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Preface

This research analyses the INDCs (Intended, Nationally Determined Contributions) submitted to the UNFCCC towards the Paris climate negotiations of 2015. The work has been done in the project "KILPI – Kansainvälisten ilmastoneuvotteluiden päästövähennystavoitteiden tarkastelu sekä EU:n taakanjakosektorin päästökehityksen arviointi", funded by the Finnish Ministry of the Environment.

The steering group for the project comprised Environment Counsellor Magnus Cederlöf, Counsellor Harri Laurikka, Ministerial Adviser Paula Perälä, Senior Officer Laura Aho and Senior Officer Maria Vuorelma. The authors wish to thank the steering group for their insights and helpful comments regarding the report.

The views expressed in this report are those of the authors, and do not necessarily represent the view of Finnish Ministry of the Environment.

November 20th, 2015
Tommi Ekholm and Tomi J. Lindroos

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Summary and conclusions of the analysis

- 142 INDCs (Intended, Nationally Determined Contributions) have been submitted to the UNFCCC by 20 November 2015. The parties cover:
  - 169 countries
  - over 90% of 2010 net GHG emissions
  - 92% of population
  - 96% of economic output

- Mitigation commitment definitions of the INDCs are very dispersed.
  - Developed countries have given their headline targets relative to a historical base year, either 1990 or 2005.
  - Most developing countries' headline targets compare reductions to a BAU scenario. However, the assumed BAU scenarios vary vastly between countries. Some countries have assumed growth in emissions exceeding 200% between 2010 and 2030 in the BAU, while other have used far more moderate assumptions.
  - China, India and a few additional countries have defined targets in terms of emission intensity reduction from a chosen historical level.
  - Many developing countries' mitigation targets are contingent on e.g. external financial aid and technology transfer. Some parties have both an unconditional and a more ambitious conditional target.

- Mitigation effort of many INDCs is not quantifiable, e.g. because the BAU scenario from which reductions are measured is not provided in the INDC.

- The report provides estimates on 53 parties' emissions in 2025, 2030 or 2035, as implied by their INDCs' headline targets.
  - Most of the wealthier countries aim at a reduction of emissions from 2010 level, but there is no correlation between a country's wealth and the targeted reduction within this group of countries.
  - Developing countries' emission developments implied by their INDCs are very divergent. Some aim at stabilizing at 2010 levels, while some target at an increase of over 200% from 2010 levels.
  - Per-capita emissions of Russia, Australia, China, Canada, US and South Korea are high in 2030, and would exceed 10 tonnes/capita.

- Availability of reliable emission estimates makes the analysis of developing countries' INDCs difficult. Improvement of inventory practices should be a key priority also for the tracking of progress in emission reductions.

- INDCs imply global GHG emissions to be from 50 to 54 Gt CO_2-eq in 2030
  - This is compatible with the 2°C target only if steep, global emission reductions are undertaken in the post-2030 period.
  - The scenario "INDCs pave the way" assumed an annual reduction rate of 5% for the developed countries and 1% for the least developed, with other countries between these, starting from year 2030. This scenario would remain below 2°C with 50% probability.
  - A reduction rate as high as 5% in the long-term is not supported by past mitigation scenario studies. Reaching the 2°C might therefore require stronger contribution also from the developing countries in the post-2030 period than what was assumed here.
  - Increasing the 2030 targets' level of ambition is critical for maintaining a robust possibility of keeping temperature increase below 2°C.

- Country-level analyses from 12 highest-emitting countries' INDCs
  - China: Intensity target is not ambitious, faster reduction is expected in the reference scenario. Non-fossil energy target is ambitious, but the resulting emission level depends also on other factors.
  - US: INDC target is ambitious, and roughly in line with the 2°C target.
  - EU: INDC target is ambitious, and in line with the 2°C target.
  - India: Intensity target is not ambitious, faster reduction is expected in the reference scenario. Non-fossil electricity target is ambitious.
  - Indonesia: INDC target is ambitious, but could be met with land-use measures alone.
  - Brazil: INDC target is ambitious, requires also other measures than avoiding deforestation, on which Brazil has been very successful.
  - Russia: INDC target does not constrain Russia's emissions, which are expected to be far below the INDC target in the reference scenario.
  - Japan: INDC target is only moderately ambitious, would put Japan on a path towards -60% reduction from 2005 levels by 2050.
  - Canada: INDC target is only mildly ambitious, would put Canada on a path towards -50% reduction from 2005 levels by 2050.
  - Mexico: INDC target is moderately ambitious, and requires a clear break from the past trend of increasing emissions.
  - Australia: INDC target is only moderately ambitious, would put Australia on a path towards -60% reduction from 2005 levels by 2050.
  - Korea: INDC target is not ambitious or sufficient to put Korea on a long-term low-carbon pathway

