al., 2014; Fay et al., 2015; Cameron et al., 2016; Hallegatte et al., 2016b; Berrueta et al., 2017; McCollum et al., 2018 | **Food Security (2.1)**<br>↑ / [+2] / 📖 / ☺ / ★<br>Using the improved stoves supports local food security and has significantly impacted on food security. By making fuel last longer, the improved stoves help improve food security and also provide a better buffer against fuel shortages induced by climate change-related events such as droughts, floods or hurricanes (Berrueta et al. 2017).<br>Berrueta et al., 2017 | **Healthy Lives and Well-being for All at All Ages (3.2/3.9)**<br>↑ / [+2] / 📖📖📖📖📖 / ☺☺☺☺ / ★★★★<br>Efficient stoves improve health, especially for indigenous and poor rural communities. Household energy efficiency has positive health impacts on children's respiratory health, weight and susceptibility to illness, and the mental health of adults. Household energy efficiency improves winter warmth, lowers relative humidity with benefits for cardiovascular and respiratory health. Further improved indoor air quality by thermal regulation and occupant comfort are realised. However, in one instance, negative health impacts (asthma) of increased household energy efficiency were also noted when housing upgrades took place without changes in occupant behaviours. Home occupants reported warmth as the most important aspect of comfort which was largely temperature-related and low in energy costs. Residents living in the deprived areas expect improved warmth in their properties after energy efficiency measures are employed.<br>Djamila et al., 2013; Huebner et al., 2013; Yue et al., 2013; Bhojvaid et al., 2014; Derbez et al., 2014; Maidment et al., 2014; Scott et al., 2014; Cameron et al., 2015; Liddell and Guiney, 2015; Sharpe et al., 2015; Wells et al., 2015; Willand et al., 2015; Berrueta et al., 2017; Zhao et al., 2017 | **Equal Access to Educational Institutions (4.1/4.2/4.3/4.5)**<br>↑ / [+2] / 📖 / ☺ / ★<br>Household energy efficiency measures reduce school absences for children with asthma due to indoor pollution.<br>Maidment et al., 2014 |
| | **Improved Access and Fuel Switch to Modern Low-carbon Energy** | **Poverty and Development (1.1/1.2/1.3/1.4)**<br>↑ / [+2] / 📖📖📖 / ☺☺☺ / ★★★★<br>Access to modern energy forms (electricity, clean stoves, high-quality lighting) is fundamental to human development since the energy services made possible by them help alleviate chronic and persistent poverty. Strength of the impact varies in the literature. (Quote from McCollum et al., 2018)<br>Kirubi et al., 2009; Casillas and Kammen, 2010; Cook, 2011; Pachauri et al., 2012; Pode, 2013; Pueyo et al., 2013; Zulu and Richardson, 2013; Bonan et al., 2014; Rao et al., 2014; Burlig and Preonas, 2016; McCollum et al., 2018 | **Food Security and Agricultural Productivity (2.1/2.4)**<br>~ / ↓ / [0,-1] / 📖📖 / ☺☺☺ / ★★<br>Modern energy access is critical to enhance agricultural yields/productivity, decrease post-harvest losses and mechanize agri-processing – all of which can aid food security. However, large-scale bioenergy and food production may compete for scarce land and other inputs (e.g., water, fertilizers), depending on how and where biomass supplies are grown and the indirect land use change impacts that result. If not implemented thoughtfully, this could lead to higher food prices globally, and thus reduce access to affordable food for the poor. Enhanced agricultural productivities can ameliorate the situation by allowing as much bioenergy to be produced on as little land as possible.<br>Cabraal et al., 2005; Tilman et al., 2009; van Vuuren et al., 2009; Asaduzzaman et al., 2010; Finco and Doppler, 2010; Msangi et al., 2010; Smith et al., 2013, 2014; Lotze-Campen et al., 2014; Hasegawa et al., 2015; Sola et al., 2016; McCollum et al., 2018 | **Disease and Mortality (3.1/3.2/3.3/3.4)**<br>↑ / [+2] / 📖📖📖 / ☺☺☺ / ★★★★<br>Access to modern energy services can contribute to fewer injuries and diseases related to traditional solid fuel collection and burning, as well as utilization of kerosene lanterns. Access to modern energy services can facilitate improved health care provision, medicine and vaccine storage, utilization of powered medical equipment, and dissemination of health-related information and education. Such services can also enable thermal comfort in homes and contribute to food preservation and safety. (Quote from McCollum et al., 2018)<br>Lam et al., 2012; Lim et al., 2012; Smith et al., 2013; Aranda et al., 2014; McCollum et al., 2018 | **Equal Access to Educational Institutions (4.1/4.2/4.3/4.5)**<br>↑ / [+1] / 📖 / ☺☺☺ / ★★<br>Access to modern energy is necessary for schools to have quality lighting and thermal comfort, as well as modern information and communication technologies. Access to modern lighting and energy allows for studying after sundown and frees constraints on time management that allow for higher school enrolment rates and better literacy outcomes. (Quote from McCollum et al., 2018)<br>Lipscomb et al., 2013; van de Walle et al., 2013; McCollum et al., 2018 |

*Social-Demand (continued)*

| Sector | Option | SDG 1 (No Poverty) | SDG 2 (Zero Hunger) | SDG 3 (Good Health and Well-Being) | SDG 4 (Quality Education) |
|---|---|---|---|---|---|
| | | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence |
| **Transport** | **Behavioural Response** | **Equal Right to Economic Resources Access Basic Services (1.1/1.4/1.a/1.b)**<br>↑ / ↓ [+2,-1] 📖📖📖 ☺☺☺ ★★★<br>The costs of daily mobility can have important economic stress impacts, not only impacting carless families with low-mobility, but in countries with high<br>levels of car dependence, the costs of motoring can be burdensome, raising questions of affordability for households with limited economic resources. During economic crisis, public transport authorities may react by reducing levels of service and increasing fares, likely exacerbating the situation for low-income households.<br>Dodson et al., 2004; Cascajo et al., 2017 | **Ensure Access to Safe Nutritious Food (2.1/2.2)**<br>↑ [+2] 📖 ☺ ★★★<br>Low-income community residents (non-white) who lack local access to affordable, quality sources of nutrition have to travel outside their immediate neighbourhood to find better sources of food to feed themselves and their families. Lack of locally available healthy food often exacerbates the rates of obesity in many of these communities since it is often difficult or expensive to travel long distances on a regular basis to shop for food.<br>Clifton, 2004; Hillier, 2011; Krukowski et al., 2013; LeDoux and Vojnovic, 2013; Ghosh-Dastidar et al., 2014; Zenk et al., 2015; Lowery et al., 2016 | **Road Traffic Accidents (3.4/3.6)**<br>↑ / ↓ [+2,-1] 📖📖📖 ☺☺☺ ★★<br>Active travel modes, such as walking and cycling, represent strategies not only for boosting energy efficiency but also, potentially, for improving health and well-being (e.g., lowering rates of diabetes, obesity, heart disease, dementia and some cancers). However, a risk associated with these measures is that they could increase rates of road traffic accidents, if the existing infrastructure is unsatisfactory. Overall health effects will depend on the severity of the injuries sustained from these potential accidents relative to the health benefits accruing from increased exercise (McCollum et al., 2018).<br>Woodcock et al., 2009; Creutzig et al., 2012; Haines and Dora, 2012; Saunders et al., 2013; Shaw et al., 2014, 2017; Chakrabarti and Shin, 2017; Hwang et al., 2017; McCollum et al., 2018 | **Equal Safe Access to Educational Institutions (4.1/4.2/4.3/4.5)**<br>↑ [+1] 📖 ☺☺☺ ★★<br>Poor road quality affects school travel safety, so collaborative efforts need to address safety issues from a dual perspective, first by working to change the existing infrastructure and use of roads to better address the traffic problems that children currently face walking to school, and then to better situate schools and control the roadways and land uses around them in the future.<br>Yu, 2015 |
| | **Accelerating Energy Efficiency Improvement** | **End Poverty in all its Forms Everywhere (1.1/1.4/1.a/1.b)**<br>↑ / ↓ [+2,-1] 📖📖📖 ☺☺☺ ★★★<br>Decarbonization of public buses in Sweden is receiving attention more than efficiency improvement. With more electrification, electricity prices go up and affordability can worsen for the poor unless redistributive policies are in place.<br>Xylia and Silveira, 2017 | [0]<br>No direct interaction | **Reduce Illnesses from Hazardous Air, Water and Soil Pollution (3.9)**<br>↑ [+2] 📖📖📖 ☺☺☺ ★★★<br>Locally relevant policies targeting traffic reductions and ambitious diffusion of electric vehicles results in measured changes in non-climatic exposure for population, including ambient air pollution, physical activity and noise. The transition to low-carbon equitable and sustainable transport can be fostered by numerous short- and medium-term strategies that would benefit energy security, health, productivity and sustainability. An evidence-based approach that takes into account GHG emissions, ambient air pollutants, economic factors (affordability, cost optimization), social factors (poverty alleviations, public health benefits) and political acceptability is needed to tackle these challenges.<br>Figueroa et al., 2014; Schucht et al., 2015; Klausbruckner et al., 2016; Peng et al., 2017 | [0]<br>No direct interaction |
| | **Improved Access and Fuel Switch to Modern Low-carbon Energy** | **End Poverty in all its Forms Everywhere (1.1/1.4/1.a/1.b)**<br>↑ / ↓ [+2,-1] 📖📖📖 ☺☺☺ ★★★<br>Increasingly volatile global oil prices have raised concerns for the vulnerability of households to fuel price increases. Pricing measures as a key component of sustainable transport policy need to consider equity. Pro-poor mitigation policies are needed to reduce climate impact and reduce threat; for example, investing more and better in infrastructure by leveraging private resources and using designs that account for future climate change and the related uncertainty. Communities in poor areas cope with and adapt to multiple-stressors including climate change. Coping strategies provide short-term relief but in the long-term may negatively affect development goals. And responses generate a trade-off between adaptation, mitigation and development. For African cities with slums, due to high commuting costs, many walk to work places which limit access. In Latin America triple informality leading to low productivity and living standards.<br>Dodson and Sipe, 2008; Suckall et al., 2014; Hallegatte et al., 2016a; Klausbruckner et al., 2016; CAF, 2017; Lall et al., 2017 | **Ensure Access to Food Security (2.1/2.3/2.a/2.b/2.c)**<br>~ [0] 📖 ☺ ★<br>21 projects aiming at resilient transport infrastructure development to improve access (e.g., C40 Cities Clean Bus Declaration, UITP Declaration on Climate Leadership, Cycling Delivers on the Global Goals, Global Sidewalk Challenge) do not substantially contribute to realizing the (indirect) transport targets with mostly a rural focus: agricultural productivity (SDG 2) and access to safe drinking water (SDG 6).<br>SLoCaT, 2017 | **Reduce Illnesses from Hazardous Air Pollution (3.9)**<br>↑ [+2] 📖 ☺ ★<br>Projects aiming at resilient transport infrastructure development (e.g., C40 Cities Clean Bus Declaration, UITP Declaration on Climate Leadership, Cycling Delivers on the Global Goals, Global Sidewalk Challenge) are targeted at reducing air pollution; electric vehicles using electricity from renewables or low carbon sources combined with e-mobility options such as trolley buses, metros, trams and electro buses, as well as promoting walking and biking, especially for short distances, need consideration.<br>Ajanovic, 2015; SLoCaT, 2017 | [0]<br>No direct interaction |

| | | 1 No Poverty | 2 Zero Hunger | 3 Good Health and Well-Being | 4 Quality Education |
|---|---|---|---|---|---|
| | | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence |
| **Replacing Coal** | **Non-biomass Renewables - solar, wind, hydro** | **Poverty and Development (1.1/1.2/1.3/1.4)**<br>↑ [+2] 📖📖📖 ☺☺☺ ★★★<br>Deployment of renewable energy and improvements in energy efficiency globally will aid climate change mitigation efforts, and this, in turn, can help to reduce the exposure of the world's poor to climate-related extreme events, negative health impacts and other environmental shocks (McCollum et al., 2018).<br>Riahi et al., 2012; IPCC, 2014; Hallegatte et al., 2016b; McCollum et al., 2018 | [0]<br>No direct interaction | **Air Pollution (3.9)**<br>↑ [+2] 📖📖📖 ☺☺☺ ★★★★<br>Promoting most types of renewables and boosting efficiency greatly aids the achievement of targets to reduce local air pollution and improve air quality; however, the order of magnitude of the effects, both in terms of avoided emissions and monetary valuation, varies significantly between different parts of the world. Benefits would especially accrue to those living in the dense urban centres of rapidly developing countries. Utilization of biomass and biofuels might not lead to any air pollution benefits, however, depending on the control measures applied. In addition, household air quality can be significantly improved through lowered particulate emissions from access to modern energy services (McCollum et al., 2018).<br>Haines et al., 2007; Nemet et al., 2010; Kaygusuz, 2011; Riahi et al., 2012; van Vliet et al., 2012; Anenberg et al., 2013; Rafaj et al., 2013; Rao et al., 2013, 2016; West et al., 2013; Chaturvedi and Shukla, 2014; Rose et al., 2014; Smith and Sagar, 2014; IEA, 2016; McCollum et al., 2018 | **Vocational Trainig, Education for Sustainability (4.b/4.7)**<br>↑ [+1] 📖 ☺ ★<br>Decentralized renewable energy systems (e.g., home- or village-scale solar power) can support education and vocational training.<br>Anderson et al., 2017 |
| | **Increased Use of Biomass** | **Poverty and Development (1.1/1.2/1.3/1.4)**<br>↑ / ↓ [+2,-2] 📖📖 ☺☺ ★<br>Large-scale bioenergy production could lead to the creation of agricultural jobs, as well as higher farm wages and more diversified income streams for farmers. Modern energy access can make marginal lands more cultivable, thus potentially generating on-farm jobs and incomes; on the other hand, greater farm mechanization can also displace labour. However, large-scale bioenergy production could alter the structure of global agricultural markets in a way that is, potentially, unfavourable to small-scale food producers. See SDG2 (McCollum et al., 2018).<br>Balishter and Singh, 1991; Gohin, 2008; de Moraes et al., 2010; van der Horst and Vermeylen, 2011; Corbera and Pascual, 2012; Rud, 2012; Creutzig et al., 2013; Davis et al., 2013; Satolo and Bacchi, 2013; Muys et al., 2014; Ertem et al., 2017; McCollum et al., 2018 | **Farm Employment and Incomes (2.3)**<br>↑ / ↓ [+2,-2] 📖📖📖 ☺☺☺ ★★★<br>Large-scale bioenergy production could lead to the creation of agricultural jobs, as well as higher farm wages and more diversified income streams for farmers. Modern energy access can make marginal lands more cultivable, thus potentially generating on-farm jobs and incomes; on the other hand, greater farm mechanization can also displace labour. However, large-scale bioenergy production could alter the structure of global agricultural markets in a way that is, potentially, unfavourable to small-scale food producers. The distributional effects of bioenergy production are underexplored in the literature (McCollum et al., 2018).<br>Balishter and Singh, 1991; Gohin, 2008; de Moraes et al., 2010; van der Horst and Vermeylen, 2011; Corbera and Pascual, 2012; Rud, 2012; Creutzig et al., 2013; Davis et al., 2013; Satolo and Bacchi, 2013; Muys et al., 2014; Ertem et al., 2017; McCollum et al., 2018 | **Disease and Mortality (3.1/3.2/3.3/3.4), Air Pollution (3.9)**<br>↑ [+2] 📖📖📖 ☺☺☺ ★★★<br>Replacing coal by biomass can reduce adverse impacts of upstream supply-chain activities, in particular local air and water pollution, and prevent coal mining accidents. Improvements to local air pollution in power generation compared to coal-fired power plants depend on the technology and fuel of biomass power plants, but could be significant when switching from outdated coal combustion technologies to state-of-the-art biogas power generation.<br>IPCC, 2005, 2014; Miller et al., 2007; Hertwich et al., 2008; de Best-Waldhober et al., 2009; Shackley et al., 2009; Wallquist et al., 2009, 2010; Wong-Parodi and Ray, 2009; Chan and Griffiths, 2010; Veltman et al., 2010; Epstein et al., 2011; Koornneef et al., 2011; Reiner and Nuttall, 2011; Singh et al., 2011; Ashworth et al., 2012; Burgherr et al., 2012; Chen et al., 2012; Asfaw et al., 2013; Corsten et al., 2013; Einsiedel et al., 2013 | [0]<br>No direct interaction |

