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Analysis of scenarios integrating the INDCs

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JRC analysis finds that submitted INDCs on climate policy can put the world on a path to reduce emissions in a more anticipated manner compared to current policies. Unconditional INDCs would lead to 56.6 $GtCO_2e$ in 2030 (excl. sinks; +17% 2010 with 42.2 $GtCO_2e$) while conditional INDCs combined would lead to a clear peak shortly before 2030 at 54.0 $GtCO_2e$ (+12% vs. 2010). These scenarios, if extended to 2050, would already cover 30% to 44% of the emissions reductions needed to remain below a 2 °C temperature increase.

The results presented here provide an analysis of the INDCs[1] submitted by the countries to the UNFCCC[2] (2015) in the preparation of the COP21[3] to be held in Paris (12/2015). They were obtained with quantified modelling using the energy-economy model POLES-JRC[4]. The assumptions on data used are described in Table 2 (Annex 2).

This policy brief is based on an update of the work conducted in the Global Energy and Climate Outlook 2015 (GECO2015) report that evaluated the transformation of the energy system and the economic cost of GHG[5] emission trajectories compatible with the objective to remain below a 2 °C increase (see Labat et al. 2015).

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1 INDC: Intended Nationally Determined Contribution, whereby countries announce their objectives in terms of GHG emissions by 2025/2030

2 UNFCCC: United Nations Framework Convention on Climate Change

3 COP21: 21st yearly session of the Conference of the Parties to the 1992 United Nations Framework Convention on Climate Change (UNFCCC), 30/11/2015 – 11/12/2015

4 https://ec.europa.eu/jrc/en/scientific-tool/poles-prospective-outlook-long-term-energy-systems

5 GHG: Greenhouse Gas, as defined in the Kyoto Protocol (CO2, CH4, N2O, SF6, PFCs, HFCs)

The following scenarios were modelled[6]:

- **No Policy**: Assumes no climate action in the future, including a relaxation of currently existing policies before 2020.
- **Reference**: Assumes announced policies for 2020[7] and a relaxation of policies after 2020; emissions are driven by income growth, energy prices and expected technological evolution with no supplementary incentivizing of low-carbon technologies. Emissions continue to grow at a decelerated pace but reach no peak by 2050[8].
- **Global Mitigation**: Assumes a rapid intensification of policies across several world countries from 2015, leading to a peak in emissions as early as 2020. A progressive convergence of underlying carbon prices after 2030, depending on their per capita income, leads to a "below 2 °C-compatible" emissions profile by 2050.
- **INDC-low**: All INDCs expressed unconditionally are implemented; countries where the *Reference* already lead to emissions at or lower than their INDCs, as well as countries with no INDCs or conditional-only INDCs, do not implement additional policies. No commitment was assumed for low-income African countries. Beyond 2030, regional carbon prices increase, including for countries that previously had no climate policies, and progressively converge, at a speed that depends on their per capita income; on average, the world GHG intensity over 2030-2050 decreases at the same rate as for 2020-2030.
- **INDC-high**: Similar to *INDC-low*, but all INDCs are implemented, including all conditional contributions.

The 120 countries that submitted INDCs as of October 13 2015 represented 88.0% of global GHG emissions in 2010 (excluding world bunkers; metrics using World Resources Institute's CAIT WRI 2014). Most of the INDCs were used in the modelling (see Table 1 in Annex).

Global emissions continue to rise in the Reference scenario throughout 2050, whereas the implementation of INDCs and a prolonged effort after 2030 result in curbing emissions and a peak in 2035 (INDC-low) or 2030 (INDC-high). The emissions in the two INDC scenarios result in a global temperature increase of around 3 °C[9].

The decrease of emissions intensity per unit of GDP marks a break from the historical trend (-1.8%/year) in all climate policy scenarios:

- it is slightly above the historical average in the *Reference* (thanks to the deployment of renewables technologies that is expected to take place even without strong climate policies);
- it more than doubles in the ambitious *Global Mitigation* scenario;
- it ranges from -3 to -3.3%/year in the *INDC* scenarios.