1. Overview of INDC's

142 submissions of "Intended, Nationally Determined Contributions" (INDCs) have been submitted to the UNFCCC by 20 November 2015. These contributions indicate the UNFCCC's parties' intentions for climate change mitigation and adaptations. The current set of submitted INDC's cover 169 countries (141 countries plus the European Union), which comprise roughly 92% of global net greenhouse gas (GHG) emissions, 92% of population and 96% the world's GDP.

As countries have been relatively free to determine their contribution for the forthcoming Paris negotiations and the possible agreement, the content of the INDCs varies considerably between countries.

All submitted INDCs include a mitigation contribution, but the way the mitigation targets are formulated is very dispersed. Almost all INDCs involve one or several "headline targets" e.g. for emissions, renewable energy or forestry; which are supplemented with a description of implemented and planned policies and measures. For some countries (e.g. Bolivia) an explicit headline target is missing, and the INDC focuses on planned mitigation actions. Most headline targets are set for the year 2030, while some countries have 2025 (e.g. United States and Brazil) or 2035 (Cameroon) as the target year.

The headline target's formulation for an explicit emission target has three main categories: reduction against a historical base year, reduction from some prescribed Business-as-usual (BAU) scenario, or a reduction of emission intensity of the economy (emissions per GDP) against a historical base year. The historical base years are typically 1990, 2005 or 2010. In the case of emission targets determined with respect to baseline, most countries have also disclosed the BAU scenario, which allows the computation of the emission level implied by the INDC, provided the assumed BAU scenario is not revised over time. However, multiple countries have submitted an emission target against a BAU, but have not specified the BAU scenario (e.g. Algeria, Ecuador, Philippines). In such cases it is not possible to estimate the emission level in the target year ex-ante, or determine ex-post whether the target has been met.

Some INDC's are contingent on the sufficient coverage of the Paris agreement or the availability of external funding, and some countries (e.g. Mexico) have provided both an unconditional and a more ambitious conditional target. Further details on some INDCs indicate whether the country intends to carry out the emis-

sion reductions fully with domestic measures, or whether it plans to use a possible market mechanisms set out in the Paris agreement; which gases and emission sources are covered, what climate metric is used to convert non-CO_2 emission to CO_2-equivalents, or whether land-use and related activities are covered by the INDC.

1.1 Purpose and approach of this report

The principles of UNFCCC state that counties should take on mitigation actions "on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities" (CBDR). In practice this means that more capable countries should take the lead in emission reductions, and that countries with similar capability should be in line with each other, while countries with less capacity can be expected to deliver a more modest contribution to the common mitigation goal. Mitigation targets intended by the parties should be therefore reviewed and compared to each other in order to ensure these principles hold.

However, the dispersion in the formulation of headline targets in parties' INDCs complicates this comparison considerably.

The choice of base year differs, making the relative reduction stated in the INDC incomparable between countries. For some countries emissions have been rapidly increasing during recent years; while for some emissions have declined, either due to deliberate mitigation efforts, economic collapses or structural change in the economy. The differences in the chosen reference year therefore obfuscate how much reductions are required from the current level. Reduction targets defined against a self-stated BAU create an additional source of divergence, as some countries have assumed much more aggressive increases in the BAU emission levels than others.

In this report, we aim to clarify the situation by estimating the emission impacts of the submitted INDCs on the country level, present a comparative analysis of countries' level of ambition, and characterizing whether and under what conditions the aggregate GHG emissions implied by the INDCs are in line with the 2°C target. The analysis is based on publicly available data sources presented in Appendix A.