*Social-Supply (continued)*

| | | 1 No Poverty (Interaction / Score / Evidence / Agreement / Confidence) | 2 Zero Hunger (Interaction / Score / Evidence / Agreement / Confidence) | 3 Good Health and Well-being (Interaction / Score / Evidence / Agreement / Confidence) | 4 Quality Education (Interaction / Score / Evidence / Agreement / Confidence) |
|---|---|---|---|---|---|
| **Replacing Coal** | **Nuclear/Advanced Nuclear** | [0]<br>No direct interaction | [0]<br>No direct interaction | **Disease and Mortality (3.1/3.2/3.3/3.4)**<br>↓ [-1] 📖📖📖 ☺☺☺ ★★★<br>In spite of the industry's overall safety track record, a non-negligible risk for accidents in nuclear power plants and waste treatment facilities remains. The long-term storage of nuclear waste is a politically fraught subject, with no large-scale long-term storage operational worldwide. Negative impacts from upstream uranium mining and milling are comparable to those of coal, hence replacing fossil fuel combustion by nuclear power would be neutral in that aspect. Increased occurrence of childhood leukaemia in populations living within 5 km of nuclear power plants was identified by some studies, even though a direct causal relation to ionizing radiation could not be established and other studies could not confirm any correlation (*low evidence/agreement* on this issue).<br>Abdelouas, 2006; Cardis et al., 2006; Kaatsch et al., 2008; Al-Zoughool and Krewski, 2009; Heinävaara et al., 2010; Schnelzer et al., 2010; Brugge and Buchner, 2011; Møller and Mousseau, 2011; Møller et al., 2011, 2012; Moomaw et al., 2011; UNSCEAR, 2011; Sermage-Faure et al., 2012; Ten Hoeve and Jacobson, 2012; Tirmarche et al., 2012; Hiyama et al., 2013; Mousseau and Møller, 2013; Smith et al., 2013; WHO, 2013; IPCC, 2014; von Stechow et al., 2016 | [0]<br>No direct interaction |
| | **CCS: Bioenergy** | **Poverty and Development (1.1/1.2/1.3/1.4)**<br>↑ / ↓ [+2,-2] 📖📖 ☺☺ ★<br>See effects of increased bioenergy use. | **Farm Employment and Incomes (2.3)**<br>↑ / ↓ [+1,-2] 📖📖📖 ☺☺☺ ★★★<br>See increased use of biomass effects. In addition, the concern that more bioenergy (for BECCS) necessarily leads to unacceptably high food prices is not founded on large agreement in the literature. AR5, for example, finds a significantly lower effect of large-scale bioenergy deployment on food prices by mid-century than the effect of climate change on crop yields. Also, Muratori et al. (2016) show that BECCS reduces the upward pressure on food crop prices by lowering carbon prices and lowering the total biomass demand in climate change mitigation scenarios. On the other hand, competition for land use may increase food prices and thereby increase risk of hunger. Use of agricultural residue for bioenergy can reduce soil carbon, thereby threatening agricultural productivity.<br>See literature on increased biomass use: IPCC, 2014; Muratori et al., 2016; Dooley and Kartha, 2018 | **Disease and Mortality (3.1/3.2/3.3/3.4)**<br>↑ / ↓ [+2,-1] 📖📖 ☺☺☺ ★★★<br>See positive impacts of increased biomass use. At the same time, there is a non-negligible risk of $CO_2$ leakage both from geological formations as well as from the transportation infrastructure from source to sequestration locations.<br>Wang and Jaffe, 2004; Hertwich et al., 2008; Apps et al., 2010; Veltman et al., 2010; Koornneef et al., 2011; Singh et al., 2011; Siirila et al., 2012; Atchley et al., 2013; Corsten et al., 2013; IPCC, 2014 | [0]<br>No direct interaction |
| **Advanced Coal** | **CCS: Fossil** | [0]<br>No direct interaction | [0]<br>No direct interaction | **Disease and Mortality (3.1/3.2/3.3/3.4)**<br>↓ [-1] 📖📖 ☺☺☺ ★★★<br>The use of fossil CCS implies continued adverse impacts of upstream supply-chain activities in the coal sector, and because of lower efficiency of CCS coal power plants, upstream impacts and local air pollution are likely to be exacerbated. Furthermore, there is a non-negligible risk of $CO_2$ leakage from geological storage or the $CO_2$ transport infrastructure from source to sequestration location.<br>Wang and Jaffe, 2004; Hertwich et al., 2008; Apps et al., 2010; Veltman et al., 2010; Koornneef et al., 2011; Singh et al., 2011; Siirila et al., 2012; Atchley et al., 2013; Corsten et al., 2013; IPCC, 2014 | [0]<br>No direct interaction |

Social-Other

Agriculture and Livestock

| Mitigation option | SDG | Target | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|---|---|
| Behavioural Response: Sustainable Healthy Diets and Reduced Food Waste | 1 No Poverty | Poverty and Development (1.1/1.2/1.3/1.4) | ~ / ↓ | [0,-1] | 🕮🕮 | ☺☺☺ | ★★ | Cutting livestock consumption can increase food security for some if land grows food not feed, but can also undermine livelihoods and culture where livestock has long been the best use of land, such as in parts of Sub-Saharan Africa. | IPCC, 2014 |
| Behavioural Response: Sustainable Healthy Diets and Reduced Food Waste | 2 Zero Hunger | Food Security, Promoting Sustainable Agriculture (2.1/2.4/2a) | ↑ | [+2] | 🕮🕮🕮🕮 | ☺☺☺☺ | ★★★★ | Curbing consumer waste of major food crops (i.e., wheat, rice and vegetables) and meats (i.e., beef, pork and poultry) in China, USA and India alone could feed ~413 million people per year (West et al., 2014). One billion extra people could be fed if food crop losses could be halved (Kummu et al., 2012). Reducing waste, especially from meat and dairy, could play a role in delivering food security and reduce the need for sustainable intensification (Smith, 2013). Dietary change toward global healthy diets could improve nutritional health, food security and reduce emissions. | Garnett, 2011; Beddington et al., 2012; Kummu et al., 2012; Smith, 2013; Bajželj et al., 2014; Tilman and Clark, 2014; West et al., 2014; Lamb et al., 2016 |
| Behavioural Response: Sustainable Healthy Diets and Reduced Food Waste | 3 Good Health and Well-Being | Tobacco Control (3.a/3.a.1) | ↑ | [+1] | 🕮 | ☺ | ★ | Consume fewer foods with low nutritional value, e.g., alcohol (Garnett, 2011). Demand-side measures aimed at reducing the proportion of livestock products in human diets, where the consumption of animal products is higher than recommended, are associated with multiple health benefits, especially in industrialized countries (Bustamante et al., 2014). | Garnett, 2011; Bustamante et al., 2014 |
| Behavioural Response: Sustainable Healthy Diets and Reduced Food Waste | 4 Quality Education | | | [0] | | | | No direct interaction | |
| Land-based GHG Reduction and Soil Carbon Sequestration | 1 No Poverty | Poverty and Development (1.1/1.2/1.3/1.4) | ↑ | [+2] | 🕮🕮🕮🕮 | ☺☺☺☺ | ★★★★ | Many CSA interventions aim to improve rural livelihoods, thereby contributing to poverty alleviation. Agroforestry or integrated crop–livestock–biogas systems can substitute costly, external inputs, saving on household expenditures – or even lead to the selling of some of the products, providing the farmer with extra income, leading to increased adaptive capacity (Bogdanski, 2012). | Branca et al., 2011; Bogdanski, 2012; Scherr et al., 2012; Vermeulen et al., 2012; Campbell et al., 2014; Lipper et al., 2014; Mbow et al., 2014; Steenwerth et al., 2014; Hammond et al., 2017 |
| Land-based GHG Reduction and Soil Carbon Sequestration | 2 Zero Hunger | Food Security, Promoting Sustainable Agriculture (2.1/2.4/2a) | ↑ | [+2] | 🕮🕮🕮🕮 | ☺☺☺☺ | ★★★★ | Safe application of biotechnology, both conventional and modern methods, can help to improve agricultural productivity, improving crop adaptability and thereby catering to food security. Reducing tillage, eliminating fallow and keeping the soil covered with residue, cover crops or perennial vegetation helps prevent soil erosion and has the potential to increase soil organic matter. Efficient land-management techniques can help in increasing crop yields, and so food security issues can be addressed. Yield projections are actually higher for developing countries than for developed countries, reflecting the fact that they have more 'catch-up' potential (Evenson, 1999). Action is needed throughout the food system on moderating demand, reducing waste, improving governance and producing more food (Godfray and Garnett, 2014). Improving cropland management is the key to increase crop productivity without further degrading soil and water resources (Branca et al., 2011). CSA practices increase productivity and prioritize food security. | Evenson, 1999; West and Post, 2002; Johnson et al., 2007; Branca et al., 2011; McCarthy et al., 2011; Behnassi et al., 2014; Campbell et al., 2014; Godfray and Garnett, 2014; Harvey et al., 2014; Lipper et al., 2014 |
| Land-based GHG Reduction and Soil Carbon Sequestration | 3 Good Health and Well-Being | Ensure Healthy Lives (3.c) | ↑ / ↓ | [+2,-2] | 🕮🕮 | ☺☺ | ★★ | Growing crops such as cassava, sorghum and millet, even in harsh conditions, is important to the diets of very poor people. Policy scenarios show that reduced research support, delayed industrialization, delayed biotechnology and climate change will delay progress in reducing childhood malnutrition. The global effects are small, but local effects for some countries, e.g., Bangladesh and Nigeria, are significant (Evenson, 1999). | Evenson, 1999; Godfray and Garnett, 2014 |
| Land-based GHG Reduction and Soil Carbon Sequestration | 4 Quality Education | Ensure Inclusive and Quality Education (4.4/4.7) | ↑ / ↓ | [+2,-2] | 🕮🕮 | ☺ | ★ | Science-based action within CSA is required to integrate data sets and sound metrics for testing hypotheses about feedback regarding climate, weather data products and agricultural productivity, such as the nonlinearity of temperature effects on crop yield and the assessment of trade-offs and synergies that arise from different agricultural intensification strategies (Steenwerth et al., 2014). Low commodity prices have led to declining investment in research and development, farmer education, etc. (Lamb et al., 2016). | Steenwerth et al., 2014; Lamb et al., 2016 |
| Greenhouse Gas Reduction from Improved Livestock Production and Manure Management Systems | 1 No Poverty | Poverty Reduction and Minimize Exposure to Risk (1.5) | ↑ | [+2] | & | J | « | With mixed-farming systems farmers can not only mitigate risks by producing a multitude of commodities, but they can also increase the productivity of both crops and animals in a more profitable and sustainable way. | Sansoucy, 1995 |
| Greenhouse Gas Reduction from Improved Livestock Production and Manure Management Systems | 2 Zero Hunger | Food Security, Promoting Sustainable Agriculture (2.1/2.4/2a) | ↑ | [+2] | &&&& | JJJJ | «««« | Fostering transitions towards more productive livestock production systems targeting land-use change appears to be the most efficient lever to deliver food availability outcomes. Genomic selection should be able to at least double the rate of genetic gain in the dairy industry. Given the prevalence of mixed crop–livestock systems in many parts of the world, closer integration of crops and livestock in such systems can give rise to increased productivity and increased soil fertility (Thornton, 2010). Managing the indirect effects of livestock systems intensification is critical for the sustainability of the global food system: such as improving productivity and the close link to land sparing (Herrero and Thornton, 2013). In East Africa pastoralists have shifted from cows to camels, which are better adapted to survive periods of water scarcity and able to consistently provide more milk (Steenwerth et al., 2014). Scenarios where zero human-edible concentrate feed is used for livestock, soil erosion potential reduces by 12%. | Thornton, 2010, 2013; Herrero and Thornton, 2013; Havlik et al., 2014; Steenwerth et al., 2014; Schader et al., 2015 |
| Greenhouse Gas Reduction from Improved Livestock Production and Manure Management Systems | 3 Good Health and Well-Being | Ensure Healthy Lives (3.c) | ↑ / ↓ | [+2,-2] | && | JJ | «« | Biodigestion, which has positive public health aspects, particularly where toilets are coupled with the biodigester; anaerobic conditions kill pathogenic organisms as well as digestive toxins. Separation processes can improve or worsen health risks related to food crops or to livestock. | Sansoucy, 1995; Burton, 2007 |
| Greenhouse Gas Reduction from Improved Livestock Production and Manure Management Systems | 4 Quality Education | | | [0] | | | | No direct interaction | |

*Social-Other (continued)*

Each SDG cell: Interaction | Score | Evidence | Agreement | Confidence

| | | 1 No Poverty | 2 Zero Hunger | 3 Good Health and Well-Being | 4 Quality Education |
|---|---|---|---|---|---|
| Forest | Reduced Deforestation, REDD+ | **Poverty Reduction (1.5)**<br>↑ [+2] 📖 ☺ ★<br>Partnerships between local forest managers, community enterprises and private sector companies can support local economies and livelihoods, and boost regional and national economic growth.<br>Katila et al., 2017 | **Food Security, Promoting Sustainable Agriculture (2.1/2.4/2a)**<br>↑ / ↓ [+1,-2] 📖📖 ☺ ★<br>Food security may lead to the conversion of productive land under forest, including community forests, into agricultural production. In a similar fashion, the production of biomass for energy purposes (SDG 7) may reduce land available for food production and/or for community forest activities . Efforts by the Government of Zambia to reduce emissions by REDD+ have contributed erosion control, ecotourism and pollination valued at 2.5% of the country's GDP.<br>Turpie et al., 2015; Epstein and Theuer, 2017; Katila et al., 2017; Dooley and Kartha, 2018 | [0]<br>No direct interaction | **Ensure Inclusive and Quality Education (4.4/4.7)**<br>↑ [+1] 📖 ☺ ★<br>Local forest users learn to understand laws, regulations and policies which facilitate their participation in society. Education and capacity building provide technical skill and knowledge (Katila et al., 2017).<br>Katila et al., 2017 |
| | Afforestation and Reforestation | **Poverty and Development (1.1/1.2/1.3/1.4)**<br>↑ / ↓ [+2,-2] 📖📖 ☺☺ ★★★<br>Clean Development Mechanism (CDM) can have different implications on local community livelihoods. For example, willingness to adopt afforestation is influenced in particular by Australian landholder's perceptions of its potential to provide a diversified income stream, and its impacts on flexibility of land management ; land sparing would have far reaching implications for the UK countryside and would affect landowners and rural communities ; and livelihoods could be threatened if subsistence agriculture is targeted .<br>Zomer et al., 2008; Schirmer and Bull, 2014; Lamb et al., 2016; Dooley and Kartha, 2018 | **Food Security (2.1)**<br>↑ / ↓ [+1,-1] 📖 ☺ ★<br>CDM can have different implications on local to regional food security and local community livelihoods.<br>Zomer et al., 2008; Dooley and Kartha, 2018 | **Ensure Healthy Lives (3.c)**<br>↑ [+1] 📖 ☺ ★<br>Urban trees are increasingly seen as a way to reduce harmful air pollutants and therefore improve cardio-respiratory health.<br>Jones and McDermott, 2018 | **Promote Knowledge and Skill to Promote SD (4.7)**<br>↓ [-1] 📖 ☺ ★<br>Most landholders reported having low levels of knowledge about tree planting for carbon sequestration – particularly available programmes, prices and markets, and government rules and regulations .<br>Schirmer and Bull, 2014 |
| | Behavioural Response (Responsible | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction |
| Oceans | Ocean Iron Fertilization | [0]<br>No direct interaction | **Food Security (2.2/2.3)**<br>↑ / ↓ [+1,-1] 📖📖 ☺ ★<br>OIF can have different implications on fish stocks and aquaculture, and it might actually increase food availability for fish stocks (increasing yields); but potentially at the cost of reducing the yields of fisheries outside the enhancement region by depleting other nutrients.<br>Lampitt et al., 2008; Smetacek and Naqvi, 2008; Williamson et al., 2012 | [0]<br>No direct interaction | [0]<br>No direct interaction |
| | Blue Carbon | **Poverty and Development (1.1/1.2/1.5)**<br>↑ [+3] 📖📖📖 ☺☺☺ ★★★<br>Avoiding loss of mangroves and maintaining the 2000 stock could save a value of ecosystem services from mangroves in South East Asia of approximately 2.16 billion USD until 2050 (2007 prices), with a 95% prediction interval of 1.58–2.76 billion USD (case study area South East Asia); seaweed aquaculture will enhance carbon uptake and provide employment; traditional management systems provide benefits for blue carbon and support livelihoods for local communities; greening of aquaculture can significantly enhance carbon storage; PES schemes could help capture the benefits derived from multiple ecosystem services beyond carbon sequestration.<br>Zomer et al., 2008; Schirmer and Bull, 2014; Lamb et al., 2016 | **Food Production (2.3/2.4)**<br>↑ [+3] 📖📖📖 ☺☺☺ ★★★<br>Avoiding loss of mangroves and maintaining the 2000 stock could save a value of ecosystem services from mangroves in South East Asia including fisheries; seaweed aquaculture will provide employment; traditional management systems provide livelihoods for local communities; greening of aquaculture can increase income and well-being; and mariculture is a promising approach for China.<br>Brander et al., 2012; Ahmed et al., 2017a, 2017b; Duarte et al., 2017; Sondak et al., 2017; Vierros, 2017; Zhang et al., 2017 | [0]<br>No direct interaction | [0]<br>No direct interaction |
| | Enhanced Weathering | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction |

| | | 5 GENDER EQUALITY<br>Interaction / Score / Evidence / Agreement / Confidence | 10 REDUCED INEQUALITIES<br>Interaction / Score / Evidence / Agreement / Confidence | 16 PEACE, JUSTICE AND STRONG INSTITUTIONS<br>Interaction / Score / Evidence / Agreement / Confidence | 17 PARTNERSHIPS FOR THE GOALS<br>Interaction / Score / Evidence / Agreement / Confidence |
|---|---|---|---|---|---|
| Industry | Accelerating Energy Efficiency Improvement | [0]<br>No direct interaction | **Knowledge and Skills Needed to Promote SD (4.7)**<br>↑ [+1] (evidence: 1 book symbol) (agreement: 3 smiley symbols) ★★★<br>There is need for skill in managing in-house energy efficiency. Sometimes ESCOs also help. Energy audits, but many times absence of skill acts as barrier for energy efficiency improvement. In many countries, especially developing countries, these act as barriers.<br>Apeaning and Thollander, 2013; Johansson and Thollander, 2018 | [0]<br>No direct interaction | **Global Partnership (17.6/17.7)**<br>↑ [+2] (evidence: 2 book symbols) (agreement: 3 smiley symbols) ★★★<br>A driving force for energy efficiency is collaboration among companies, networks, experience sharing and management tools. Sharing among countries can help accelerate managerial action. Absence of information, budgetary funding, lack of access to capital, etc. are<br>Apeaning and Thollander, 2013; Griffin et al., 2018; Johansson and Thollander, 2018; Lawrence et al., 2018 |
| | Low-carbon Fuel Switch | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction | **Global Partnership (17.6/17.7)**<br>↑ [+2] (evidence: 1 book symbol) (agreement: 2 smiley symbols) ★★<br>Ultra-low carbon steel making and breakthrough technologies are under trial across many countries and helping in enhancing the learning.<br>Abdul Quader et al., 2016 |
| | Decarbonization/CCS/CCU | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction | **Global Partnership (17.6/17.7)**<br>↑ [+2] (evidence: 1 book symbol) (agreement: 3 smiley symbols) ★★★<br>EPI plants are capital intensive and are mostly operated by multinationals with long investment cycles. In developed countries new innovation investments are happening in brown fields. Such large innovation investments need strong collaboration among partners/competitors which can be facilitated by public funds. They happen at national and supranational scales and across sectors, needs fresh revisit at Intellectual Property Rights issues. Global production of bio-based polymers increasingly need public support and incentives to push forward.<br>Wesseling et al., 2017; Griffin et al., 2018 |