The aggregate level of ambition of the INDCs by 2025 and 2030 thus represents a significant deviation from historical trends and will require efforts to implement current and new policies. This will mean a significant transformation of the energy sector and land use policies.

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[6] All scenarios share the same macroeconomic assumptions.

[7] Derived from Elzen M. den et al. (2015); announced policies in 2020 across the world are not always reached in our Reference.

[8] The *Reference* scenario falls in the range defined by Representative Concentration Pathways RCP6.0 and RCP8.5; see IPCC's Fifth Assessment Report (IPCC 2014) WG III Figure TS.8 and TS.2.2,

[9] The *INDC* scenarios fall in the middle of the range defined by Representative Concentration Pathway RCP4.5, corresponding to a likelihood of "staying below 3 °C over the 21st century" of "likely" and "more likely than not"; see IPCC's Fifth Assessment Report (IPCC 2014) WG III, Figure TS.8 and Table TS.1

Nevertheless, emissions in both *INDC* scenarios are above least-cost pathways to limit the global temperature increase below 2 °C (illustrated by the *Global Mitigation* scenario).

Emissions from world marine and air bunkers continue to rise in all scenarios, as they are not subject to an international climate policy to curb their emissions. They rise at an average of 2.4%/year over 2015-2030 (2.9%/year over 1990-2015), driven by international mobility and trade, and increase from 1.4 GtCO_2 in 2013 (i.e. 3% of global emissions) to about 2.1 GtCO_2 in 2030 (3.5-4% of global emissions in the INDC scenarios).