The analysis between INDCs and the 2°C target is bi-directional. First, we take a top-down view and analyse what the ambition level of the INDCs is, and whether the INDCs collectively support the ability of keeping temperature increase below 2°C from the pre-industrial period. Towards this aim, we compare the ambition level of countries' to each other, estimate the global level of GHG emissions for 2030, and This will answer how coherent countries are in their level of ambition, after allowing for differentiation of commitments based on the respective capabilities of countries; and whether the countries as a whole present a sufficient level of ambition to keep the 2°C target within reach.

Second, we take a bottom-up view and analyse the INDCs of 12 highest-emitting parties individually, comparing the targets stated in the country's INDC to

existing reference and 2°C scenarios for the country in question. These 12 parties cover already 32.7 Gt CO_2-eq, or 73% of global GHG emissions in 2010. This approach answers in more detail how ambitious each country's INDC is, how much effort is required to meet the INDC targets, or whether the targets might be met already in a reference scenario without any additional efforts. These two approaches give an indication of both how the INDCs look like in the light of past 2°C emission scenarios, whether the INDC targets of some given country put it on the 2°C path; and also how the meeting of the 2°C target looks in the light of the submitted INDCs.

The comparison of parties' stated efforts is made in the spirit of "common but differentiated responsibilities and respective capabilities": an equal reduction, e.g. from the 2010 level, cannot be expected from all countries. A higher ambition level is expected from more wealthy countries, based on their higher level of welfare and capability to act; as also is stated in the principles of the UNFCCC. Least wealthy countries, on the other hand, can be allowed to moderately increase their emissions in order to provide energy and welfare to their citizens.

This principle is illustrated in Figure 1 for a comparison between countries' INDC targets against their respective capabilities. Two metrics are used for a country's emission leve and reduction effort: change from the 2010 emission level to the INDC target and emissions per capita implied by the INDC target; with GDP/capita being a measure of the country's capability for carrying out emission reductions. With both metrics, less developed countries are allowed for rapid economic development – and relatedly to increase their emissions – while emission reductions are expected from more developed countries.

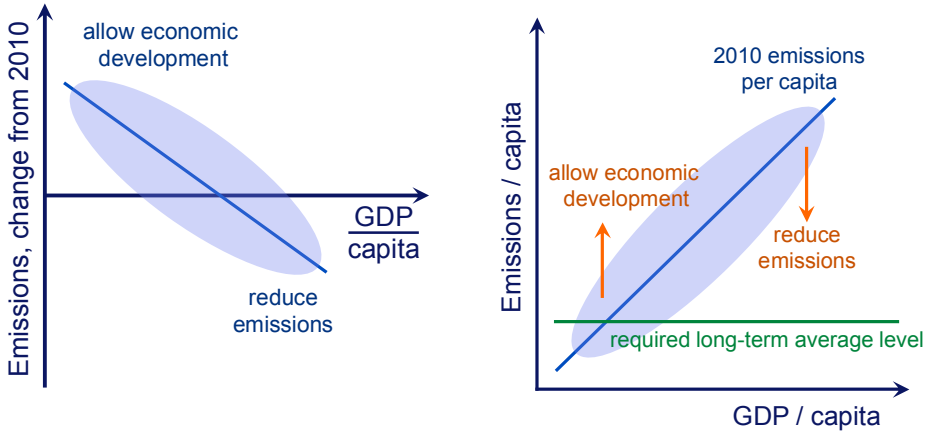

Figure 1. Illustration on the comparison of countries' INDC targets against their respective capabilities with the change of emissions from 2010 level (left) and the per-capita emissions (right) implied by the INDC target.

For the change in emissions from 2010 level, Figure 1 depicts an ideal line which indicates how developed countries should take the lead in reducing emissions. Up to 2030 – on which the current INDC targets are centred – less-developed countries are allowed to moderately increase their emissions. The exact position and slope of this line is obviously debatable, and the comparison can merely highlight whether countries are broadly in-line with each other, or if there are clear outliers. In addition to capability, the prospects for reducing emissions vary between countries: some countries might have large potential for low-cost emission reductions, while others' reduction potential at the same cost-level might be much more modest. This is indicated with a pale blue area in the figure, denoting that somewhat differing contributions can be expected also from countries with the same level of development. This aspect, however, is outside the scope of this study.