*Social 2-Demand (continued)*

| Buildings | SDG 5 (Interaction / Score / Evidence / Agreement / Confidence) | SDG 10 (Interaction / Score / Evidence / Agreement / Confidence) | SDG 16 (Interaction / Score / Evidence / Agreement / Confidence) | SDG 17 (Interaction / Score / Evidence / Agreement / Confidence) |
|---|---|---|---|---|
| **Behavioural Response** | [0]<br>No direct interaction | [0]<br>No direct interaction | **Environmental Justice (16.7)**<br>↑ [+2] 🕮 ☺ ★<br>Consumption perspectives strengthen environmental justice discourse (as it claims to be a more just way of calculating global and local environmental effects) while possibly also increasing the participatory environmental discourse.<br>Hult and Larsson, 2016 | [0]<br>No direct interaction |
| **Accelerating Energy Efficiency Improvement** | **Gender Equality and Women's Empowerment (5.1/5.4)**<br>↑ [+1] 🕮 ☺☺ ★★<br>Efficient stoves lead to empowerment of rural and indigenous women.<br>Bhojvaid et al., 2014; Berrueta et al., 2017 | **Empowerment and Inclusion (10.1/10.2/10.3/10.4)**<br>↑ / ↓ [1,-1] 🕮🕮🕮 ☺☺☺ ★★★<br>Energy efficiency measures and the provision of energy access can free up resources that can then be put towards other productive uses (e.g., educational and employment opportunities), especially for women and children in poor, rural areas. The distributional costs of new energy policies are dependent on instrument design. If costs fall disproportionately on the poor, then this could work against the promotion of social, economic and political equality for all. The impacts of energy efficiency measures and policies on inequality can be both positive, if they reduce energy costs, or negative, if mandatory standards increase the need for purchasing more expensive equipment and appliances.<br>Dinkelman, 2011; Casillas and Kammen, 2012; Pachauri et al., 2012; Cayla and Osso, 2013; Hirth and Ueckerdt, 2013; Pueyo et al., 2013; Jakob and Steckel, 2014; Fay et al., 2015; Cameron et al., 2016; Hallegatte et al., 2016b; McCollum et al., 2018 | **Capacity and Accountability (16.1/16.3/16.5/16.6/16.7/16.8)**<br>↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★★<br>Institutions that are effective, accountable and transparent are needed at all levels of government (local to national to international) for providing energy access, promoting modern renewables and boosting efficiency. Strengthening the participation of developing countries in international institutions (e.g., international energy agencies, UN organizations, WTO, regional development banks and beyond) will be important for issues related to energy trade, foreign direct investment, labour migration and knowledge and technology transfer. Reducing corruption, where it exists, will help these bodies and related domestic institutions maximize their societal impacts. Limiting armed conflict and violence will aid most efforts related to sustainable development, including progress in the energy dimension.<br>Acemoglu, 2009; Tabellini, 2010; Acemoglu et al., 2014; ICSU and ISSC, 2015; McCollum et al., 2018 | **Enhance Policy Coherence for Sustainable Development (17.4)**<br>↑ [+2] 🕮 ☺ ★<br>Implementing refrigerant transition and energy efficiency improvement policies in parallel for room ACs, roughly doubles the benefit of either policy implemented in isolation.<br>Shah et al., 2015 |
| **Improved Access and Fuel Switch to Modern Low-carbon Energy** | **Women's Safety and Worth (5.1/5.2/5.4)/Opportunities for Women (5.1/5.5)**<br>↑ [+1] 🕮🕮 ☺☺ ★★<br>Improved access to electric lighting can improve women's safety and girls' school enrolment. Cleaner cooking fuel and lighting access can reduce health risks and drudgery, which women disproportionately face. Access to modern energy services has the potential to empower women by improving their income-earning and entrepreneurial opportunities and reducing drudgery. Participating in energy supply chains can increase women's opportunities and agency and improve business outcomes.<br>Chowdhury, 2010; Dinkelman, 2011; Kaygusuz, 2011; Köhlin et al., 2011; Clancy et al., 2012; Haves, 2012; Matinga, 2012; Anenberg et al., 2013; Pachauri and Rao, 2013; Burney et al., 2017; McCollum et al., | [0]<br>No direct interaction | **Capacity and Accountability (16.1/16.3/16.5/16.6/16.7/16.8)**<br>↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★★<br>Institutions that are effective, accountable and transparent are needed at all levels of government (local to national to international) for providing energy access, promoting modern renewables and boosting efficiency. Strengthening the participation of developing countries in international institutions (e.g., international energy agencies, UN organizations, WTO, regional development banks and beyond) will be important for issues related to energy trade, foreign direct investment, labour migration, and knowledge and technology transfer. Reducing corruption, where it exists, will help these bodies and related domestic institutions maximize their societal impacts. Limiting armed conflict and violence will aid most efforts related to sustainable development, including progress in the energy dimension.<br>Acemoglu, 2009; Tabellini, 2010; Acemoglu et al., 2014; ICSU and ISSC, 2015; McCollum et al., 2018 | **Promote Transfer and Diffusion of Technology (17.6/17.7)**<br>↑ [+2] 🕮 ☺ ★<br>Green building technology in Kazakhstan was based on transfer of knowledge among various parties.<br>Kim and Sun, 2017 |

*Social 2-Demand (continued)*

| Sector | Measure | 5 Gender Equality (Interaction / Score / Evidence / Agreement / Confidence) | 10 Reduced Inequalities (Interaction / Score / Evidence / Agreement / Confidence) | 16 Peace, Justice and Strong Institutions (Interaction / Score / Evidence / Agreement / Confidence) | 17 Partnerships for the Goals (Interaction / Score / Evidence / Agreement / Confidence) |
|---|---|---|---|---|---|
| **Transport** | **Behavioural response** | **Recognize Women's Unpaid Work (5.1/5.4)/Opportunities for Women (5.1/5.5)**<br>↑ [+1] 📖📖 ☺☺ ★★<br>The woman's average trip to work differs markedly from the man's average trip. Working-poor women rely on extensive social networks creating communities of spatial necessity, bartering for basic needs to overcome transportation constraints. Women earn lower wages and so are less likely to justify longer commutes. Many women need to manage dual roles as workers and mothers. Women tend to perform multi-purpose commuting, combining both work and household needs .<br>Crane, 2007; Rogalsky, 2010 | **Reduce Inequality (10.2)**<br>↑ [+2] 📖📖 ☺☺ ★★<br>The equity impacts of climate change mitigation measures for transport, and indeed of transport policy intervention overall, are poorly understood by policymakers. This is in large part because standard assessment of these impacts is not a statutory requirement of current policymaking. Managing transport energy demand growth will have to be advanced alongside efforts in passenger travel towards reducing the deep inequalities in access to transport services that currently affect the poor worldwide. Free provision of roads and parking spaces converts vast amounts of public land and capital into under-priced space for cars, in extreme cases like Los Angeles, USA, roads and streets free for parking and driving are 20% of land area; as governments give drivers free land, people drive more than they would otherwise. High levels of car dependence and the costs of motoring can be burdensome, and lead to increasing debt, raising questions of affordability for households with limited resources, particularly low-income houses located in suburban areas.<br>Figueroa et al., 2014; Lucas and Pangbourne, 2014; Walks, 2015; Manville, 2017; Belton Chevallier et al., 2018 | **Accountable and Transparent Institutions at All Levels (16.6/16.8)**<br>↑ / ↓ [+1, -1] 📖 ☺ ★<br>With behavioural change towards walking for short distances, pedestrian safety on the road might reduce, unless public policy is appropriately formulated. Prevalence of high levels of triple forms of informality, in jobs, housing and transportation, are responsible for low productivity and low standards of living, and are a major challenge for policies targeting urban growth in Latin America.<br>CAF, 2017; SLoCaT, 2017 | **Help Promote Global Partnership (17.1/17.3/17.5/17.6/17.7)**<br>↑ [+2] 📖 ☺ ★<br>Projects aiming at resilient transport infrastructure development (e.g., C40 Cities Clean Bus Declaration, UITP Declaration on Climate Leadership, Cycling Delivers on the Global Goals, Global Sidewalk Challenge) are happening through multi-stakeholder coalitions.<br>SLoCaT, 2017 |
| | **Accelerating Energy Efficiency Improvement** | [0]<br>No direct interaction | [0]<br>No direct interaction | **Responsive, Inclusive, Participatory Decision-making (16.7)**<br>↑ [+2] 📖📖 ☺☺ ★★<br>In transport mitigation it is necessary to conduct needs assessments and stakeholder consultation to determine plausible challenges, prior to introducing desired planning reforms. Further, the involved personnel should actively engage transport-based stakeholders during policy identification and its implementation to achieve the desired results. User behaviour and stakeholder integration are key for successful transport policy implementation.<br>Aggarwal, 2017; AlSabbagh et al., 2017 | **Help Promote Global Partnership (17.1/17.3/17.5/17.6/17.7)**<br>↑ [+2] 📖 ☺ ★<br>Projects aiming at resilient transport infrastructure development and technology adoption (e.g. C40 Cities Clean Bus Declaration, UITP Declaration on Climate Leadership, Cycling Delivers on the Global Goals, Global Sidewalk Challenge) are happening through multi-stakeholder coalitions.<br>SLoCaT, 2017 |
| | **Improved Access and Fuel Switch to Modern Low-carbon Energy** | [0]<br>No direct interaction | **Reduce Inequality (10.2)**<br>↑ [+2] 📖📖 ☺☺ ★★<br>The equity impacts of climate change mitigation measures for transport, and indeed of transport policy intervention overall, are poorly understood by policymakers. This is in large part because standard assessment of these impacts is not a statutory requirement of current policymaking. Managing transport energy demand growth will have to be advanced alongside efforts in passenger travel towards reducing the deep inequalities in access to transport services that currently affect the poor worldwide.<br>Figueroa et al., 2014; Lucas and Pangbourne, 2014 | **Responsive, Inclusive, Participatory Decision-making (16.7)**<br>↑ / ↓ [+1, -1] 📖 ☺ ★<br>Formal transport infrastructure improvement in many cities in developing countries leads to eviction from informal settlements; need for appropriate redistributive policies and cooperation and partnerships with all stakeholders.<br>Colenbrander et al., 2016 | **Help Promote Global Partnership (17.1/17.3/17.5/17.6/17.7)**<br>↑ [+2] 📖 ☺ ★<br>Projects aiming at resilient transport infrastructure development (e.g. C40 Cities Clean Bus Declaration, UITP Declaration on Climate Leadership, Cycling Delivers on the Global Goals, Global Sidewalk Challenge) are happening through multi-stakeholder coalitions.<br>SLoCaT, 2017 |

*Social 2-Supply*

| | | 5 Gender Equality | 10 Reduced Inequalities | 16 Peace, Justice and Strong Institutions | 17 Partnerships for the Goals |
|---|---|---|---|---|---|
| | | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence |
| Replacing Coal | Non-biomass Renewables - solar, wind, hydro | **Gender Equality and Women's Empowerment (5.1/5.4)**<br>↑ [+1] 🕮 ☺ ★<br>Decentralized renewable energy systems (e.g., home- or village-scale solar power) can reduce the burden on girls and women of procuring traditional biomass.<br>Schwerhoff and Sy, 2017 | **Empowerment and Inclusion (10.1/10.2/10.3/10.4)**<br>↑ [+1] 🕮🕮 ☺☺ ★★<br>Decentralized renewable energy systems (e.g., home- or village-scale solar power) can enable a more participatory, democratic process for managing energy-related decisions within communities.<br>Walker and Devine-Wright, 2008; Cass et al., 2010; Cumbers, 2012; Kunze and Becker, 2015; McCollum et al., 2018 | **Energy Justice**<br>↑ [+2] 🕮 ☺ ★<br>The energy justice framework serves as an important decision-making tool in order to understand how different principles of justice can inform energy systems and policies. Islar et al. (2017) state that off-grid and micro-scale energy development offers an alternative path to fossil-fuel use and top-down resource management as they democratize the grid and increase marginalized communities' access to renewable energy, education and health care.<br>Islar et al., 2017 | **International Cooperation (All Goals)**<br>↑ / ~ [+2,0] 🕮🕮 ☺☺ ★★<br>International cooperation (in policy) and collaboration (in science) is required for the protection of shared resources. Fragmented approaches have been shown to be more costly. Specific to SDG7, to achieve the targets for energy access, renewables and efficiency, it will be critical that all countries: (i) are able to mobilize the necessary financial resources (e.g., via taxes on fossil energy, sustainable financing, foreign direct investment, financial transfers from industrialized to developing countries); (ii) are willing to disseminate knowledge and share innovative technologies between each other; (iii) follow recognized international trade rules while at the same time ensuring that the least developed countries are able to take part in that trade; (iv) respect each other's policy space and decisions; (v) forge new partnerships between their public and private entities and within civil society; and (vi) support the collection of high-quality, timely and reliable data relevant to furthering their missions. There is some disagreement in the literature on the effect of some of the above strategies, such as free trade. Regarding international agreements, 'no-regrets options', where all sides gain through cooperation, are seen as particularly beneficial (e.g., nuclear test ban treaties) (McCollum et al., 2018).<br>UN, 1989; Ramaker et al., 2003; Clarke et al., 2009; NCE, 2015; Riahi et al., 2015, 2017; Eis et al., 2016; O'Neill et al., 2017; McCollum et al., 2018 |
| | Increased use of Biomass | [0] No direct interaction | [0] No direct interaction | [0] No direct interaction | [0] No direct interaction |
| | Nuclear/Advanced Nuclear | [0] No direct interaction | [0] No direct interaction | **Reduce Illicit Arms Trade (16.4)**<br>↓ [-1] 🕮🕮 ☺☺ ★★<br>Continued use of nuclear power poses a constant risk of proliferation.<br>Adamantiades and Kessides, 2009; Rogner, 2010; Sagan, 2011; von Hippel et al., 2011, 2012; Yim and Li, 2013; IPCC, 2014 | [0] No direct interaction |
| | CCS: Bioenergy | [0] No direct interaction | [0] No direct interaction | [0] No direct interaction | [0] No direct interaction |
| Advanced Coal | CCS: Fossil | [0] No direct interaction | [0] No direct interaction | [0] No direct interaction | [0] No direct interaction |

| | | 5 Gender Equality (Interaction / Score / Evidence / Agreement / Confidence) | 10 Reduced Inequalities (Interaction / Score / Evidence / Agreement / Confidence) | 16 Peace, Justice and Strong Institutions (Interaction / Score / Evidence / Agreement / Confidence) | 17 Partnerships for the Goals (Interaction / Score / Evidence / Agreement / Confidence) |
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| Agriculture and Livestock | Behavioural Response: Sustainable Healthy Diets and Reduced Food Waste | [0]<br>No direct interaction | [0]<br>No direct interaction | **making (16.6/16.7/16.a)**<br>↑ / ↓ [+1,-1] 🕮🕮🕮 ☺☺ ★★<br>Appropriate incentives to reduce food waste may require some policy innovation and experimentation, but a strong commitment for devising and monitoring them seems essential.<br>A financial incentive to minimize waste could be created through effective taxation (e.g., by taxing foods with the highest wastage rates, or by increasing taxes on waste disposal). Decision makers should try to integrate agricultural, environmental and nutritional objectives through appropriate policy measures to achieve sustainable healthy diets coupled with reduction in food waste. It is surprising that politicians and policymakers demonstrate little regarding the need to have strategies to reduce meat consumption and to encourage more sustainable eating practices.<br>Garnett, 2011; Dagevos and Voordouw, 2013; Bajželj et al., 2014; Lamb et al., 2016 | **Resource Mobilization and Strengthen Partnership**<br>↑ / ↓ [+1,-1] 🕮 ☺ ★<br>Decision makers should try to integrate agricultural, environmental and nutritional objectives through appropriate policy measures to achieve sustainable healthy diets coupled with reduction in food waste. It is surprising that politicians and policymakers demonstrate little regarding the need to have strategies to reduce meat consumption and to encourage more sustainable eating practices .<br>Garnett, 2011; Dagevos and Voordouw, 2013 |
| | Land-based Greenhouse Gas Reduction and Soil Carbon Sequestration | **Equal Access, Empowerment of Women (5.5)**<br>↑ / ~ [+2,0] 🕮🕮 ☺☺ ★★★<br>Many programmes for CSA have been used to empower women and to improve gender equality. Women often have an especially important role to play in adaptation, because of their gendered indigenous knowledge on matters such as agriculture (Terry, 2009). Without access to land, credit and agricultural technologies, women farmers face major constraints in their capacity to diversify into alternative livelihoods (Demetriades and Esplen, 2008).<br>Denton, 2002; Nelson et al., 2002; Morton, 2007; Demetriades and Esplen, 2009; Terry, 2009; Bernier et al., 2013; Jost et al., 2016 | **Empower Economic and Political Inclusion of All, Irrespective of Sex (10.2)**<br>↑ / ~ [+1,0] 🕮🕮 ☺☺ ★★<br>In many rural societies women are side-lined from decisions regarding agriculture even when male household heads are absent, and they often lack access to important inputs such as irrigation water, credit, tools and fertilizer. To be effective, agricultural mitigation strategies need to take these and other aspects of local gender relations into account (Terry, 2009). Women's key role in maintaining biodiversity, through conserving and domesticating wild edible plant seed, and in food crop breeding, is not sufficiently recognized in agricultural and economic policymaking; nor is the importance of biodiversity to sustainable rural livelihoods in the face of predicted climate changes (Nelson et al., 2002).<br>Nelson et al., 2002; Demetriades and Esplen, 2009; Terry, 2009 | **Build Effective, Accountable and Inclusive Institutions (16.6/16.7/16.8)**<br>~ / ↓ [0,-1] 🕮🕮🕮 ☺☺ ★★<br>Action is needed throughout the food system for improving governance and producing more food (Godfray and Garnett, 2014). CSA requires policy intervention for careful adjustment of agricultural practices to natural conditions, a knowledge-intensive approach, huge financial investment, etc., so having strong institutional frameworks is very important. The main source of climate finance for CSA in developing countries is the public sector. Lack of institutional capacity (as a means for securing creation of equal institutions among social groups and individuals) can reduce feasibility of AFOLU mitigation measures in the near future, especially in areas where small-scale farmers or forest users are the main stakeholders (Bustamante et al., 2014).<br>Behnassi et al., 2014; Bustamante et al., 2014; Godfray and Garnett, 2014; Lipper et al., 2014; Steenwerth et al., 2014 | **Resource Mobilization and Strengthen Multi-stakeholder Partnership (17.1/ 17.3/17.5/17.17)**<br>↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★<br>CSA requires more careful adjustment of agricultural practices to natural conditions, a knowledge-intensive approach, huge financial investment and policy and institutional innovation, etc. Besides private investment, quality of public investment is also important (Behnass et al., 2014). Sources of climate finance for CSA in developing countries include bilateral donors and multilateral financial institutions, besides public sector finance. CSA is committed to new ways of engaging in participatory research and partnerships with producers (Steenwerth et al., 2014).<br>Behnassi et al., 2014; Lipper et al., 2014; Steenwerth et al., 2014 |
| | Greenhouse Gas Reduction from Improved Livestock Production and Manure Management Systems | **Equal Access to Economic Resources, Promote Empowerment of Women (5.5/5.a/5.b)**<br>↑ / ~ [+2,0] 🕮 ☺ ★<br>Most of the animal farming activities such as fodder collection and feeding are performed by women. Alongside the considerable involvement and contribution of women, gender inequalities are pervasive in Indian villages in terms of accessing natural resources, extension services, marketing opportunities and financial services as well as in exercising their decision-making powers. Therefore, there is a need to correct gender bias in the farming sector. Efforts are needed to increase the capacity of women to negotiate with confidence and meet their strategic needs. Access to and control and management of small ruminants, grazing areas and feed resources empower women and lead to an overall positive impact on the welfare of the household.<br>Patel et al., 2016 | **Empower Economic and Political Inclusion of All, Irrespective of Sex (10.2)**<br>↑ / ~ [+1,0] 🕮 ☺ ★<br>Livestock ownership is increasing women's decision-making and economic power within both the household and the community. Access to and control and management of small ruminants, grazing areas and feed resources empower women and lead to an overall positive impact on the welfare of the household.<br>Patel et al., 2016 | **Responsible Decision-making (16.7)**<br>↑ [+1] 🕮 ☺ ★<br>To minimize the economic and social cost, policies should target emissions at their source—on the supply side—rather than on the demand side as supply-side policies have lower calorie cost than demand-side policies. The role of livestock system transitions in emission reductions depends on the level of the carbon price and which emissions sector is targeted by the policies.<br>Havlík et al., 2014 | **Improve Domestic Capacity for Tax Collection (17.1)**<br>↑ [+2] 🕮🕮 ☺☺ ★★<br>The role of livestock system transitions in emission reductions depends on the level of the carbon price and which emissions sector is targeted by the policies (Havlík et al., 2014). Mechanisms for affecting behavioural change in livestock systems need to be better understood by implementing combinations of incentives and taxes simultaneously in different parts of the world (Herrero and Thornton, 2013).<br>Herrero and Thornton, 2013; Havlík et al., 2014 |