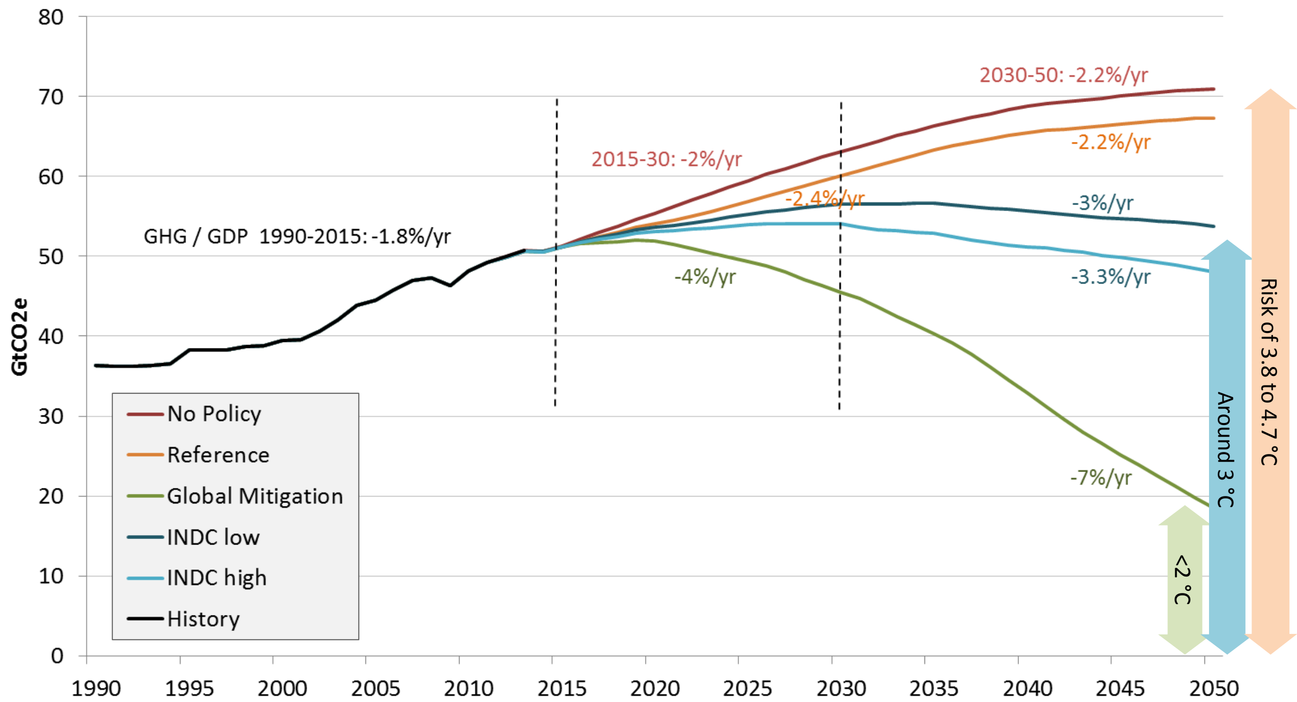

Figure 1: World emissions (GtCO_2e, total excluding sinks) and percent change in emission intensity per unit of GDP

Source: POLES-JRC model
For a comparison with other studies see for instance PBL (2015)

The total emissions in 2030 are 3.5 GtCO_2e lower in the *INDC-low* versus the *Reference* case, and conditional INDCs lead them 2.5 GtCO_2e lower. The majority of emissions reductions are achieved in the power sector (51% from *Reference* to *INDC-high*), followed by CO_2 in other energy sectors (19%), non-CO_2 greenhouse gases in energy and industry (13%), non-CO_2 in agriculture (11%) and CO_2 in LULUCF (6%; the effect of sinks[10] has not been taken into account here) – see Figure 2.

[10] CO_2 sinks are defined as negative emissions

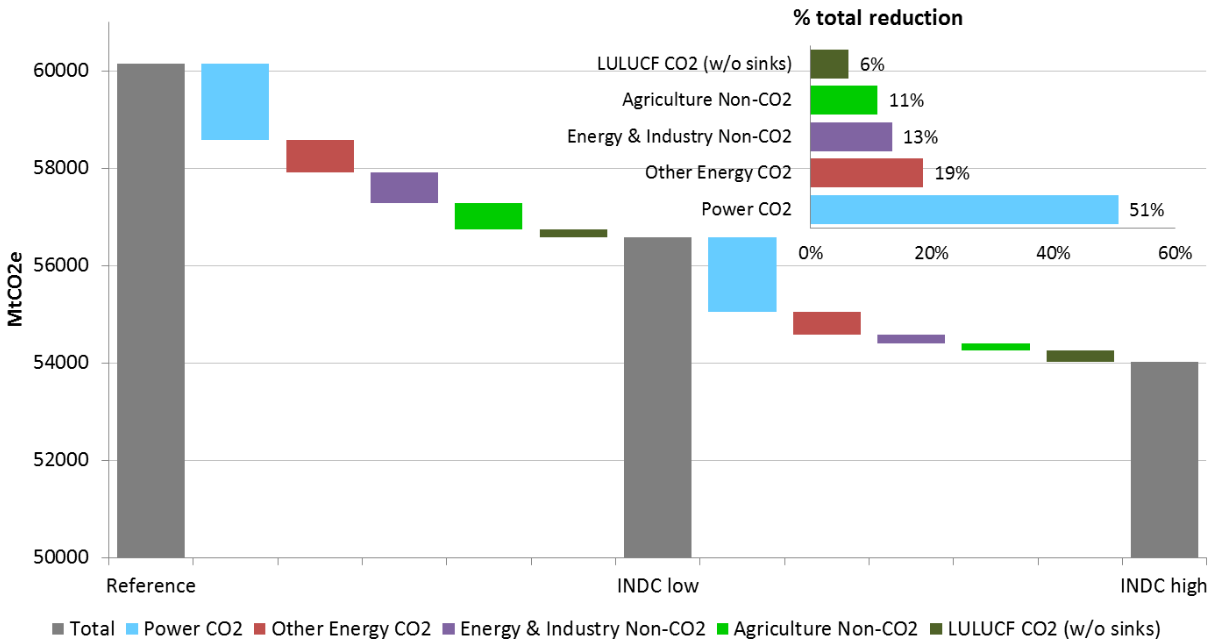

Figure 2: Sectoral contributions to differences between Reference and INDC-low scenarios, and between INDC-low and INDC-high scenarios, world, 2030 ($MtCO_2e$, excluding sinks)