For the per-capita emissions, Figure 1 portrays 2010 emissions, which are loosely correlated to the countries' level of economic development. From this starting point, developing countries are again allowed to increase their emissions moderately towards 2030, while reductions are expected from more wealthy countries. In the emission-per-capita context, however, a clear reference point in the long-term is that average emissions per capita compatible with the 2°C target are around 1 tonne. Therefore, although less-developed countries can moderately increase their emissions in the medium term, the 2°C target necessitates very low emissions per capita in the long-term also from countries that are the currently in the developing stage.

2. Comparative analysis of headline targets

To improve the understanding on countries' level of ambition and to facilitate a comparative analysis, we have interpreted and compiled the emission levels implied by the headline targets from 53 INDC's. The selected INDC's represent major emitters (GHG emissions above 25 Mt CO_2-eq in 2010) who have provided a headline emission target that can be quantified to an explicit emission level, in some cases with the aid of an economic or population growth projection.

In practice, such the headline target is either:

- reduction target relative to a historical base year;
- reduction target relative to a BAU, and the BAU has been specified;
- emission intensity target relative to a historical base year (requires an economic growth projection);
- emission per capita target (requires a population projection).

These 53 covered parties produced 38 Gt CO_2-eq of GHG emissions in 2010, or roughly 80% of the global emissions.

Reasons for excluding a country's INDC from this analysis include:

- the reduction target relative to BAU cannot be quantified as absolute emissions because the INDC did not provide the BAU projection (e.g. Algeria, Ecuador, Philippines);
- the emission estimates diverge between INDC and external sources, preventing a reliable analysis of the emission level implied by the INDC (e.g. Cambodia, Central African Republic, Ivory Coast, Mali);
- INDC provided planned mitigation measures, but did not quantify an emission level that would be reached with the planned measures (e.g. Bolivia, Mongolia, Mozambique, Myanmar).

Table 1 presents the selected countries' emissions in 2010 and the estimates for the INDC target year; along with the change in emissions between these years, projected GDP/capita level and emissions per capita implied by the INDC. The data sources, additional to the countries' INDCs themselves, used in the estimation and characterization of countries are provided in Appendix A. In cases where the country has provided a target range, instead of a single target; or both unconditional and conditional targets, these are represented as ranges in Table 1.

Table 1. An overview of headline targets from 53 selected INDC's.