*Social 2-Other (continued)*

| | | 5 Gender Equality (Interaction / Score / Evidence / Agreement / Confidence) | 10 Reduced Inequalities (Interaction / Score / Evidence / Agreement / Confidence) | 16 Peace, Justice and Strong Institutions (Interaction / Score / Evidence / Agreement / Confidence) | 17 Partnerships for the Goals (Interaction / Score / Evidence / Agreement / Confidence) |
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| **Forest** | **Reduced Deforestation, REDD+** | **Opportunities for Women (5.1/5.5)**<br>↑/↓ [+1,-1] 🕮 ☺ ★<br>Women have been less involved in REDD+ initiative (pilot project) design decisions and processes than men. Girls and women have an important role in forestry activities, related to fuel-wood, forest-food and pharmaceutical. Their empowerment contributes to sustainable forestry as well as reducing inequality .<br>Brown, 2011; Larson et al., 2014; Katila et al., 2017 | **Reduced Inequality, Empowerment and Inclusion (10.1/10.2/10.3/10.4)**<br>↑ [+2] 🕮 ☺ ★<br>Urges developed countries to support, through multilateral and bilateral channels, the development of REDD+ national strategies or action plans and implementation . Girls and women have an important role in forestry activities, related to fuel-wood, forest-food and medicine. Their empowerment contributes to sustainable forestry as well as reducing inequality .<br>Bastos Lima et al., 2017; Katila et al., 2017 | **Build Effective, Accountable and Inclusive Institutions, Responsible Decision-making (16.6/16.7/16.8)**<br>↑ [+2] 🕮🕮 ☺☺☺ ★★★<br>Institutional building (National Forest Monitoring Systems, Safeguard Information Systems, etc.), with full and effective participation of all relevant countries . REDD+ actions also deliver non-carbon benefits (e.g. local socioeconomic benefits, governance improvements). Forest governance is another central aspect in recent studies, including the debate on decentralization of forest management, logging concessions in public-owned commercially valuable forests and timber certification, primarily in temperate forests .<br>Bustamante et al., 2014; Bastos Lima et al., 2015, 2017 | **Resource Mobilization and Strengthen Multi-stakeholder Partnership (17.1/ 17.3/17.5/17.17)**<br>↑/↓ [+1,-1] 🕮 ☺ ★<br>To provide finance and technology to developing countries to support emissions reductions. Be supported by adequate and predictable financial and technology support, including support for capacity building . Partnerships in the form of significant aid money from, e.g., Norway, other bilateral donors and the World Bank's Forest Carbon Partnership Facility (FCPF) are forthcoming . Estimates of opportunity cost for REDD+ are very low. Lower costs and/or higher carbon prices could combine to protect more forests, including those with lower carbon content. Conversely, where the cost of action is high, a large amount of additional funding would be required for the forest to be protected (Miles and Kapos, 2008). Forest governance is another central aspect in recent studies, including debate on decentralization of forest management, logging concessions in public-owned commercially valuable forests and timber certification, primarily in temperate forests . Partnerships between local forest managers, community enterprises and private sector companies can support local economies and livelihoods and boost regional and national economic growth .<br>Miles and Kapos, 2008; Bustamante et al., 2014; Andrew, 2017; Bastos Lima et al., 2017; Katila et al., 2017 |
| | **Afforestation and Reforestation** | **Opportunities for Women (5.1/5.5)**<br>↑ [+1] 🕮 ☺ ★<br>Many women in developing countries are already prominently engaged in economic sectors related to climate adaptation and mitigation efforts such as agriculture, renewable energy and forest management and are important drivers and leaders in climate responses that are innovative and effective, benefitting not only their families but also their wider communities. Women's participation in the decision-making process of forest management, for example, has been shown to increase rates of reforestation while decreasing the illegal extraction of forest products.<br>UN-Women et al., 2015 | **Empower Economic and Political Inclusion of All, Irrespective of Sex (10.2)**<br>↑ [+1] 🕮 ☺ ★<br>Women's participation in the decision-making process of forest management, for example, has been shown to increase rates of reforestation while decreasing the illegal extraction of forest products.<br>UN-Women et al., 2015 | **Responsible Decision-making (16.7)**<br>↑ [+1] 🕮 ☺ ★<br>Land-related mitigation, such as biofuel production, as well as conservation and reforestation action can increase competition for land and natural resources, so these measures should be accompanied by complementary policies. (Quoted from Epstein and Theur, 2017)<br>Epstein and Theuer, 2017 | **Resource Mobilization and Strengthen Partnership (17.1/17.14)**<br>↑ [+2] 🕮🕮 ☺☺ ★★<br>Financing at the national and international level is required to grow more seedlings/sapling, restore land, create awareness and education factsheets, provide training to local communities regarding the benefits of afforestation and reforestation. Article 12 of the Kyoto Protocol further sets a Clean Development Mechanism through which countries in Annex I earn 'certified emissions reductions' through projects implemented in developing countries (Montanarella and Alva, 2015). Afforestation and reforestation in India are being carried out under various programmes, namely social forestry initiated in the early 1980s, the Joint Forest Management Programme initiated in 1990, afforestation under National Afforestation and Eco-development Board programmes since 1992, and private farmer and industry initiated plantation forestry. If the current rate of afforestation and reforestation is assumed to continue, the carbon stock could increase by 11% by 2030 (Ravindranath et al., 2008).<br>Ravindranath et al., 2008; Kibria, 2015; Montanarella and Alva, 2015 |
| | **Behavioural Response (Responsible Sourcing)** | [0]<br>No direct interaction | [0]<br>No direct interaction | **Responsible Decision-making (16.7)**<br>↑ [+1] 🕮🕮 ☺☺ ★★<br>Indonesian factories may seek advantages through non-price competition—perhaps by highlighting decent working conditions or the existence of a union—or to see trade associations or government agencies promoting the country as a responsible sourcing location (Bartley, 2010). In the absence of domestic legal instruments providing incentives to improve sustainability of sourcing, it appears that initiatives to engage the major importing enterprises in developing responsible sourcing practices and policies is a practical approach. Unless initiatives involve all the major importers, they are unlikely to be successful since the high costs associated with accreditation would increase production costs for these firms relative to their competitors (Huang et al., 2013).<br>Bartley, 2010; Huang et al., 2013 | **Finance and Trade (17.1/17.10)**<br>↑ [+1] 🕮🕮 ☺☺ ★★<br>Private certification initiatives for wood product and biomass sourcing may extend their schemes with criteria for 'leakage' (external GHG effects). Also recycling of waste wood in pellets is not yet practiced, due to unclear rules in the EU Waste Directive about overseas shipping (Sikkema et al., 2014). Engagement of Chinese government and private sector stakeholders in supply-country sustainability initiatives may be the best way to support this gradual process of improvement. Although carrying out due diligence in timber sourcing can require considerable internal resources, it may be substantially less of a financial burden than the potential fines and reputational damage resulting from sourcing unknown or controversial timber (Huang et al., 2013).<br>Huang et al., 2013; Sikkema et al., 2014 |

*Social 2-Other (continued)*

| | | 5 Gender Equality | | | | | 10 Reduced Inequalities | | | | | 16 Peace, Justice and Strong Institutions | | | | | 17 Partnerships for the Goals | | | | |
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| | | Interaction | Score | Evidence | Agreement | Confidence | Interaction | Score | Evidence | Agreement | Confidence | Interaction | Score | Evidence | Agreement | Confidence | Interaction | Score | Evidence | Agreement | Confidence |
| **Oceans** | **Ocean Iron Fertilization** | | [0] | No direct interaction | | | | [0] | No direct interaction | | | | [0] | No direct interaction | | | | [0] | No direct interaction | | |
| | **Blue Carbon** | | [0] | No direct interaction | | | | [0] | No direct interaction | | | | [0] | No direct interaction | | | | [0] | No direct interaction | | |
| | **Enhanced Weathering** | | [0] | No direct interaction | | | | [0] | No direct interaction | | | | [0] | No direct interaction | | | | [0] | No direct interaction | | |

*Environment-Demand*

| Sector | Option | SDG 6 Clean Water and Sanitation (Interaction / Score / Evidence / Agreement / Confidence) | SDG 12 Responsible Consumption and Production (Interaction / Score / Evidence / Agreement / Confidence) | SDG 14 Life Below Water (Interaction / Score / Evidence / Agreement / Confidence) | SDG 15 Life on Land (Interaction / Score / Evidence / Agreement / Confidence) |
|---|---|---|---|---|---|
| Industry | Accelerating Energy Efficiency Improvement | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑/↓ / [+2,-1] / 🕮🕮 / ☺☺ / ★★<br>Efficiency and behavioural changes in the industrial sector that lead to reduced energy demand can lead to reduced requirements on energy supply. As water is used to convert energy into useful forms, the reduction in industrial demand is anticipated to reduce water consumption and waste water, resulting in more clean water for other sectors and the environment. Likewise, reducing material inputs for industrial processes through efficiency and behavioural changes will reduce water inputs in the material supply chains. In extractive industries there can be a trade-off with production unless strategically managed.<br>Vassolo and Döll, 2005; Nguyen et al., 2014; Holland et al., 2015; Fricko et al., 2016 | **Sustainable and Efficient Resource (12.2/12.5/12.6/12.7/12.a)**<br>↑ / [+1] / 🕮🕮🕮 / ☺☺☺ / ★★★<br>Once started leads to chain of actions within the sector and policy space to sustain the effort. Helps in expansion of sustainable industrial production (Ghana).<br>Apeaning and Thollander, 2013; Fernando et al., 2017 | [0]<br>No direct interaction | [0]<br>No direct interaction |
| Industry | Low-carbon Fuel Switch | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑/↓ / [+2,-2] / 🕮🕮 / ☺☺ / ★★★<br>A switch to low-carbon fuels can lead to a reduction in water demand and waste water if the existing higher-carbon fuel is associated with a higher water intensity than the lower-carbon fuel. However, in some situations the switch to a low-carbon fuel such as, for example, biofuel could increase water use compared to existing conditions if the biofuel comes from a water-intensive feedstock.<br>Hejazi et al., 2015; Fricko et al., 2016; Song et al., 2016 | **Sustainable Production (12.2/12.3/12.a)**<br>↑ / [+2] / 🕮🕮🕮🕮 / ☺☺☺☺ / ★★★★<br>A circular economy instead of linear global economy can achieve climate goals and can help in economic growth through industrialization which saves on resources, the environment and supports small, medium and even large industries, and can lead to employment generation. So new regulations, incentives and a tax regime can help in achieving the goal, especially in newly emerging developing countries - although also applicable for large industrialized countries.<br>Liu and Bai, 2014; Lieder and Rashid, 2016; Stahel, 2016; Supino et al., 2016; Fan et al., 2017; Shi et al., 2017; Zeng et al., 2017 | [0]<br>No direct interaction | **Sustainable Production (15.1/15.5/15.9/15.10)**<br>↑ / [+1,-1] / 🕮 / ☺ / ★<br>A circular economy help in managing local biodiversity better by having less resource use footprint<br>Shi et al., 2017 |
| Industry | Decarbonisation/CCS/CCU | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑/↓ / [+1,-1] / 🕮🕮🕮 / ☺ / ★★<br>CCU/S requires access to water for cooling and processing which could contribute to localized water stress. CCS/U processes can potentially be configured for increased water efficiency compared to a system without carbon capture via process integration.<br>Meldrum et al., 2013; Byers et al., 2016; Fricko et al., 2016; Brandl et al., 2017 | **Sustainable Production and Consumption (12.1/12.6/12.a)**<br>↑ / [+2] / 🕮 / ☺☺☺☺ / ★★★★<br>EPI plants are capital intensive and are mostly operated by multinationals with long investment cycles. In developed countries new investments are happening in brown fields, while in developing countries these are in green fields. Collaboration among partners and user demand change, policy change is essential for encouraging these large risky investments.<br>Wesseling et al., 2017 | **Conserve and Sustainably Use Ocean (14.1/14.5)**<br>↓ / [-1] / 🕮 / ☺ / ★<br>CCU/S in the chemical industry faces challenges for transport costs and storage. In the UK cluster region have been identified for storage under sea.<br>Griffin et al., 2018 | [0]<br>No direct interaction |

*Environment-Demand (continued)*

Each SDG column has the sub-columns Interaction | Score | Evidence | Agreement | Confidence.

| | | SDG 6 Clean Water and Sanitation | SDG 12 Responsible Consumption and Production | SDG 14 Life Below Water | SDG 15 Life on Land |
|---|---|---|---|---|---|
| Buildings | Behavioural Response | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑ [+2] 📖📖 ☺☺☺ ★★★<br>Behavioural changes in the residential sector that lead to reduced energy demand can lead to reduced requirements on energy supply. As water is used to convert energy into useful forms, the reduction in residential demand is anticipated to reduce water consumption and waste water, resulting in more clean water for other sectors and the environment.<br>Bartos and Chester (2014); Fricko et al. (2016); Holland et al. (2016) | **Responsible and Sustainable Consumption**<br>↑ [+2] 📖📖📖 ☺☺☺ ★★★<br>Technological improvements alone are not sufficient to increase energy savings. Zhao et al. (2017) found that building technology and occupant behaviours interact with each other and finally affect energy consumption from home. They found that occupant habits could not take advantage of more than 50% of energy efficiency potential allowed by an efficient building. In the electronic segment, product obsolescence represents a key challenge for sustainability. Echegaray (2016) discusses the dissonance between consumers' product durability experience, orientations to replace devices before terminal technical failure, and perceptions of industry responsibility and performance. The results from their urban sample survey indicate that technical failure is far surpassed by subjective obsolescence as a cause for fast product replacement. At the same time Liu et al. (2017) suggest that we need to go beyond individualist and structuralist perspectives to analyse sustainable consumption (i.e., combines both human agency paradigm and social structural perspective).<br>Sweeney et al., 2013; Webb et al., 2013; Allen et al., 2015; Echegaray (2015); He et al., 2016; Hult and Larsson, 2016; Isenhour and Feng, 2016; van Sluisveld et al., 2016; Zhao et al., 2017; Liu et al., 2017; Sommerfeld et al., 2017 | [0]<br>No direct interaction | [0]<br>No direct interaction |
| | Accelerating Energy Efficiency Improvement | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑ [+2] 📖📖📖 ☺☺☺ ★★★<br>Efficiency changes in the residential sector that lead to reduced energy demand can lead to reduced requirements on energy supply. As water is used to convert energy into useful forms, the reduction in residential demand is anticipated to reduce water consumption and waste water, resulting in more clean water for other sectors and the environment. A switch to low-carbon fuels in the residential sector can lead to a reduction in water demand and waste water if the existing higher-carbon fuel is associated with a higher water intensity than the lower-carbon fuel. However, in some situations the switch to a low-carbon fuel such as, for example, biofuel could increase water use compared to existing conditions if the biofuel comes from a water-intensive feedstock. As water is used to convert energy into useful forms, energy efficiency is anticipated to reduce water consumption and waste water, resulting in more clean water for other sectors and the environment. Subsidies for renewables are anticipated to lead to the benefits and trade-offs outlined when deploying renewables. Subsidies for renewables could lead to improved water access and treatment if subsidies support projects that provide both water and energy services (e.g., solar desalination).<br>Bilton et al., 2011; Scott, 2011; Kumar et al., 2012; Meldrum et al., 2013; Bartos and Chester, 2014; Hendrickson and Horvath, 2014; Kern et al., 2014; Holland et al., 2015; Fricko et al., 2016; Kim et al., 2017 | **Sustainable Practices and Lifestyles (12.6/12.7/12.8)**<br>↑ [+1] 📖📖📖 ☺☺☺ ★★★<br>Sustainable practices adopted by public and private bodies in their operations (e.g., for goods procurement, supply chain management and accounting) create an enabling environment in which renewable energy and energy efficiency measures may gain greater traction (McCollum et al., 2018).<br>Stefan and Paul, 2008; ECF, 2014; CDP, 2015; Khan et al., 2015; NCE, 2015; McCollum et al., 2018 | [0]<br>No direct interaction | **Reduced Deforestation (15.2)**<br>↑ [+2] 📖📖 ☺☺☺ ★★★<br>Improved stoves has helped halt deforestation in rural India.<br>Bhojvaid et al., 2014 |