Source: POLES-JRC model

In order to reach the objective of remaining below 2°C, parties will need to implement more drastic policies beyond 2030 and increase the intensity of the effort (see below the *INDC-high-2C* scenario). A different option would be to decrease the gap to the *Global Mitigation* scenario before 2030, by strengthening the ambition of the INDCs dynamically over 2015-2030.

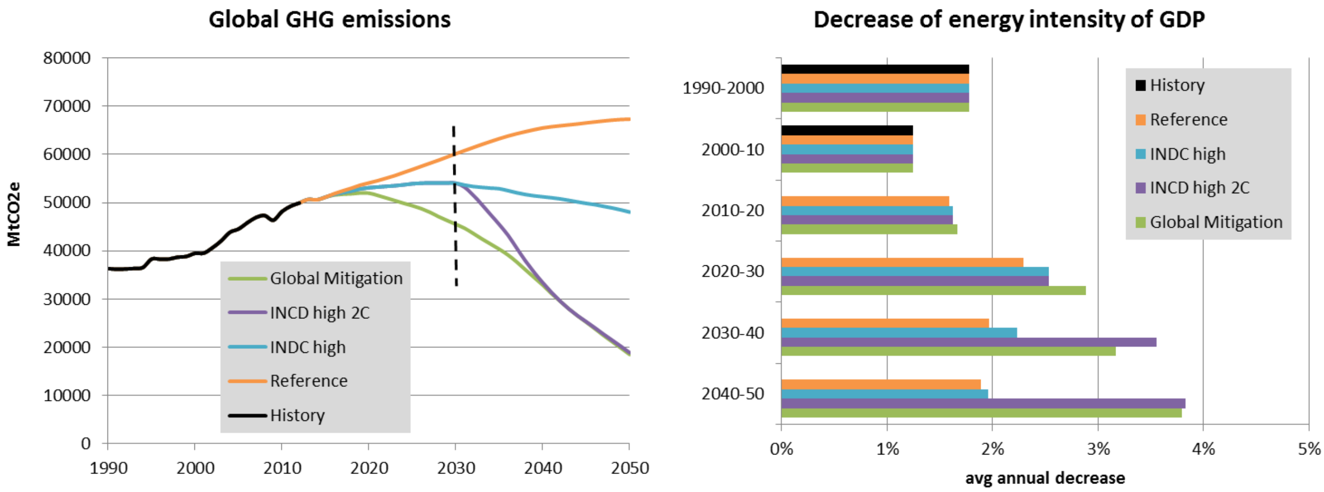

Figure 3: Emissions (excl. sinks) and percent change of energy intensity of GDP (final demand) in the "bridging" scenario INDC-high-2C