	Headline target (by 2030, unless otherwise noted) (GHGwoL = excludes land-use)	GDP/capita (1000US$) 2030	GHG emissions (Mt CO2-eq) 2010	target year	(%) from 2010	Emissions per capita (t CO2-eq) 2010	target year	from 2010
China	CO2/GDP: -60%..-65% from 2005	24	10600	15800..18100	49%..70%	7.9	11..13	+3.5..+5.2
United States	GHG: -26%..-28% from 2005 by 2025	58	5880	4500..4600	-24%..-22%	18.9	12..13	-6.5..-6.2
European Union	GHG: -40% from 1990	36	4400	3100	-29%	8.7	5.9	-2.8
India	GHG/GDP: -33%..-35% from 2005	8	2490	6200..6400	151%..158%	2.0	4.1..4.2	+2.1..+2.2
Indonesia	GHG: -29%..-41% from BAU	11	1960	1700..2000	-13%..4%	8.2	6.1..7.4	-2.0..-0.8
Brazil	GHG: -37% from 2005 by 2025	17	1880	1400	-23%	9.6	6.5	-3.1
Russia	GHG: -25%..-30% from 1990	29	1700	2300..2500	38%..48%	11.9	17..18	+4.9..+6.1
Japan	GHG: -25% from 2005	40	1210	970	-20%	9.5	8.0	-1.5
Canada	GHG: -30% from 2005	45	749	530	-29%	22.0	13	-9.1
Mexico	GHG: -22%..-36% from BAU	20	643	620..760	-3%..18%	5.7	4.6..5.5	-1.1..-0.1
Australia	GHG: -26%..-28% from 2005	49	569	390..410	-31%..-29%	25.5	13..14	-12..-12
South Korea	GHG: -37% from BAU	51	588	540	-9%	12.2	11	-1.4
South Africa	GHG: 392 to 614 Mt in 2030	17	419	390..610	-6%..47%	8.3	6.7..10	-1.7..+2.1
Argentina	GHG: -15%..-30% from BAU	26	470	470..570	0%..21%	11.6	10..12	-1.5..+0.7
Thailand	GHG: -20%..-25% from BAU	17	374	420..440	11%..19%	5.4	5.5..5.9	+0.1..+0.5
Turkey	GHG: -21% from BAU	23	357	930	160%	4.9	11	+5.7
Ukraine	GHG: -40% from 1990	14	353	520	49%	7.8	13	+5.0
Kazakhstan	GHG: -15%..-25% from 1990	28	317	270..300	-16%..-4%	19.8	14..16	-5.5..-3.6
Congo (Dem. Rep.)	GHG: -17% from BAU	1	290	360	23%	4.4	3.3	-1.1
Vietnam	GHG: -8% from BAU	8	259	720	179%	3.0	7.1	+4.2
Colombia	GHG: -20%..-30% from BAU	14	208	230..270	12%..29%	4.5	4.1..4.7	-0.4..+0.2
Bangladesh	GHG: -5% from BAU	4	207	230	10%	1.4	1.3	-0.1
Cameroon	GHGwoL: -32% from BAU by 2035	4	148	71	83%	7.6	2.6	-5.0
Tanzania	GHG: -10%..-20% from BAU	3	146	140..150	-5%..5%	3.2	1.9..2.1	-1.4..-1.2
Peru	GHG: -20%..-30% from BAU	20	137	210..240	52%..74%	4.7	6.3..7.2	+1.6..+2.5
Ethiopia	GHG: -64% from BAU	2	135	150	8%	1.6	1.2	-0.5
Chile	CO2/GDP: -30%..-45% from 2007	26	105	130..170	25%..59%	6.1	6.7..8.5	+0.5..+2.3
Paraguay	GHG: -10%..-20% from BAU	9	102	330..370	227%..267%	15.8	39..44	+24..+29
Zambia	GHG: -0%..-47% from 2010	3	78	41..78	-47%..0%	6.0	1.9..3.7	-4.0..-2.3
Ghana	GHG: -15% from BAU	4	78	74	-5%	3.2	2.1	-1.1
Belarus	GHGwoL: -28% from 1990	26	77	100	-4%	8.1	12	+3.5
Morocco	GHG: -13%..-32% from BAU	10	77	120..150	50%..92%	2.4	3.2..4.1	+0.8..+1.7
Israel	GHG/cap: -26% from 2005	39	76	85	12%	10.3	7.7	-2.6
Guinea	GHGwoL: -13% from 1994	5	64	20	-61%	6.4	1.5	-4.9
Zimbabwe	GHGwoL: -33% from BAU	1	62	30	23%	4.9	2.2	-2.7
Kenya	GHG: -30% from BAU	3	61	100	65%	1.5	1.7	+0.2
Madagascar	GHGwoL: -14% from BAU	1	60	180	207%	2.9	5.5	+2.6
Trinidad and Tobago	GHG: -15% from BAU	35	58	88	51%	43.4	64	+21
Switzerland	GHG: -50% from 1990	49	54	26	-52%	7.0	3.0	-4.0
Azerbaijan	GHG: -35% from 1990	12	50	51	2%	5.4	4.8	-0.6
Singapore	GHG/GDP: -36% from 2005	79	49	72	46%	9.7	12	+2.1
Chad	GHG: -18%..-71% from BAU	2	48	15..42	-69%..-12%	4.2	.8..2.3	-3.4..-1.9
Mongolia	GHGwoL: -14% from BAU	16	47	44	94%	17.0	13	-4.1
Honduras	GHGwoL: -15% from BAU	6	46	25	36%	6.0	2.4	-3.6
New Zealand	GHG: -30% from 2005	32	43	36	-16%	9.7	6.7	-3.0
Guatemala	GHG: -11%..-23% from BAU	7	41	42..48	1%..16%	2.9	2.0..2.3	-0.8..-0.5
Norway	GHG: -40% from 1990	56	37	29	-23%	7.6	4.8	-2.8
Tunisia	GHG/GDP: -13%..-41% from 2010	18	37	54..79	46%..115%	3.5	4.4..6.5	+0.9..+3.0
Burkina Faso	GHG: -7%..-12% from BAU	2	35	100..110	202%..220%	2.1	3.8..4.0	+1.7..+1.9
Dominican Republic	GHG: -25% from 2010	15	32	24	-25%	3.2	2.0	-1.2
Senegal	CO2: -5%..-21% from BAU	3	29	29..35	1%..21%	2.3	1.5..1.8	-0.8..-0.5
Benin	GHGwoL: -21% from BAU	2	26	18	14%	3.0	1.2	-1.7
Jordan	GHG: -14%..-27% from BAU	10	25	38..44	48%..73%	4.1	3.8..4.5	-0.3..+0.3