*Environment-Demand (continued)*

| Sector | Measure | SDG 6<br>Interaction \| Score \| Evidence \| Agreement \| Confidence | SDG 12<br>Interaction \| Score \| Evidence \| Agreement \| Confidence | SDG 14<br>Interaction \| Score \| Evidence \| Agreement \| Confidence | SDG 15<br>Interaction \| Score \| Evidence \| Agreement \| Confidence |
|---|---|---|---|---|---|
| **Buildings** | **Improved Access and Fuel Switch to Modern Low-carbon Energy** | **Access to Improved Water and Sanitation (6.1/6.2), Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑ / ↓ \| [+2,-1] \| 📖📖 \| ☺☺ \| ★★★<br>A switch to low-carbon fuels in the residential sector can lead to a reduction in water demand and waste water if the existing higher-carbon fuel is associated with a higher water intensity than the lower-carbon fuel. However, in some situations the switch to a low-carbon fuel such as, for example, biofuel could increase water use compared to existing conditions if the biofuel comes from a water-intensive feedstock. Improved access to energy can support clean water and sanitation technologies. If energy access is supported with water-intensive energy sources, there could be trade-offs with water efficiency targets.<br>Hejazi et al., 2015; Cibin et al., 2016; Fricko et al., 2016; Song et al., 2016; Rao and Pachauri, 2017 | **Sustainable Use and Management of Natural Resource (12.2)**<br>↑ / ↓ \| [+2,-1] \| 📖📖 \| ☺☺ \| ★★★<br>A switch to low-carbon fuels in the residential sector can lead to a reduction in water demand and waste water if the existing higher-carbon fuel is associated with a higher water intensity than the lower-carbon fuel. However, in some situations the switch to a low-carbon fuel such as, for example, biofuel could increase water use compared to existing conditions if the biofuel comes from a water-intensive feedstock. Improved access to energy can support clean water and sanitation technologies. If energy access is supported with water-intensive energy sources, there could be trade-offs with water efficiency targets.<br>Hejazi et al., 2015; Cibin et al., 2016; Fricko et al., 2016; Song et al., 2016; Rao and Pachauri, 2017 | [0]<br>No direct interaction | **Healthy Terrestrial Ecosystems (15.1/15.2/15.4/15.5/15.8)**<br>↑ \| [+2] \| 📖📖 \| ☺☺☺ \| ★★★<br>Ensuring that the world's poor have access to modern energy services would reinforce the objective of halting deforestation, since firewood taken from forests is a commonly used energy resource among the poor (McCollum et al., 2018).<br>Bazilian et al., 2011; Karekezi et al., 2012; Bailis et al., 2015; Winter et al., 2015; McCollum et al., 2018 |
| **Transport** | **Behavioural Response** | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑ \| [+2] \| 📖📖 \| ☺☺ \| ★★<br>Behavioural changes in the transport sector that lead to reduced transport demand can lead to reduced transport energy supply. As water is used to produce a number of important transport fuels, the reduction in transport demand is anticipated to reduce water consumption and waste water, resulting in more clean water for other sectors and the environment.<br>Vidic et al., 2013; Holland et al., 2015; Fricko et al., 2016; Tiedeman et al., 2016 | **Ensure Sustainable Consumption amd Production Patterns (12.3)**<br>↑ \| [+2] \| 📖📖 \| ☺☺ \| ★★<br>Urban carbon mitigation must consider the supply chain management of imported goods, the production efficiency within the city, the consumption patterns of urban consumers, and the responsibility of the ultimate consumers outside the city. Important for climate policy of monitoring the $CO_2$ clusters that dominate $CO_2$ emissions in global supply chains, because they offer insights on where climate policy can be effectively directed.<br>Kagawa et al., 2015; Lin et al., 2015; Creutzig et al., 2016 | [0]<br>No direct interaction | [0]<br>No direct interaction |
| **Transport** | **Accelerating Energy Efficiency Improvement** | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑ \| [+2] \| 📖📖📖 \| ☺☺☺ \| ★★★<br>Similar to behavioural changes, efficiency measures in the transport sector that lead to reduced transport demand can lead to reduced transport energy supply. As water is used to produce a number of important transport fuels, the reduction in transport demand is anticipated to reduce water consumption and waste water, resulting in more clean water for other sectors and the environment.<br>Vidic et al., 2013; Holland et al., 2015; Fricko et al., 2016; Tiedeman et al., 2016 | **Sustainable Consumption (12.2/12.8)**<br>↑ \| [+2] \| 📖📖📖 \| ☺☺☺ \| ★★★<br>Relational complex transport behaviour resulting in significant growth in energy-inefficient car choices, as well as differences in mobility patterns (distances driven, driving styles) and actual fuel consumption between different car segments all affect non-progress on transport decarbonization. Consumption choices and individual lifestyles are situated and tied to the form of the surrounding urbanization. Major behavioural changes and emissions reductions require understanding of this relational complexity, consideration of potential interactions with other policies, and the local context and implementation of both command-and-control as well as market-based measures.<br>Stanley et al., 2011; Gallego et al., 2013; Heinonen et al., 2013; Aamaas and Peters, 2017; Azevedo and Leal, 2017; Gössling and Metzler, 2017 | [0]<br>No direct interaction | [0]<br>No direct interaction |

*Environment-Demand (continued)*

| | | Interaction | Score | Evidence | Agreement | Confidence | Interaction | Score | Evidence | Agreement | Confidence | Interaction | Score | Evidence | Agreement | Confidence | Interaction | Score | Evidence | Agreement | Confidence |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Transport** | **Improved Access and Fuel Switch to Modern Low-carbon Energy** | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)** | | | | | **Ensure Sustainable Consumption and Production Patterns (12.3)** | | | | | | | | | | | | | | |
| | | ↑ / ↓ | [+2,-1] | 🕮🕮 | ☺☺ | ★★★ | ↑ | [+2] | 🕮🕮🕮 | ☺☺☺ | ★★★ | | [0] | | | | | [0] | | | |
| | | A switch to low-carbon fuels in the transport sector can lead to a reduction in water demand and waste water if the existing higher-carbon fuel is associated with a higher water intensity than the lower-carbon fuel. However, in some situations the switch to a low-carbon fuel such as, for example, biofuel could increase water use compared to existing conditions if the biofuel comes from a water-intensive feedstock. Transport electrification could lead to trade-offs with water use if the electricity is provided with water intensive power generation. | | | | | Due to persistent reliance on fossil fuels, it is posited that transport is more difficult to decarbonize than other sectors. This study partially confirms that transport is less reactive to a given carbon tax than the non-transport sectors: in the first half of the century, transport mitigation is delayed by 10–30 years compared to non-transport mitigation. The extent to which earlier mitigation is possible strongly depends on implemented technologies and model structures. | | | | | No direct interaction | | | | | No direct interaction | | | | |
| | | Hejazi et al., 2015; Fricko et al., 2016; Song et al., 2016 | | | | | Figueroa et al., 2014; IPCC, 2014; Pietzcker et al., 2014; Creutzig et al., 2015 | | | | | | | | | | | | | | |

*Environement-Supply*

| | | SDG 6 | SDG 12 | SDG 14 | SDG 15 |
|---|---|---|---|---|---|
| | | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence |
| **Replacing Coal** | **Non-biomass Renewables - solar, wind hydro** | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)/ Access to Improved Water and Sanitation (6.1/6.2)**<br>↑ / ↓ [+2,-2] 📖📖📖📖📖 ☺☺☺☺ ★★★★<br>Wind/solar renewable energy technologies are associated with very low water requirements compared to existing thermal power plant technologies. Widespread deployment is therefore anticipated to lead to improved water efficiency and avoided thermal pollution. However, managing wind and solar variability can increase water use at thermal power plants and can cause poor water quality downstream from hydropower plants. Access to distributed renewables can provide power to improve water access, but could also lead to increased groundwater pumping and stress if mismanaged. Developing dams to support reliable hydropower production can fragment rivers and alter natural flows reducing water and ecosystem quality. Developing dams to support reliable hydropower production can result in disputes for water in basins with up- and down-stream users. Storing water in reservoirs increases evaporation, which could offset water conservation targets and reduce availability of water downstream. However, hydropower plays an important role in energy access for water supply in developing regions, can support water security, and has the potential to reduce water demands if used without reservoir storage to displace other water intensive energy processes.<br>Bilton et al., 2011; Scott et al., 2011; Kumar et al., 2012; Ziv et al., 2012; Meldrum et al., 2013; Kern et al., 2014; Grill et al., 2015; Fricko et al., 2016; Grubert, 2016; De Stefano et al., 2017 | **Natural Resource Protection (12.2/12.3/12.4/12.5)**<br>↑ [+2] 📖📖📖 ☺☺☺ ★★★★<br>Renewable energy and energy efficiency slow the depletion of several types of natural resources, namely coal, oil, natural gas and uranium. In addition, the phasing-out of fossil fuel subsidies encourages less wasteful energy consumption; but if that is done, then the policies implemented must take care to minimize any counteracting adverse side-effects on the poor (e.g., fuel price rises). (Quote from McCollum et al., 2018)<br>Banerjee et al., 2012; Riahi et al., 2012; Schwanitz et al., 2014; Bhattacharyya et al., 2016; Cameron et al., 2016; McCollum et al., 2018 | **Marine Economies (14.7)/ Marine Protection (14.1/14.2/14.4/14.5)**<br>↑ / ↓ [2,-1] 📖📖 ☺☺☺ ★★★<br>Ocean-based energy from renewable sources (e.g., offshore wind farms, wave and tidal power) are potentially significant energy resource bases for island countries and countries situated along coastlines. Multi-use platforms combining renewable energy generation, aqua-culture, transport services and leisure activities can lay the groundwork for more diversified marine economies. Depending on the local context and prevailing regulations, ocean-based energy installations could either induce spatial competition with other marine activities, such as tourism, shipping, resources exploitation, and marine and coastal habitats and protected areas, or provide further grounds for protecting those exact habitats, therefore enabling marine protection. (Quote from McCollum et al., 2018) Hydropower disrupts the integrity and connectivity of aquatic habitats and impacts the productivity of inland waters and their fisheries.<br>Inger et al., 2009; Michler-Cieluch et al., 2009; Buck and Krause, 2012; WBGU, 2013; Cooke et al., 2016; Matthews and McCartney, 2018; McCollum et al., 2018 | **Healthy Terrestrial Ecosystems (15.1/15.2/15.4/15.5/15.8)**<br>↓ [-1] 📖📖📖 ☺☺☺ ★★★<br>Landscape and wildlife impact for wind; habitat impact for hydropower.<br>Alho, 2011; Garvin et al., 2011; Grodsky et al., 2011; Jain et al., 2011; Kumar et al., 2011; Kunz et al., 2011; Wiser et al., 2011; Dahl et al., 2012; de Lucas et al., 2012; Ziv et al., 2012; Lovich and Ennen, 2013; Smith et al., 2013; Matthews and McCartney, 2018 |
| | **Increased Use of Biomass** | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑ / ↓ [+1,-2] 📖📖📖📖 ☺☺ ★★★★<br>Biomass expansion could lead to increased water stress when irrigated feedstocks and water-intensive processing steps are used. Bioenergy crops can alter flow over land and through soils as well as require fertilizer, and this can reduce water availability and quality. Planting bioenergy crops on marginal lands or in some situations to replace existing crops can lead to reductions in soil erosion and fertilizer inputs, improving water quality.<br>Hejazi et al., 2015; Bonsch et al., 2016; Cibin et al., 2016; Song et al., 2016; Gao and Bryan, 2017; Griffiths et al., 2017; Ha and Wu, 2017; Taniwaki et al., 2017; Woodbury et al., 2018 | **Natural Resource Protection (12.2/12.3/12.4/12.5)**<br>↑ [+2] 📖📖📖 ☺☺☺ ★★★★<br>Switching to renewable energy reduces the depletion of finite natural resources.<br>Banerjee et al., 2012; Riahi et al., 2012; Schwanitz et al., 2014; Bhattacharyya et al., 2016; Cameron et al., 2016; McCollum et al., 2018 | [0]<br>No direct interaction | **Healthy Terrestrial Ecosystems (15.1/15.2/15.4/15.5/15.8)**<br>↑ / ↓ [+1,-2] 📖 ☺☺☺ ★★<br>Protecting terrestrial ecosystems, sustainably managing forests, halting deforestation, preventing biodiversity loss and controlling invasive alien species could potentially clash with renewable energy expansion, if that would mean constraining large-scale utilization of bioenergy or hydropower. Good governance, cross-jurisdictional coordination and sound implementation practices are critical for minimizing trade-offs (McCollum et al., 2018).<br>Smith et al., 2010, 2014; Acheampong et al., 2017; McCollum et al., 2018 |

*Environement-Supply (continued)*

| | | SDG 6 (Interaction / Score / Evidence / Agreement / Confidence) | SDG 12 (Interaction / Score / Evidence / Agreement / Confidence) | SDG 14 (Interaction / Score / Evidence / Agreement / Confidence) | SDG 15 (Interaction / Score / Evidence / Agreement / Confidence) |
|---|---|---|---|---|---|
| **Replacing Coal** | **Nuclear/Advanced Nuclear** | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑/↓ [+2,-1] &&& JJJ «««<br>Nuclear power generation requires water for cooling which can lead to localized water stress and the resulting cooling effluents can cause thermal pollution in rivers and oceans.<br>Webster et al., 2013; Holland et al., 2015; Fricko et al., 2016; Raptis et al., 2016 | [0]<br>No direct interaction | [0]<br>No direct interaction | **Healthy Terrestrial Ecosystems (15.1/15.2/15.4/15.5/15.8)**<br>↓ [-1] && JJ ««<br>Safety and waste concerns from uranium mining and milling.<br>Bickerstaff et al., 2008; Sjoberg and Sjoberg, 2009; Ahearne, 2011; Corner et al., 2011; Visschers and Siegrist, 2012; IPCC, 2014 |
| | **CCS: Bioenergy** | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑/↓ [+1,-2] 📖📖 ☺ ★★<br>CCU/S requires access to water for cooling and processing which could contribute to localized water stress. However, CCS/U processes can potentially be configured for increased water efficiency compared to a system without carbon capture via process integration. The bioenergy component adds the additional trade-offs associated with bioenergy use. Large-scale bioenergy increases input demand, resulting in environmental degradation and water stress.<br>Meldrum et al., 2013; Byers et al., 2016; Fricko et al., 2016; Brandl et al., 2017; Dooley and Kartha, 2018 | **Natural Resource Protection (12.2/12.3/12.4/12.5)**<br>↑ [+1] 📖📖 ☺☺ ★★<br>Switching to renewable energy reduces the depletion of finite natural resources. On the other hand, the availability of underground storage is limited and therefore reduces the benefits of switching from finite resources to bioenergy.<br>Banerjee et al., 2012; Riahi et al., 2012; Schwanitz et al., 2014; Bhattacharyya et al., 2016; Cameron et al., 2016; McCollum et al., 2018 | [0]<br>No direct interaction | **Healthy Terrestrial Ecosystems (15.1/15.2/15.4/15.5/15.8)**<br>↑/↓ [+1,-2] 📖 ☺☺☺ ★★<br>Protecting terrestrial ecosystems, sustainably managing forests, halting deforestation, preventing biodiversity loss and controlling invasive alien species could potentially clash with renewable energy expansion, if that would mean constraining large-scale utilization of bioenergy or hydropower. Good governance, cross-jurisdictional coordination and sound implementation practices are critical for minimizing trade-offs (McCollum et al., 2018). Large-scale bioenergy increases input demand, resulting in environmental degradation and water stress.<br>Smith et al., 2010, 2014; Acheampong et al., 2017; Dooley and Kartha, 2018, McCollum et al., 2018) |
| **Advanced Coal** | **CCS: Fossil** | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑/↓ [+1,-2] 📖📖📖 ☺ ★★<br>CCU/S requires access to water for cooling and processing which could contribute to localized water stress. However, CCS/U processes can potentially be configured for increased water efficiency compared to a system without carbon capture via process integration. Coal mining to support clean coal CCS will negatively impact water resources due to the associated water demands, waste water and land-use requirements.<br>Meldrum et al., 2013; Byers et al., 2016; Fricko et al., 2016; Brandl et al., 2017 | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction |

Environement-Other

| Sector | Mitigation option | SDG | Target | Interaction | Score | Evidence | Agreement | Confidence | Explanation | References |
|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture and Livestock | Behavioural Response: Sustainable Healthy Diets and Reduced Food Waste | 6 Clean Water and Sanitation | Water Efficiency and Pollution Prevention (6.3/6.4/6.6) | ↑ / ↓ | [+2,-1] | 📖📖📖📖 | ☺☺☺☺ | ★★★★ | Reduced food waste avoids direct water demand and waste water for crops and food processing, and avoids water used for energy supply by reducing agricultural, food processing and waste management energy inputs. Healthy diets will support water efficiency targets if the shift towards healthy foods results in food supply chains that are less water intensive than the supply chains supporting the historical dietary pattern. | Khan et al., 2009; Ingram, 2011; Kummu et al., 2012; Haileselassie et al., 2013; Bajželj et al., 2014; Tilman and Clark, 2014; Walker et al., 2014; Ran et al., 2016 |
| Agriculture and Livestock | Behavioural Response: Sustainable Healthy Diets and Reduced Food Waste | 12 Responsible Consumption and Production | Ensure Sustainable Consumption and Production Patterns, Sustainable Practices and Lifestyle (12.3/12.4/12.6/12.7/12.8) | ↑ | [+2] | 📖📖📖📖 | ☺☺☺☺ | ★★★★ | Reduce loss and waste in food systems, processing, distribution and by changing household habits. To reduce environmental impact of livestock both production and consumption trends in this sector should be traced. Livestock production needs to be intensified in a responsible way (i.e., be made more efficient in the way that it uses natural resources). Wasted food represents a waste of all the emissions generated during the course of producing and distributing that food. Mitigation measures include: eat no more than needed to maintain a healthy body weight; eat seasonal, robust, field-grown vegetables rather than protected, fragile foods prone to spoilage and requiring heating and lighting in their cultivation, refrigeration stage; consume fewer foods with low nutritional value e.g., alcohol, tea, coffee, chocolate and bottled water (these foods are not needed in our diet and need not be produced); shop on foot or over the Internet (reduced energy use). Reduction in food waste will not only pave the path for sustainable production but will also help in achieving sustainable consumption (Garnett, 2011). Reduce meat consumption to encourage more sustainable eating practices. | Stehfest et al., 2009; Steinfeld and Gerber, 2010; Garnett, 2011; Ingram, 2011; Beddington et al., 2012; Kummu et al., 2012; Bellarby et al., 2013; Dagevos and Voordouw, 2013; Smith, 2013; Bajželj et al., 2014; Hedenus et al., 2014; Tilman and Clark, 2014; West et al., 2014; Hiç et al., 2016; Lamb et al., 2016 |
| Agriculture and Livestock | Behavioural Response: Sustainable Healthy Diets and Reduced Food Waste | 14 Life Below Water | | | [0] | | | | No direct interaction | |
| Agriculture and Livestock | Behavioural Response: Sustainable Healthy Diets and Reduced Food Waste | 15 Life on Land | Conservation of Biodiversity and Restoration of Land (15.1/15.5/15.9) | ↑ | [+1] | 📖 | ☺ | ★ | Reducing food waste has secondary benefits like protecting soil from degradation, and decreasing pressure for land conversion into agriculture and thereby protecting biodiversity.<br>The agricultural area that becomes redundant through the dietary transitions can be used for other agricultural purposes such as energy crop production, or will revert to natural vegetation. A global food transition to less meat, or even a complete switch to plant-based protein food, could have a dramatic effect on land use. Up to 2,700 Mha of pasture and 100 Mha of crop land could be abandoned (Quoted from Stehfest et al., 2009) | Stehfest et al., 2009; Kummu et al., 2012 |
| Agriculture and Livestock | Land-based Greenhouse Gas Reduction and Soil Carbon Sequestration | 6 Clean Water and Sanitation | Water Efficiency and Pollution Prevention (6.3/6.4/6.6) | ↑ / ↓ | [+1,-1] | 📖📖📖 | ☺☺ | ★★★ | Soil carbon sequestration can alter the capacity of soils to store water, which impacts the hydrological cycle and could be positive or negative from a water perspective, dependent on existing conditions. CSA enrich linkages across sectors including management of water resources. Minimum tillage systems have been reported to reduce water erosion and thus sedimentation of water courses (Bustamante et al., 2014). | Behnassi et al., 2014; Bustamante et al., 2014; P. Smith et al., 2016b |
| Agriculture and Livestock | Land-based Greenhouse Gas Reduction and Soil Carbon Sequestration | 12 Responsible Consumption and Production | Ensure Sustainable Production Patterns (12.3) | ↑ | [+1] | 📖 | ☺ | ★ | Millet or sorghum yield can double as compared with unimproved land by more than 1 tonne per hectare due to sustainable intensification. An integrated approach to safe applications of both conventional and modern agricultural biotechnologies will contribute to increased yield (Lakshmi et al., 2015). | Campbell et al., 2014; Lakshmi et al., 2015 |
| Agriculture and Livestock | Land-based Greenhouse Gas Reduction and Soil Carbon Sequestration | 14 Life Below Water | | | [0] | | | | No direct interaction | |
| Agriculture and Livestock | Land-based Greenhouse Gas Reduction and Soil Carbon Sequestration | 15 Life on Land | Conservation of Biodiversity and Restoration of Land (15.1/15.5/15.9) | ↑ / ↓ | [+1,-1] | 📖📖📖 | ☺☺☺ | ★★★ | Agricultural intensification can promote conservation of biological diversity by reducing deforestation, and by rehabilitation and restoration of biodiverse communities on previously developed farm or pasture land. However, planting monocultures on biodiversity hot spots can have adverse side-effects, reducing biodiversity. Genetically modified crops reduce demand for cultivated land. Adaptation of integrated landscape approaches can provide various ecosystem services. CSA enrich linkages across sectors including management of land and bio-resources. Land sparing has the potential to be beneficial for biodiversity, including for many species of conservation concern, but benefits will depend strongly on the use of spared land. In addition, high yield farming involves trade-offs and is likely to be detrimental for wild species associated with farm land (Lamb et al., 2016). | Lybbert and Sumner, 2010; Behnassi et al., 2014; Harvey et al., 2014; IPCC, 2014; Lamb et al., 2016) |

*Environement-Other (continued)*

**SDG 6 – Clean Water and Sanitation**

| Sector | Option | Target | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|---|---|
| Agriculture and Livestock | Greenhouse Gas Reduction from Improved Livestock Production and Manure Management Systems | Water Efficiency and Pollution Prevention (6.3/6.4/6.6) | ↑ / ↓ | [+2,-1] | 📖📖📖 | ☺☺☺ | ★★★ | Livestock efficiency measures are expected to reduce water required for livestock systems as well as associated livestock waste water flows. However, efficiency measures that include agricultural intensification could increase water demands locally, leading to increased water stress if the intensification is mismanaged. In scenarios where zero human-edible concentrate feed is used for livestock, freshwater use reduces by 21%. | Haileselassie et al., 2013; Schader et al., 2015; Kong et al., 2016; Ran et al., 2016 |
| Forest | Reduced Deforestation, REDD+ | Water Efficiency and Pollution Prevention (6.3/6.4/6.6) | ↑ / ↓ | [+1,-1] | 📖📖 | ☺☺ | ★★ | Forest management alters the hydrological cycle which could be positive or negative from a water perspective and is dependent on existing conditions. Conservation of ecosystem services indirectly could help countries maintain watershed integrity. Forests provide sustainable and regulated provision and help in water purification. | Zomer et al., 2008; Kibria, 2015; Bonsch et al., 2016; Gao and Bryan, 2017; Griffiths et al., 2017; Katila et al., 2017 |
| Forest | Afforestation and Reforestation | Enhance Water Quality (6.3) | ↑ / ↓ | [+2,-1] | 📖📖📖 | ☺☺☺ | ★★★ | Similar to REDD+, forest management alters the hydrological cycle which could be positive or negative from a water perspective and is dependent on existing conditions. Forest landscape restoration can have a large impact on water cycles. Strategic placement of tree belts in lands affected by dryland salinity can remediate the affected lands by modifying landscape water balances. Watershed scale reforestation can result in the restoration of water quality. Fast-growing species can increase nutrient input and water inputs that can cause ecological damage and alter local hydrological patterns. Reforestation of mixed native species and in carefully chosen sites could increase biodiversity and restore waterways, reducing run-off and erosion (Dooley and Kartha, 2018). | Zomer et al., 2008; Bustamante et al., 2014; Kibria, 2015; Lamb et al., 2016; Dooley and Kartha, 2018 |

**SDG 12 – Responsible Consumption and Production**

| Sector | Option | Target | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|---|---|
| Agriculture and Livestock | Greenhouse Gas Reduction from Improved Livestock Production and Manure Management Systems | Ensure Sustainable Production Patterns and Restructing Taxation (12.3/12c) | ↑ | [+1] | 📖📖 | ☺☺ | ★★ | In the future, many developed countries will see a continuing trend in which livestock breeding focuses on other attributes in addition to production and productivity, such as product quality, increasing animal welfare, disease resistance (Thornton, 2010). Diet composition and quality are key determinants of the productivity and feed-use efficiency of farm animals (Herrero, et al., 2013). Mechanisms for effecting behavioural change in livestock systems need to be better understood by implementing combinations of incentives and taxes simultaneously in different parts of the world (Herrero and Thornton, 2013). Reducing the amount of human-edible crops that are fed to livestock represents a reversal of the current trend of steep increases in livestock production, and especially of monogastrics, so would require drastic changes in production and consumption (Schader et al., 2015). | Thornton, 2010; Herrero and Thornton, 2013; Herrero et al., 2013; Schader et al., 2015 |
| Forest | Reduced Deforestation, REDD+ | Ensure Sustainable Consumption (12.3) | ↑ | [+1] | 📖 | ☺ | ★ | Reduce the human pressure on forests, including actions to address drivers of deforestation. | Bastos Lima et al., 2017 |
| Forest | Afforestation and Reforestation | | | [0] | | | | No direct interaction | |

**SDG 14 – Life Below Water**

| Sector | Option | Target | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|---|---|
| Agriculture and Livestock | Greenhouse Gas Reduction from Improved Livestock Production and Manure Management Systems | | | [0] | | | | No direct interaction | |
| Forest | Reduced Deforestation, REDD+ | | | [0] | | | | No direct interaction | |
| Forest | Afforestation and Reforestation | Marine Economies (14.7)/Marine Protection and Income Generation (14.1/14.2/14.4/14.5) | ↑ | [+2] | 📖 | ☺ | ★ | Mangroves would help to enhance fisheries and tourism businesses. | Kibria, 2015 |

**SDG 15 – Life on Land**

| Sector | Option | Target | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|---|---|
| Agriculture and Livestock | Greenhouse Gas Reduction from Improved Livestock Production and Manure Management Systems | Restoration of Land (15.1) | ↑ | [+1] | 📖 | ☺ | ★ | Grasslands are valuable, but improved management is required as grass accounts for close to 50% of feed use in livestock systems . The scenario with 100% reduction of food-competing-feedstuffs resulted in a 335 Mha decrease in arable land area, which corresponds to a decrease of 22% in arable and 7% in the total agricultural area . | Herrero et al., 2013; Schader et al., 2015 |
| Forest | Reduced Deforestation, REDD+ | Conservation of Biodiversity, Sustainability of Terrestrial Ecosystems (15.2/15.3/15.4/15.5/15.9) | ↑ | [+1] | 📖📖📖 | ☺☺☺ | ★★★ | Policies and programmes for reducing deforestation and forest degradation for rehabilitation and restoration of degraded lands can promote conservation of biological diversity. Reduce the human pressure on forests, including actions to address drivers of deforestation. Efforts by the Government of Zambia to reduce emissions by REDD+ have contributed erosion control, ecotourism and pollination valued at 2.5% of the country's GDP. | Miles and Kapos, 2008; IPCC, 2014; Bastos Lima et al., 2015; Turpie et al., 2015; Epstein and Theuer, 2017; Katila et al., 2017 |
| Forest | Afforestation and Reforestation | Conservation of Biodiversity and Restoration of Land (15.1/15.5/15.9) | ↑ | [+2] | 📖📖📖📖 | ☺☺☺☺ | ★★★★ | Identified large amounts of land (749 Mha) globally as biophysically suitable and meeting the CDM eligibility criteria . Forest landscape restoration can conserve biodiversity and reduce land degradation. Mangroves reduce impacts of disasters (cyclones/storms/floods) acting as live seawalls and enhance forest resources/biodiversity. Forest goal can conserve/restore 3.9–8.8 m ha/year average, 77.2–176.9 m ha in total and 7.7–17.7 m ha /year in 2030 of forest area by 2030 (Wolosin, 2014). Forest and biodiversity conservation, protected area formation and forestry-based afforestation are practices that enhance resilience of forest ecosystems to climate change (IPCC, 2014). Strategic placement of tree belts in lands affected by dryland salinity can remediate the affected lands by modifying landscape water balances and protect livestock. It can restore biologically diverse communities on previously developed farmland . Large-scale restoration is likely to benefit ecosystem service provision, including recreation, biodiversity, conservation and flood mitigation. Reforestation of mixed native species and in carefully chosen sites could increase biodiversity, reducing run-off and erosion . | Zomer et al., 2008; Bustamante et al., 2014; IPCC, 2014; Kibria, 2015; Lamb et al., 2016; Epstein and Theuer, 2017; Dooley and Kartha, 2018 |

*Environement-Other (continued)*

| | | SDG 6 (Interaction / Score / Evidence / Agreement / Confidence) | SDG 12 (Interaction / Score / Evidence / Agreement / Confidence) | SDG 14 (Interaction / Score / Evidence / Agreement / Confidence) | SDG 15 (Interaction / Score / Evidence / Agreement / Confidence) |
|---|---|---|---|---|---|
| **Forest** | **Behavioural Response (Responsible Sourcing)** | **Water Efficiency and Pollution Prevention (6.3/6.4/6.6)**<br>↑/↓ [+2,-1] 🕮 ☺☺ ★★<br>Responsible sourcing will have co-benefits for water efficiency and pollution prevention if the sourcing strategies incorporate water metrics. There is a risk that shifting supply sources could lead to increased water use in another part of the economy. At local levels, forest certification programmes and practicing sustainable forest management provide freshwater supplies.<br>van Oel and Hoekstra, 2012; Launiainen et al., 2014; Hontelez, 2016 | **Ensure Sustainable Production Patterns (12.3)**<br>↑ [+1] 🕮 ☺ ★<br>At local levels, forest certification programmes and practicing sustainable forest management provide the provision of raw materials for a 'low ecological footprint' economy.<br>Hontelez, 2016 | [0]<br>No direct interaction | **Sustainability and Conservation (15.1/15.2/15.3)**<br>↑/↓ [+1,-1] 🕮 ☺ ★<br>At the macro level, forest certification has done little to stem the tide of forest degradation, conversion of forest land to agriculture, and illegal logging—all of which remain serious threats to Indonesian forests (Bartley, 2010). At local levels, forest certification programmes and practicing sustainable forest management help in biodiversity protection.<br>Bartley, 2010; Hontelez, 2016 |
| **Oceans** | **Ocean Iron Fertilization** | [0]<br>No direct interaction | [0]<br>No direct interaction | **Nutrient Pollution, Ocean Acidification, Fish Stocks, MPAs, SISD (14.1/14.3/14.4/14.5/14.7)**<br>↑/↓ [+1,-2] 🕮🕮🕮 ☺☺ ★<br>OIF could exacerbate or reduce nutrient pollution, increase the likelihood of mid-water deoxygenation, increase ocean acidification, might contribute to the rebuilding of fish stocks in producing plankton, therefore generating benefits for SISD, but might also be in conflict with designing MPAs.<br>Gnanadesikan et al., 2003; Jin and Gruber, 2003; Denman, 2008; Lampitt et al., 2008; Smetacek and Naqvi, 2008; Güssow et al., 2010; Oschlies et al., 2010; Trick et al., 2010; Williamson et al., 2012 | [0]<br>No direct interaction |
| | **Blue Carbon** | **Integrated Water Resources Management (6.3/6.5)**<br>↑ [+2] 🕮 ☺ ★<br>Development of blue carbon resources (coastal and marine vegetated ecosystems) can lead to coordinated management of water in coastal areas.<br>Vierros et al., 2015 | [0]<br>No direct interaction | **Ocean Acidification, Nutrient Pollution (14.3/14.1)**<br>↑/~ [+2,0] 🕮 ☺☺☺ ★★★<br>Mangroves could buffer acidification in their immediate vicinity; seaweeds have not been able to mitigate the effect on ocean foraminifera.<br>Pettit et al., 2015; Sippo et al., 2016 | **Conservation of Biodiversity and Restoration of Land (15.1/15.2/15.3/15.4/15.9)**<br>↑ [+3] 🕮 ☺☺☺☺ ★★★★<br>Average difference of 31 mm per year in elevation rates between areas with seagrass and unvegetated areas (case study areas: Scotland, Kenya, Tanzania and Saudi Arabia); mangroves fostering sediment accretion of about 5mm a year.<br>Alongi, 2012; Potouroglou et al., 2017 |
| | **Enhanced Weathering** | [0]<br>No direct interaction | [0]<br>No direct interaction | **Ocean Acidification, Nutrient Pollution (14.3/14.1)**<br>↑/↓ [+2,-1] 🕮🕮🕮 ☺☺☺ ★★★<br>Enhanced weathering (either by spreading lime or quicklime, in combination with CCS, over the ocean or olivine at beaches or the catchment area of rivers) opposes ocean acidification. "End-of-century ocean acidification is reversed under RCP4.5 and reduced by about two-thirds under RCP8.5; additionally, surface ocean aragonite saturation state, a key control on coral calcification rates, is maintained above 3.5 throughout the low latitudes, thereby helping maintain the viability of tropical coral reef ecosystems ." However, marine biology would also be affected, in particular if spreading olivine is used, which works like ocean (iron) fertilization.<br>Köhler et al., 2010, 2013; Hartmann et al., 2013; Paquay and Zeebe, 2013; P. Smith et al., 2016a; Taylor et al., 2016 | **Protect Inland Freshwater Systems (14.1)**<br>↓ [-2] 🕮 ☺ ★<br>Olivine can contain toxic metals such as nickel which could accumulate in the environment or disrupt the local ecosystem by changing the pH of the water (in case of spreading in the catchment area of rivers).<br>Hartmann et al., 2013 |

Economic-Demand

**SDG 7**

| Sector | Measure | Target | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|---|---|
| Industry | Accelerating Energy Efficiency Improvement | Energy Savings (7.1/7.3/7.a/7.b) | ↑ | [+2] | 📖📖📖📖 | ☺☺☺ | ★★★★ | Energy efficiency leads to reduced energy demand and hence energy supply and energy security, reduces import. Positive rebound effect can raise demand but to a very less extent due to low rebound effect in industry sector in many countries and by appropriate mix of industries (China) can maintain energy savings gain. Supplying surplus energy to cities is also happening, proving maintenance culture, switching off idle equipment helps in saving energy (e.g Ghana). | Apeaning and Thollander, 2013; Chakravarty et al., 2013; IPCC, 2014; Karner et al., 2015; Zhang et al., 2015; Li et al., 2016; Fernando et al., 2017; Wesseling et al., 2017 |
| Industry | Low-Carbon Fuel Switch | Sustainable and Modern (7.2/7.a) | ↑ | [+2] | 📖 | ☺ | ★ | Industries are becoming suppliers of energy, waste heat, water and roof tops used for solar energy generation, and therefore helping to reduce primary energy demand. CHP in chemical industries can help in providing surplus power in the grid. | Karner et al., 2015; Griffin et al., 2018 |
| Industry | Decarbonization/CCS/CCU | Affordable and Sustainable Energy Sources | ↑ / ↓ | [+2,-2] | 📖📖 | ☺☺ | ★★ | CCS for EPIs can be incremental, but need additional space and can need additional energy, sometimes compensating for higher efficiency. For example, recirculating blast R furnace and CCS for iron steel means high energy demand; electric melting in glass can mean higher electricity prices; in the paper industry, new separation and drying technologies are key to reducing the energy intensity, allowing for carbon neutral operation in the future; bio-refineries can reduce petro-refineries; DRI in iron and steel with H2 encourages innovation in hydrogen infrastructure; and the chemicals industry also encourage renewable electricity and hydrogen as bio-based polymers can increase biomass price. | Griffin et al., 2017; Wesseling et al., 2017 |