Source: POLES-JRC model

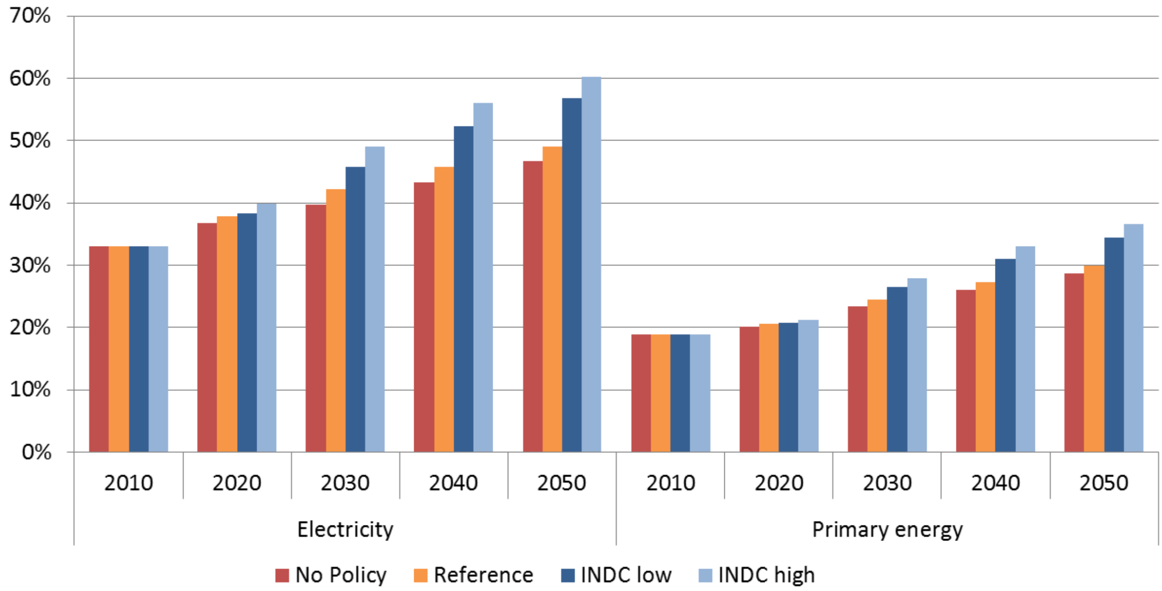

Figure 4: Global share of non-fossil fuels in the electricity and the total primary energy mix

Source: POLES-JRC model

The global share of non-fossil fuels in the energy mix (renewable energies and nuclear) increases over time for all scenarios, including in the *No Policy* scenario, due to the increase in the competitiveness of these technologies. The implementation of INDCs could push their contribution to the power generation to rise to nearly 50% in 2030.

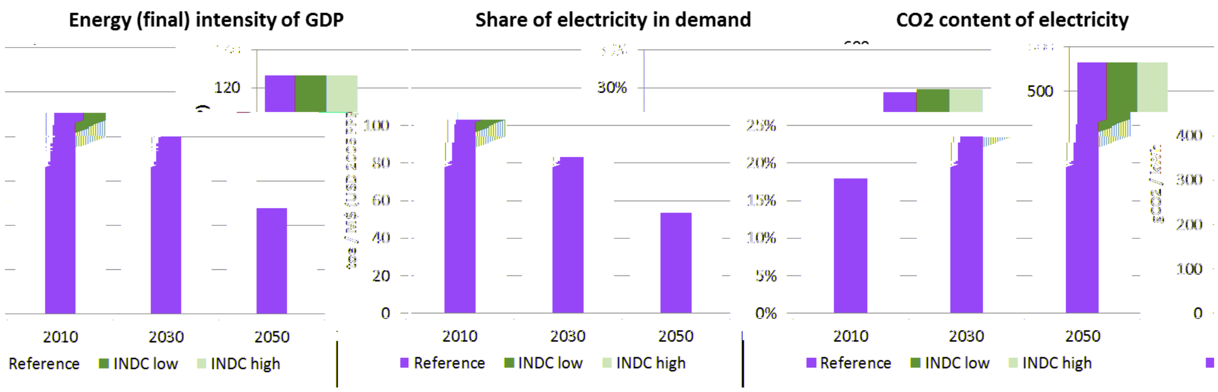

Figure 5: Global indicators of final energy and power generation

Source: POLES-JRC model

The INDCs have a slight influence on the decrease of energy intensity of GDP and on the electrification of the final demand. But they lead to a significant reduction of the carbon content of electricity production (see also Figure 2), that is, by 2030, 17% lower in the *INDC-high* than in the *Reference* scenario.