To enable comparisons between countries, Table 1 presents two metrics that measure the ambition level of the INDC and the emission level of the country. First, the change from 2010 emission level to the target year represents the direction of the emission pathway from the present – whether emissions are declining or how much they might be increasing. Second, based on the emission level implied by the INDC and a projection for population, emissions-per-capita levels are presented.

Figure 2 presents illustrations for the data presented in Table 1. Reflecting the "respective capabilities", the change in emissions and the per-capita emissions are plotted against the projected GDP/capita of each party in 2030. The 12 highest-emitting parties in 2010 are highlighted in the figure. A more detailed analysis on these countries is presented in Section 4.

The comparison between parties' targeted emission change from 2010 to the target year (primarily 2030) reveals that the targeted change varies considerably. Most of the wealthier countries (EU, Japan, Canada, Australia, Korea and US) aim at a reduction of emissions from 2010 level, but there is no correlation between wealth and targeted reductions within this group of countries. However, the country with the highest projected GDP/capita level in 2030 (Singapore) is instead targeting nearly a 50% increase in its emissions by 2030, which is not in line with the CBDR principle and the contributions of other countries.

The divergence is considerably higher for the less-affluent countries. Some parties' INDC targets would imply an increase in emissions of over 200% by 2030; while many parties with the same level of economic development target a much more moderate increase – between 50% and 100% – or close to zero increase. India is on the high side, with a projected 150% increase based on its emission intensity target.

Among the 12 highest-emitting countries, the headline targets of India, China and Russia would imply a considerable increase in their emissions from 2010. Based on the "respective capability" principle, the headline targets of these countries are not in line with countries of similar economic development status. Indonesia, Brazil and Mexico have more ambitious targets than China or Russia, but are expected to have lower GDP/per capita in 2030. Regarding India, most countries with similar economic status target far more moderate increases in their emissions.