**SDG 8**

| Sector | Measure | Target | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|---|---|
| Industry | Accelerating Energy Efficiency Improvement | Reduces Unemployment (8.2/8.3/8.4/8.5/8.6) | ↑ | [+1] | 📖📖 | ☺☺☺ | ★★★ | Unemployment rate reduction from 25% to 12% in South Africa. Enhances firm productivity and technical and managerial capacity of the employees. New jobs for managing energy efficiency opens up opportunities in energy service delivery sector. | Altieri et al., 2016; Fernando et al., 2017; Johansson and Thollander, 2018 |
| Industry | Low-Carbon Fuel Switch | Economic Growth with Decent Employment (8.1/8.2/8.3/8.4) | ↑ | [+2] | 📖📖📖📖 | ☺☺☺☺ | ★★★★ | The circular economy instead of linear global economy can achieve climate goals and can help in economic growth through industrialization, which saves on resources and the environment and supports small, medium and even large industries, which can lead to employment generation. So new regulations, incentives and a revised tax regime can help in achieving the goal. | Stahel, 2013, 2017; Liu et al., 2014; Leider et al., 2015; Supino et al., 2015; Zheng et al., 2016; Fan et al., 2017; Shi et al., 2017 |
| Industry | Decarbonization/CCS/CCU | Decouple Growth from Environmental Degradation (8.1/8.2/8.4) | ↑ | [+2] | 📖📖 | ☺☺☺ | ★★★ | EPI s are important players for economic growth. Deep decarbonization of EPIs through radical innovation is consistent with well-below 2°C scenarios. | Denis-Ryan et al., 2016; Åhman et al., 2017; Wesseling et al., 2017 |

**SDG 9**

| Sector | Measure | Target | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|---|---|
| Industry | Accelerating Energy Efficiency Improvement | Infrastructure Renewal (9.1/9.3/9.5/9.a) | ↑ | [+1] | 📖📖 | ☺☺ | ★★ | Transitioning to a more renewables-based energy system that is highly energy efficient is well-aligned with the goal of upgrading energy infrastructure and making the energy industry more sustainable. At the same time, infrastructure upgrades in other parts of the economy, such as modernized telecommunications networks, can create the conditions for a successful expansion of renewable energy and energy efficiency measures (e.g., smart metering and demand-side management; McCollum et al., 2018). | Riahi et al., 2012; Apeaning and Thollander, 2013; Goldthau, 2014; Bhattacharyya et al., 2016; Meltzer, 2016; McCollum et al., 2018 |
| Industry | Low-Carbon Fuel Switch | Innovation and New Infrastructure (9.2/9.3/9.4/9.5/9.a) | ↑ | [+2] | 📖📖📖📖 | ☺☺☺☺ | ★★★★ | A circular economy instead of linear global economy is helping new innovation, and infrastructure can achieve climate goals and can help in economic growth through industrialization which saves on resources and the environment and supports small, medium and even large industries, which can lead to employment generation. So new regulations, incentives and revised tax regime can help in achieving the goal. | Stahel, 2013, 2017; Liu et al., 2014; Leider et al., 2015; Supino et al., 2015; Zheng et al., 2016; Fan et al., 2017; Shi et al., 2017 |
| Industry | Decarbonization/CCS/CCU | Innovation and New Infrastructure (9.2/9.4/9.5) | ↑ | [+2] | 📖 | ☺☺☺☺ | ★★★★ | Deep decarbonization through radical technological change in EPI will lead to radical innovations, for example, in completely changing industries' innovation strategies, plants and equipment, skills, production techniques, design, etc. Radical CCS will need new infrastructure to transport $CO_2$. | Denis-Ryan et al., 2016; Åhman et al., 2017; Wesseling et al., 2017; Griffin et al., 2018 |

**SDG 11**

| Sector | Measure | Target | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|---|---|
| Industry | Accelerating Energy Efficiency Improvement | Sustainable Cities (15.6/15.8/15.9) | ↑ | [+2] | 📖 | ☺ | ★ | Industries are becoming suppliers of energy, waste heat and water to neighbourial human settlements, and therefore there is a reduced primary energy demand, which also makes towns and cities grow sustainably. | Karner et al., 2015 |
| Industry | Low-Carbon Fuel Switch | Sustainable Cities (15.6/15.8/15.9) | ↑ | [+2] | 📖 | ☺ | ★ | Industries are becoming suppliers of energy, waste heat, water and roof tops used for solar energy generation, and supply to neighbourial human settlements, therefore reducing primary energy demand, which also makes towns and cities grow sustainably. | Karner et al., 2015 |
| Industry | Decarbonization/CCS/CCU | | | [0] | | | | No direct interaction | |

*Economic-Demand (continued)*

| Sector | Measure | SDG 7 (Interaction / Score / Evidence / Agreement / Confidence) | SDG 8 (Interaction / Score / Evidence / Agreement / Confidence) | SDG 9 (Interaction / Score / Evidence / Agreement / Confidence) | SDG 11 (Interaction / Score / Evidence / Agreement / Confidence) |
|---|---|---|---|---|---|
| Buildings | Behavioural Response | **Saving Energy, Improvement in Energy Efficiency (7.3/7.a/7.b)**<br>↑ \| [+2] \| 📖📖📖📖 \| ☺☺☺☺ \| ★★★<br>Lifestyle change measures and adoption behaviour affect residential energy use and implementation of efficient technologies as residential HVAC systems. Also, social influence can drive energy savings in users exposed to energy consumption feedback. Effect of autonomous motivation on energy savings behaviour is greater than that of other more established predictors, such as intentions, subjective norms, perceived behavioural control and past behaviour. Use of a hybrid engineering approach using social psychology and economic behaviour models are suggested for residential peak electricity demand response. However, some take-back in energy savings can happen due to rebound effects unless managed appropriately or accounted for welfare improvement. Adjusting thermostats helps in saving energy. Uptake of energy efficient appliances by households with an introduction to appliance standards, training, promotional material dissemination and the desire to save on energy bills are helping to change acquisition behaviour.<br>Chakravarty et al., 2013; Gyamfi et al., 2013; Hori et al., 2013; Huebner et al., 2013; Jain et al., 2013; Sweeney et al., 2013; Webb et al., 2013; Yue et al., 2013; Anda and Temmen, 2014; Allen et al., 2015; Noonan et al., 2015; de Koning et al., 2016; Isenhour and Feng, 2016; Santarius et al., 2016; Song et al., 2016; van Sluisveld et al., 2016; Sommerfeld et al., 2017; Zhao et al., 2017; Roy et al., 2018 | **Progressively Improve Resource Efficiency (8.4), Employment Opportunities (8.2/8.3/8.5/8.6)**<br>↑ \| [+2] \| 📖 \| ☺ \| ★<br>Behavioural change programmes help in sustaining energy savings through new infrastructure developments.<br>Anda and Temmen, 2014 | **Innovation and New Infrastructure (9.2/9.4/9.5)**<br>↑ \| [+2] \| 📖📖 \| ☺☺ \| ★★<br>Adoption of smart meters and smart grids following community-based social marketing help with infrastructure expansion. People are adopting solar rooftops, white roof/vertical garden/green roofs at much faster rates due to new innovations and regulations.<br>Anda and Temmen, 2014; Roy et al., 2018 | **Sustainable Cities (15.6/15.8/15.9)**<br>↑ \| [+2] \| 📖📖 \| ☺☺ \| ★★<br>Behavioural change programmes help in making cities more sustainable.<br>Anda and Temmen, 2014; Roy et al., 2018 |
| Buildings | Accelerating Energy Efficiency Improvement | **Increase in Energy Savings (7.3)**<br>↑ \| [+2] \| 📖📖📖 \| ☺☺☺ \| ★★★★<br>There is high agreement among researchers based on a great deal of evidence across various countries that energy efficiency improvement reduces energy consumption and therefore leads to energy savings (e.g., efficient stoves save bioenergy). Countries with higher hours of use due to higher ambient temperatures or more carbon intensive electricity grids benefit more from available improvements in energy efficiency and use of refrigerant transition.<br>McLeod et al., 2013; Noris et al., 2013; Bhojvaid et al., 2014; Holopainen et al., 2014; Kwong et al., 2014; Yang et al., 2014; Cameron et al., 2015; Liddell and Guiney, 2015; Shah et al., 2015; Berrueta et al., 2017; Kim et al., 2017; Salvalai et al., 2017 | **Employment Opportunities (8.2/8.3/8.5/8.6)/Strong Financial Institutions (8.10)**<br>↑ / ↓ \| [+2,-1] \| 📖📖 \| ☺ \| ★★<br>Deploying renewables and energy efficient technologies, when combined with other targeted monetary and fiscal policies, can help spur innovation and reinforce local, regional and national industrial and employment objectives. Gross employment effects seem likely to be positive; however, uncertainty remains regarding the net employment effects due to several uncertainties surrounding macro-economic feedback loops playing out at the global level. Moreover, the distributional effects experienced by individual actors may vary significantly. Strategic measures may need to be taken to ensure that a large-scale switch to renewable energy minimizes any negative impacts on those currently engaged in the business of fossil fuels (e.g., government support could help businesses re-tool and workers re-train). To support clean energy and energy efficiency efforts, strengthened financial institutions in developing country communities are necessary for providing capital, credit and insurance to local entrepreneurs attempting to enact change (McCollum et al., 2018).<br>Babiker and Eckaus, 2007; Fankhauser and Tepic, 2007; Gohin, 2008; Frondel et al., 2010; Dinkelman, 2011; Guivarch et al., 2011; Jackson and Senker, 2011; Borenstein, 2012; Creutzig et al., 2013; Blyth et al., 2014; Clarke et al., 2014; Dechezleprêtre and Sato, 2014; Bertram et al., 2015; Johnson et al., 2015; IRENA, 2016; A. Smith et al., 2016; Berrueta et al., 2017; McCollum et al., 2018 | **Innovation and New Infrastructure (9.2/9.4/9.5)**<br>↑ \| [+2] \| 📖📖 \| ☺☺ \| ★★<br>Adoption of smart meters and smart grids following community-based social marketing help in infrastructure expansion. Statutory norms to enhance energy and resource efficiency in buildings is encouraging green building projects.<br>Anda and Temmen, 2014; Roy et al., 2018 | **Urban Environmental Sustainability (11.3/11.6/11.b/11.c)**<br>↑ \| [+2] \| 📖📖 \| ☺☺☺ \| ★★★★<br>Renewable energy technologies and energy efficient urban infrastructure solutions (e.g., public transit) can also promote urban environmental sustainability by improving air quality and reducing noise. Efficient transportation technologies powered by renewably based energy carriers will be a key building block of any sustainable transport system (McCollum et al., 2018). Green buildings help in sustainable construction.<br>Creutzig et al., 2012; Kahn Ribeiro et al., 2012; Riahi et al., 2012; Bongardt et al., 2013; Grubler and Fisk, 2013; Raji et al., 2015; Kim et al., 2017; McCollum et al., 2018 |

*Economic-Demand (continued)*

| Sector | Measure | SDG target | Interaction | Score | Evidence | Agreement | Confidence | Description | References |
|---|---|---|---|---|---|---|---|---|---|
| Buildings | Improved Access and Fuel Switch to Modern Low-carbon Energy | Meeting Energy Demand | ↑ | [+2] | 📖📖📖 | ☺☺☺ | ★★★ | Renewable energies could potentially serve as the main source to meet energy demand in rapidly growing developing country cities. Ali et al. (2015) estimated the potential of solar, wind and biomass renewable energy options to meet part of the electricity demand in Karachi, Pakistan. | Li et al., 2013; Peng and Lu, 2013; Pietzcker, 2013; Pode, 2013; Yanine and Sauma, 2013; Zulu and Richardson, 2013; Connolly et al., 2014; Creutzig et al., 2014; Pietzcker et al., 2014; Ali et al., 2015; O'Mahony and Dufour, 2015; Abanda et al., 2016; Mittlefehldt, 2016; Biligii et al., 2017; Byravan et al., 2017; Islar et al., 2017; Ozturk et al., 2017 |
| Buildings | Improved Access and Fuel Switch to Modern Low-carbon Energy | Sustainable Economic Growth and Employment | ↑ | [+2] | 📖📖 | ☺☺☺ | ★★ | Creutzig et al. (2014) assessed the potential for renewable energies in the European region. They found that a European energy transition with a high-level of renewable energy installations in the periphery could act as an economic stimulus, decrease trade deficits and possibly have positive employment effects. Provision of energy access can play a critical enabling role for new productive activities, livelihoods and employment. Reliable access to modern energy services can have an important influence on productivity and earnings (McCollum et al., 2018). | Grogan and Sadanand, 2013; Pueyo et al., 2013; Rao et al., 2013; Chakravorty et al., 2014; Creutzig et al., 2014; Ali et al., 2015; Bernard and Torero, 2015; Byravan et al., 2017; McCollum et al., 2018 |
| Buildings | Improved Access and Fuel Switch to Modern Low-carbon Energy | Innovation and New Infrastructure (9.2/9.4/9.5) | ↑ | [+2] | 📖📖 | ☺☺ | ★★ | Adoption of smart meters and smart grids following community-based social marketing help in infrastructure expansion. Statutory norms to enhance energy and resource efficiency in buildings is encouraging green building projects. Introduction of incentives and norms for solar rooftops/white/green roofs in cities are helping to accelerate innovation and the expansion of infrastructure. | Roy et al., 2018; Anda and Temmen, 2014 |
| Buildings | Improved Access and Fuel Switch to Modern Low-carbon Energy | Housing (11.1) | ↑ | [+3] | 📖📖📖 | ☺☺☺ | ★★★★ | Ensuring access to basic housing services implies that households have access to modern energy forms. (Quote from McCollum et al., 2018) Solar roof tops in Macau make cities sustainable. Introduction of incentives and norms for solar/white/green rooftops in cities are helping to accelerate the expansion of the infrastructure. | Bhattacharyya et al., 2016; Song et al., 2016; UN, 2016; McCollum et al., 2018; Roy et al., 2018 |
| Transport | Behavioural Response | Energy Savings ( 7.3/7.a/7.b) | ↑ | [+2] | 📖📖 | ☺☺ | ★★ | Behavioural responses will reduce the volume of transport needs and, by extension, energy demand. | Figueroa and Ribeiro, 2013; Ahmad and Puppim de Oliveira, 2016 |
| Transport | Behavioural Response | Promote Sustained, Inclusive Economic Growth (8.3) | ↓ | [-2] | 📖📖📖 | ☺☺☺ | ★★★ | Policy contradictions (e.g., standards, efficient technologies leading to increased electricity prices leading the poor to switch away from clean(er) fuels) and unintended outcomes (e.g., redistribution of income generated by carbon taxes) results in contradictions of the primary aims of (productive) job creation and poverty alleviation, and in trade-offs between mitigation, adaptation and development policies. Detailed assessments of mitigation policies consequences requires developing methods and reliable evidence to enable policymakers to more systematically identify how different social groups may be affected by the different available policy options. | Lucas and Pangbourne, 2014; Suckall et al., 2014; Klausbruckner et al., 2016 |
| Transport | Behavioural Response | Build Resilient Infrastructure (9.1) | ↑ | [+2] | 📖📖 | ☺☺ | ★★ | As people prefer more mass transportation – train lines, tram lines, BRTs, gondola lift systems, bicycle-sharing systems and hybrid buses – and telecommuting, the need for new infrastructure increases. | Dulac, 2013; Aamaas and Peters, 2017; Martínez-Jaramillo et al., 2017; Xylia and Silveira, 2017 |
| Transport | Behavioural Response | Make Cities and Human Settlements Inclusive, Safe, Resilient | ↑ | [+2] | 📖📖 | ☺☺ | ★★ | Climate change threatens to worsen poverty, therefore pro-poor mitigation policies are needed to reduce this threat; for example, investing more and better in infrastructure by leveraging private resources and using designs that account for future climate change and the related uncertainty. | Ahmad and Puppim de Oliveira, 2016; Hallegatte et al., 2016a |
| Transport | Accelerating Energy Efficiency Improvement | Energy Savings ( 7.3/7.a/7.b) | ↑ | [+2] | 📖 | ☺ | ★ | Accelerating efficiency in tourism transport reduces energy demand (China). | Shukxin et al., 2016 |
| Transport | Accelerating Energy Efficiency Improvement | Promote Sustained, Inclusive Economic Growth (8.3) | ↑ / ↓ | [+2,-2] | 📖📖 | ☺☺ | ★★ | Significant opportunities to slow travel growth and improve efficiency exist and, similarly, alternatives to petroleum exist but have different characteristics in terms of availability, cost, distribution, infrastructure, storage and public acceptability. Production of new technologies, fuels and infrastructure can favour economic growth; however, efficient financing of increased capital spending and infrastructure is critical. | Gouldson et al., 2015; Karkatsoulis et al., 2016 |
| Transport | Accelerating Energy Efficiency Improvement | Build Resilient Infrastructure (9.1) | ↑ | [+2] | 📖📖 | ☺☺ | ★★ | Combining promotion of mass transportation – train lines, tram lines, BRTs, gondola lift systems, bicycle-sharing systems and hybrid buses – and telecommuting reduces traffic and significantly contributes to meeting climate targets. A comprehensive package of complementary mitigation options is necessary for deep and sustained emissions reductions. In Sweden, a public bus fleet is aiming more towards decarbonization than efficiency. | Dulac, 2013; Aamaas and Peters, 2017; Martínez-Jaramillo et al., 2017; Xylia and Silveira, 2017 |
| Transport | Accelerating Energy Efficiency Improvement | Make Cities Sustainable (11.2/11.3) | ↑ | [+2] | 📖 | ☺ | ★ | The two most important elements of making cities sustainable are efficient buildings and transport (e.g., Macau). | Song et al., 2016 |
| Transport | Improved Access and Fuel Switch to Modern Low-carbon Energy | Increase Share of Renewable (7.2) | ↑ | [+2] | 📖📖 | ☺☺ | ★★ | Biofuel increases share of the renewables but can perform poorly if too many countries increase their use of biofuel, whereas electrification performs best when many other countries implement this technology. The strategies are not mutually exclusive and simultaneous implementation of some provides synergies for national energy security. Therefore, it is important to consider the results of material and contextual factors that co-evolve. Electric vehicles using electricity from renewables or low carbon sources combined with e-mobility options such as trolley buses, metros, trams and electro buses, as well as promote walking and biking, especially for short distances, need consideration. | Ajanovic, 2015; Månsson, 2016; Alahakoon, 2017; Wolfram et al., 2017 |
| Transport | Improved Access and Fuel Switch to Modern Low-carbon Energy | Promote Sustained, Inclusive Economic Growth (8.3) | ↑ / ↓ | [+2,-2] | 📖📖 | ☺☺ | ★★ | The decarbonization of the freight sector tends to occur in the second part of the century, and the sector decarbonizes by a lower extent than the rest of the economy. Decarbonizing road freight on a global scale remains a challenge even when notable progress in biofuels and electric vehicles has been accounted for. | IPCC, 2014; Creutzig et al., 2015; Carrara and Longden, 2017 |
| Transport | Improved Access and Fuel Switch to Modern Low-carbon Energy | Help Building Inclusive Infrastructure (9.1/9.a) | ↑ | [+2] | 📖📖📖 | ☺☺☺ | ★★★ | Lack of appropriate infrastructure leads to limited access to jobs for the urban poor (Africa, Latin America, India). | Figueroa et al., 2013; Gouldson et al., 2015; Vasconcellos and Mendonça, 2016; Lall et al., 2017 |
| Transport | Improved Access and Fuel Switch to Modern Low-carbon Energy | Make Cities and Human Settlements Inclusive, Safe, Resilient | ↑ | [+2] | 📖📖 | ☺☺ | ★★ | In rapidly growing cities, the carbon savings from investments at scale, in cost-effective low-carbon measures, could be quickly overwhelmed – in as little as 7 years – by the impacts of sustained population and economic growth, highlighting the need to build capacities that enable the exploitation not only of the economically attractive options in the short term but also of those deeper and more structural changes that are likely to be needed in the longer term. With hybrid electric vehicles and plug-in electric vehicles, there is the emergence of new concepts in transportation, such as electric highways. | Figueroa et al., 2013; Gouldson et al., 2015; Vasconcellos and Mendonça, 2016; Alahakoon, 2017 |