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Annex 1

Table 1: Modelled regions and countries INDCs used to inform each region's emissions targets

Country/region	Proxy to / INDC taken from
EU-28	EU-28
Norway	Norway
Switzerland	Switzerland
Rest Central Europe	Albania, Bosnia-Herzegovina, Serbia
Turkey	Turkey
Canada	Canada
USA	USA
Mexico	Mexico
Rest Central America	Dominican Rep. , Guatemala, Honduras, Trinidad & T.
Chile	Chile
Argentina	Argentina
Brazil	Brazil
Rest South America	Bolivia, Colombia, Paraguay, Peru
Russian Federation	Russian Federation
Ukraine	Ukraine
Rest Central Asia (CIS)	Azerbaijan, Belarus, Kazakhstan, Tajikistan, Turkmenistan
South Korea	South Korea
China	China
Indonesia	Indonesia
Malaysia	*n/a*
Thailand	Thailand
Vietnam	Vietnam
Rest South East Asia	Cambodia, Philippines
India	India
Rest South Asia	Afghanistan, Bangladesh
Japan	Japan
Australia	Australia
New Zealand	New Zealand
Rest Pacific	*n/a*
North Africa Producers	Algeria
North Africa non Producers	Morocco, Tunisia
Egypt	*n/a*
South Africa	South Africa
Rest Sub-Saharan Africa	No commitment assumed
Mediterranean Middle East	Israel, Jordan, Lebanon
Iran	*n/a*
Saudi Arabia	*n/a*
Rest Persian Gulf	*n/a*

Annex 2

Table 2: Sources and models used for both historical data and for the projections

Series		Historical data	Projections
Population		UN (2015)	UN (2015, medium fertility)
GDP, growth		WB (2015)	EC (2015), IMF (2015), OECD[1] (2013)
Other activity drivers	Value added	WB (2015)	POLES-JRC model
	Mobility, vehicles, households, tons of steel	Sectoral databases	
Energy resources	Oil, gas, coal	BGR (2014), USGS (2013), WEC (2013a), sectoral databases	
	Uranium	OECD (2014)	
	Biomass	EU: Green-X model[2] Non-EU: GLOBIOM model[3]	
	Hydro	Enerdata (2015)	
	Wind, solar	NREL (2013), PIK (2014)[4]	
Energy balances	Reserves, production	BP (2015), Enerdata (2015), IEA (2015)	POLES-JRC model
	Demand by sector and fuel, transformation (including. power), losses	Enerdata (2015), IEA (2015)	
Energy prices	International prices, prices to consumer	EIA (2015), Enerdata (2015), IEA (2015)	POLES-JRC model
GHG emissions	Energy CO2	Derived from POLES-JRC energy balances	POLES-JRC model
	Other GHG Annex 1	UNFCCC (2015)	POLES-JRC model, (GLOBIOM model[3])
	Other GHG Non-Annex 1 (excl. LULUCF)	EDGAR (EC-JRC 2015), national sources	POLES-JRC model, (GLOBIOM model[3])
	LULUCF Non-Annex 1	FAO (2015), national sources	POLES-JRC model, (GLOBIOM model[3])
Technology costs		Own estimates based on specialised literature & market monitoring, including but not only: EC-JRC (2014), IEA Technology Roadmaps, WEC (2013b), TECHPOL database[5]	POLES-JRC model based on endogenous learning curves from aforementioned sources

Notes:
1 *OECD:* see also Dellink at al. (2014)
2 *Information from Green-X is used as an input to POLES-JRC; University of Vienna:* http://www.green-x.at/
3 *Information from GLOBIOM is used as an input to POLES-JRC; IIASA:* http://www.globiom.org/ *; see also Havlík et al. (2014)*
4 *PIK: see Pietzcker et al. (2014)*
5 *developed in several European research projects: SAPIENT, SAPIENTIA, CASCADE MINTS - see for instance:* http://cordis.europa.eu/result/rcn/47819_en.html

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