*Economic-Supply*

| | | SDG 7: Interaction / Score / Evidence / Agreement / Confidence | SDG 8: Interaction / Score / Evidence / Agreement / Confidence | SDG 9: Interaction / Score / Evidence / Agreement / Confidence | SDG 11: Interaction / Score / Evidence / Agreement / Confidence |
|---|---|---|---|---|---|
| Replacing Coal | Non-biomass Renewables - solar, wind, hydro | **Sustainable and Modern Energy (7.2/7.a)**<br>↑ [+3] 📖📖📖 ☺☺☺ ★★★★<br>Decarbonization of the energy system through an upscaling of renewables will greatly facilitate access to clean, affordable and reliable energy. Hydropower plays an increasingly important role for the global electricity supply. This mitigation option is in line with the targets of SDG7 under the caveat of a transition to modern biomass.<br>Rogelj et al., 2013; Cherian, 2015; Jingura and Kamusoko, 2016 | **Innovation and Growth (8.1/8.2/8.4)**<br>~ [0] 📖📖 ☺☺ ★★<br>Decarbonization of the energy system through an upscaling of renewables and energy efficiency is consistent with sustained economic growth and resource decoupling. Long-term scenarios point towards slight consumption losses caused by a rapid and pervasive expansion of such energy solutions. Whether sustainable growth, as an overarching concept, is attainable or not is more disputed in the literature. Existing literature is also undecided as to whether or not access to modern energy services causes economic growth (McCollum et al., 2018).<br>Jackson and Senker, 2011; Bonan et al., 2014; Clarke et al., 2014; NCE, 2014; OECD, 2017; York and McGee, 2017; McCollum et al., 2018 | **Inclusive and Sustainable Industrialization (9.2/9.4)**<br>~ / ↓ [0,-1] 📖📖 ☺☺☺ ★★<br>A rapid upscaling of renewable energies could necessitate the early retirement of fossil energy infrastructure (e.g., power plants, refineries, pipelines) on a large scale. The implications of this could in some cases be negative, unless targeted policies can help alleviate the burden on industry (McCollum et al., 2018).<br>Fankhaeser et al., 2008; McCollum et al., 2008; Guivarch et al., 2011; Bertram et al., 2015; Johnson et al., 2015 | **Disaster Preparedness and Prevention (11.5)**<br>↑ [+2] 📖📖📖 ☺☺ ★★★<br>Deployment of renewable energy and improvements in energy efficiency globally will aid climate change mitigation efforts, and this, in turn, can help to reduce the exposure of people to certain types of disasters and extreme events (McCollum et al., 2018).<br>Tully, 2006; Riahi et al., 2012; Daut et al., 2013; IPCC, 2014; Hallegatte et al., 2016b; McCollum et al., 2018 |
| Replacing Coal | Increased Use of Biomass | **Sustainable and Modern Energy (7.2/7.a)**<br>↑ [+3] 📖📖📖 ☺☺☺ ★★★<br>Increased use of modern biomass will facilitate access to clean, affordable and reliable energy. This mitigation option is in line with the targets of SDG7.<br>Rogelj et al., 2013; Cherian, 2015; Jingura and Kamusoko, 2016 | **Innovation and Growth (8.1/8.2/8.4)**<br>↑ [+1] 📖 ☺ ★<br>Decarbonization of the energy system through an upscaling of renewables will greatly facilitate access to clean, affordable and reliable energy.<br>Jingura and Kamusoko, 2016 | **Innovation and New Infrastructure (9.2/9.4/9.5)**<br>↑ [+1] 📖📖 ☺☺☺ ★★<br>Access to modern and sustainable energy will be critical to sustain economic growth.<br>Jingura and Kamusoko, 2016; Shahbaz et al., 2016 | [0]<br>No direct interaction |
| Replacing Coal | Nuclear/Advanced Nuclear | **Sustainable and Modern Energy (7.2/7.a)**<br>↑ [1] 📖📖 ☺ ★★<br>Increased use of nuclear power can provide stable baseload power supply and reduce price volatility.<br>IPCC, 2014 | **Innovation and Growth (8.1/8.2/8.4)**<br>↑ [1] 📖📖 ☺ ★★<br>Local employment impact and reduced price volatility.<br>IPCC, 2014 | **Innovation and New Infrastructure (9.2/9.4/9.5)**<br>↓ [-1] 📖📖 ☺☺☺ ★★★<br>Legacy cost of waste and abandoned reactors.<br>Marra and Palmer, 2011; Greenberg et al., 2013; Schwenk-Ferrero, 2013; Skipperud et al., 2013; Tyler et al., 2013; IPCC, 2014 | [0]<br>No direct interaction |
| Replacing Coal | CCS: Bioenergy | **Sustainable and Modern Energy (7.2/7.a)**<br>↑ [+2] 📖📖📖 ☺☺☺ ★★★<br>Increased use of modern biomass will facilitate access to clean, affordable and reliable energy.<br>IPCC, 2014 | **Innovation and Growth (8.1/8.2/8.4)**<br>↑ [+1] 📖 ☺ ★<br>See positive impacts of bioenergy use. | **Innovation and New Infrastructure (9.2/9.4/9.5)**<br>↑ [+1] 📖 ☺ ★<br>See positive impacts of bioenergy use and CCS/CCU in industrial demand. | [0]<br>No direct interaction |
| Advanced Coal | CCS: Fossil | **Ensure energy access and promote investment in new technologies (7.1/7.b)**<br>↑ [+2] 📖📖📖 ☺☺☺ ★★★<br>Advanced and cleaner fossil fuel technology is in line with the targets of SDG7.<br>IPCC, 2014 | **Innovation and Growth (8.1/8.2/8.4)**<br>↓ [-1] 📖📖📖 ☺☺☺ ★★★<br>Lock-in of human and physical capital in the fossil resources industry.<br>IPCC, 2005, 2014; Benson and Cole, 2008; Fankhaeser et al., 2008; Vergragt et al., 2011; Markusson et al., 2012; Shackley and Thompson, 2012; Bertram et al., 2015; Johnson et al., 2015 | **Innovation and New Infrastructure (9.2/9.4/9.5)**<br>↑ [+1] 📖 ☺ ★<br>See positive impacts of CCS/CCU in industrial demand. | [0]<br>No direct interaction |

*Economic-Other*

| | | 7 | 8 | 9 | 11 |
|---|---|---|---|---|---|
| | | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence | Interaction / Score / Evidence / Agreement / Confidence |
| **Agriculture and Livestock** | **Behavioural Response: Sustainable Healthy Diets and Reduced Food Waste** | **Energy Efficiency, Universal Access (7.1/7.3)**<br>↑ [+1] 🕮 ☺ ★<br>Reducing global food supply chain losses have several important secondary benefits like conserving energy.<br>Kummu et al., 2012 | **Sustained and Inclusive Economic Growth (8.2)**<br>↑ [+1] 🕮🕮🕮 ☺☺☺ ★★★<br>23–24% of total cropland and fertilizers are used to produce losses. So reduction in food losses will help to diversify these valuable resources into other productive activities.<br>Kummu et al., 2012; Hiç et al., 2016 | **Infrastructure Building and Promotion of Inclusive Industrialization (9.1/9.2)**<br>↑ [+1] 🕮🕮🕮 ☺☺☺ ★★★<br>By targeting infrastructure, processing and distribution losses, wastage in food systems can be minimized. 23–24% of total cropland and fertilizers are used to produce losses. So reduction in food losses will help to diversify these valuable resources into other productive activities.<br>Ingram, 2011; Beddington et al., 2012; Kummu et al., 2012; Hiç et al., 2016; Lamb et al., 2016 | [0]<br>No interaction |
| | **Land-based Greenhouse Gas Reduction and Soil Carbon Sequestration** | **Sustainable and Modern Energy (7.b)**<br>↑ [+1] 🕮🕮🕮 ☺☺☺ ★★★<br>Conventional agricultural biotechnology methods such as energy efficient farming can help in sequestration of soil carbon. Modern biotechnologies such as green energy and N-efficient GM crops can also help in C-sequestration. Biotech crops allow farmers to use less – and environmentally friendly – energy and practice soil carbon sequestration. Biofuels, both from traditional and GMO crops, such as sugar cane, oilseed, rapeseed and jatropha, can be produced. Green energy programmes through plantations of perennial nonedible oilseed producing plants and production of biodiesel for direct use in the energy sector or blending biofuels with fossil fuels in certain proportions can thereby minimize fossil fuel use. (Quoted from Lakshmi et al., 2015) GM crops reduce demand for fossil fuel-based inputs.<br>Johnson et al., 2007; Sarin et al., 2007; Treasury, 2009; Jain and Sharma, 2010; Lybbert and Sumner, 2010; Mtui, 2011; Lakshmi et al., 2015 | **Sustainable Growth (8.2)**<br>↑ / ↓ [+2,-1] 🕮🕮 ☺☺ ★★<br>Many developing countries including Gulf States will benefit from CSA given the central role of agriculture in their economic and social development. (Quoted from Behnassi et al. 2014). Low commodity prices have reduced the incentive to invest in yield growth and have led to declining farm labour and farm capital investment. (Quoted from Lamb et al., 2016)<br>Behnassi et al., 2014; Lamb et al., 2016 | **Infrastructure Building, Promotion of Inclusive Industrialization and Innovation (9.1/9.2/9.5/9.b)**<br>↑ / ↓ [+2,-2] 🕮🕮🕮 ☺☺☺ ★★★<br>Reduced research support and delayed industrialization will have an adverse effect on food security and nourishment of children. Organic farming technologies utilizing bio-based fertilizers (composted human and animal manure) are some of the conventional biotechnological options for reducing artificial fertilizer use (Lakshmi et al., 2015). CSA requires huge financial investment and institutional innovation. CSA is committed to new ways of engaging in participatory research and partnerships with producers (Steenwerth et al., 2014). Technologies used on-farm and during food processing to increase productivity which also helps in adaptation and/or mitigation are new, so convincing potential customers is difficult. Also, low-awareness of CSA, inaccessible language, high costs, lack of verified impact of technologies, hard to reach and train farmers, low consumer demand and unequal distribution of costs/benefits across supply chains are barriers to CSA technology adoption (Long et al., 2016). Low commodity prices have reduced the incentive to invest in yield growth and have led to declining investment in research and development (Lamb et al., 2016).<br>Evenson, 1999; Behnassi et al., 2014; Steenwerth et al., 2014; Lakshmi et al., 2015; Lamb et al., 2016; Long et al., 2016 | [0]<br>no direct interaction |
| | **Greenhouse Gas Reduction from Improved Livestock Production and Manure** | **Energy Efficiency (7.3)**<br>↑ [+1] & J «<br>Scenarios where zero human-edible concentrate feed is used for livestock, non-renewable energy use is reduced by 36%.<br>Schader et al., 2015 | **Sustainable Economic Growth (8.4)**<br>↑ [+1] & J «<br>Exploiting the increasingly decoupled interactions between crops and livestock could be beneficial for promoting structural changes in the livestock sector and is a prerequisite for the sustainable growth of the sector. (Quoted from Herrero et al., 2013)<br>Herrero and Thornton, 2013; Herrero et al., 2013 | **Technological Upgradation and Innovation (9.2)**<br>↑ [+2] 🕮🕮🕮 ☺☺☺ ★★★<br>Complete genome maps for poultry and cattle now exist, and these open up the way to possible advances in evolutionary biology, animal breeding and animal models for human diseases. Genomic selection should be able to at least double the rate of genetic gain in the dairy industry. (Quoted from Thornton, 2010) Nanotechnology, biogas technology and separation technologies are disruptive technologies that enhance biogas production from anaerobic digesters or to reduce odours.<br>Sansoucy, 1995; Burton, 2007; Thornton, 2010 | [0]<br>No direct interaction |

*Economic-Other (continued)*

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| **Forest** | **Reduced Deforestation, REDD+** | **Energy Efficiency (7.3)**<br>↑/↓ [+1,-1] 🕮 ☺ ★<br>Consider the entire sinks and reservoirs of GHG while developing the nationally appropriate mitigation actions. For countries with a significant contribution of forest degradation (and GHG emissions) from wood fuels, this should be considered. (Quoted from Bastos Lima et al., 2017). Biomass for energy is recognized as often being inefficient, and is often harvested in an unsustainable manner, but is a renewable energy source.<br>Bastos Lima et al., 2017; Katila et al., 2017 | **Sustainable Economic Growth (8.4)**<br>↑ [+1] 🕮 ☺ ★<br>Efforts by the Government of Zambia to reduce emissions by REDD+ have contributed to erosion control, ecotourism and pollination valued at 2.5% of the country's GDP. Partnerships between local forest managers, community enterprises and private sector companies can support local economies and livelihoods, and boost regional and national economic growth.<br>Turpie et al., 2015; Epstein and Theuer, 2017; Katila et al., 2017 | **Infrastructure, Promotion of Inclusive Industrialization (9.1/9.2/9.5)**<br>↑/↓ [+1,-1] 🕮 ☺ ★<br>Expanding road networks are recognized as one of the main drivers of deforesting and forest degradation, diminishing forest benefits to communities, On the other hand, roads can enhance market access, thereby boosting local benefits (SDG 1) from the commercialization of forest products. (Quoted from Katila et al., 2017). Efforts by the Government of Zambia to reduce emissions by REDD+ have contributed to erosion control, ecotourism and pollination valued at 2.5% of the country's GDP<br>Turpie et al., 2015; Epstein and Theuer, 2017; Katila et al., 2017 | [0]<br>No direct interaction |
| | **Afforestation and Reforestation** | **Energy Conservation (7.3/7.b)**<br>↑ [+1] 🕮 ☺ ★<br>The US Forest Service estimates that an average NYC street tree (urban afforestation) produces 209 USD in annual benefits, which is primarily driven by aesthetic (90 USD per tree) and energy savings (from shade) benefits (47.63 USD per tree).<br>Jones and McDermott, 2018 | **Decent Job Creation and Sustainable Economic Growth (8.3/8.4)**<br>↑ [+2] 🕮🕮 ☺☺ ★★<br>Many tree plantations worldwide have higher growth rates which can provide higher rates of returns for investors. Agroforestry initiatives that offer significant opportunities for projects to provide benefits to smallholder farmers can also help address land degradation through community-based efforts in more marginal areas. Mangroves reduce impacts of disasters (cyclones/storms/floods) and enhance water quality, fisheries, tourism businesses and livelihoods.<br>Zomer et al., 2008; Kibria, 2015 | [0]<br>No direct interaction | **Improving Air Quality, Green and Public Spaces (11.6/11.7/11.a/11.b)**<br>↑ [+2] 🕮🕮🕮🕮 ☺☺☺☺ ★★★★<br>Many urban tree plantations worldwide are created with a focus on multiple benefits, like air quality improvement, cultural preference for green nature, healthy community interaction as well as temperature control and biodiversity enhancement goals.<br>Chen and Qi, 2018; Fu et al., 2018; Kowarik, 2018; McKinney and Ingo, 2018; McPherson et al., 2018; Pei et al., 2018 |
| | **Behavioural Response (Responsible Sourcing)** | **Universal Access (7.3)**<br>↑ [+1] 🕮 ☺ ★<br>The trade of wood pellets from clean wood waste should be facilitated with less administrative import barriers by the EU, in order to have this new option seriously accounted for as a future resource for energy. (Quoted from Sikkema et al., 2014) Recommends further harmonization of legal harvesting, sustainable sourcing and cascaded use requirements for woody biomass for energy with the current requirements of voluntary SFM certification schemes.<br>Sikkema et al., 2014 | **Decent Job Creation and Sustainable Economic Growth (8.3/8.4)**<br>↑ [+2] 🕮 ☺ ★<br>Some standards seek primarily to coordinate global trade, many purport to promote ecological sustainability and social justice or to institutionalize CSR, for example, labour standards developed in the wake of sweatshops and child labour scandals. Environmental standards for pollution control, etc. Indonesian factories may seek advantages through non-price competition—perhaps by highlighting decent working conditions or the existence of a union—or to see trade associations or government promoting the country as a responsible sourcing location.<br>Bartley, 2010 | **Technological Upgradation and Innovation, Promotion of Inclusive Industrialization (9.1/9.2/9.5)**<br>↑ [+2] 🕮🕮 ☺☺ ★<br>Capacity for processing certified timber is often underutilized, due to the limited supply available. As a result, manufacturing firms that are seeking to tap into green markets often turn to other sources of timber. (Quoted from Bartley, 2010) Responsible sourcing, when integrated into business practices, can enable retailers to better manage brand value and reputation by avoiding negative public relations, as well as maintaining and enhancing brand integrity (Huang et al., 2013).<br>Bartley, 2010; Huang et al., 2013 | **Improving Air Quality, Green and Public Spaces, Peri-urban Spaces (11.6/11.7/11.a/11.b)**<br>↑ [+2] 🕮🕮🕮🕮 ☺☺☺☺ ★★★★<br>Many urban tree plantations worldwide are created with a focus on multiple benefits, like air quality improvement, cultural preference for green nature, healthy community interaction as well as temperature control and biodiversity enhancement goals. People's preference for urban forest gardens are encouraging new urban green spaces, and tree selection helps in building resilience to disaster.<br>Chen and Qi, 2018; Fu et al., 2018; Kowarik, 2018; McKinney and Ingo, 2018; McPherson et al., 2018; Pei et al., 2018 |
| **Oceans** | **Ocean Iron Fertilization** | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction |
| | **Blue Carbon** | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction |
| | **Enhanced Weathering** | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction | [0]<br>No direct interaction |