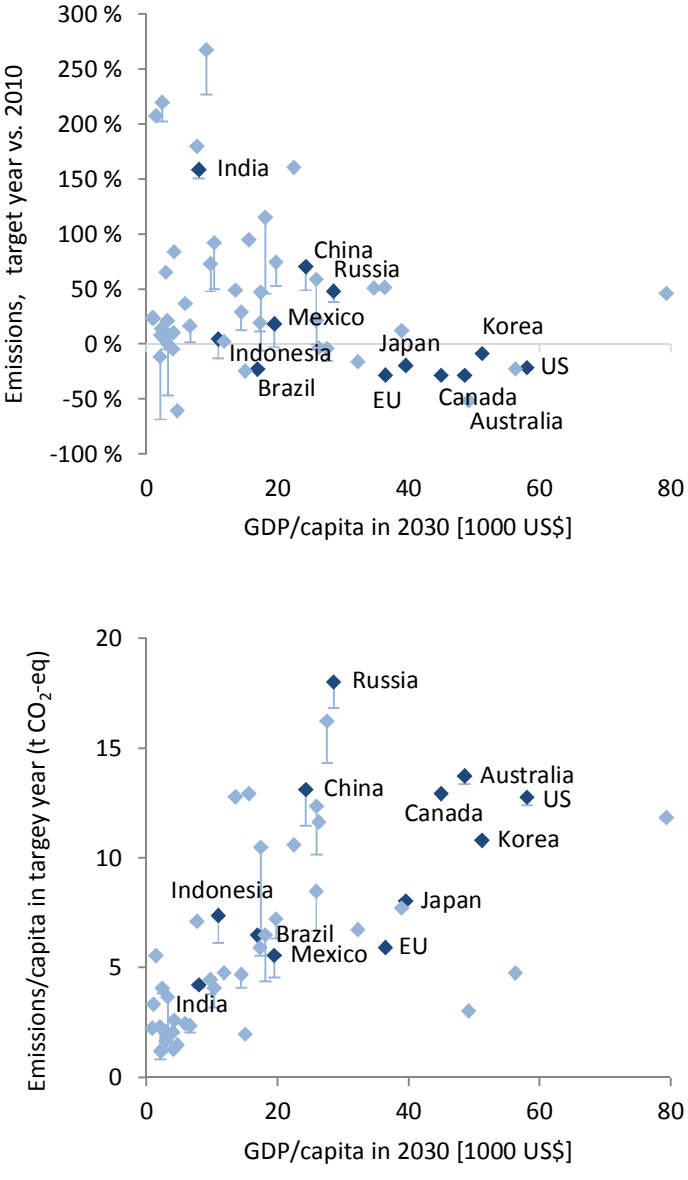

Figure 2. Change in emissions from 2010 (top) and emissions per capita (bottom) implied by the country's INDC, plotted against projected GDP per capita in 2030, for 54 top emitters of 2010 with an explicitly quantified emission target in the INDC. Top 12 emitters are highlighted and the name indicated beside the data-point. A possible lower emission target is noted with a range below the datapoint. Paraguay and Trinidad and Tobago are not depicted in the lower figure, as they are off the chart with their per capita emissions being over 40 t CO_2-eq.

A slightly different picture, however, emerges from the projected emissions-per-capita levels. Despite the substantial projected increase, India's emissions would be below 5 t CO_2-eq per capita – far less than those of the other 12 highest-emitting parties, and in line with other countries of similar GDP/capita level. Emissions per capita would be the highest in Russia, and also China, Australia, Canada, US and Korea would exceed 10 tonnes/capita. Those of the EU would be instead relatively low given its GDP/capita level, at 6 tonnes per capita.

Therefore, although the reduction efforts of EU, Japan, Canada, Australia, Korea and US from their 2010 levels are relatively similar, their starting level is very different in per-capita terms. The emissions of EU have steadily decreased since 1990, while for the others of these countries emissions have been steady (Australia and US) or increased (South Korea, Japan, Canada).

For a mitigation scenario consistent with the 2°C target, the average emission per-capita should decline to roughly 1 tonne/capita in the long-term. Many of the major emitters would therefore have a long-way to go down with this metric after 2030.

On the other hand, although less-developed countries are allowed to increase their emission in the short-term, also most of them would be far above the 1 tonne/capita level in 2030, and have to prepare for reducing their emissions in the future. Two countries stand up in this respect, and are excluded from Figure 2's per-capita presentation due to their high level of per-capita emissions: Paraguay and Trinidad and Tobago. Both have already relatively high emissions per capita in 2010, on top of which Paraguay's INDC target implies an increase around 250% from the 2010 level. These are in stark conflict with a low-carbon pathway or the 2°C target.

A few additional remarks should be taken into account when interpreting the headline targets analysed above. For China, India and Russia, reference scenarios calculated with integrated assessment models indicate a far more moderate increase in emission than what the countries' headline targets would imply. Moreover, the INDC targets for non-fossil energy of both China and India are far more ambitious than their emission intensity targets. Therefore the future emission projections in Table 1 and Figure 2 might be overestimates for these countries. These aspects are elaborated further in Section 4.

3. INDCs and the 2°C target

The objective of the UNFCCC is to "prevent dangerous anthropogenic interference with the climate system", while in the Copenhagen Accord parties agreed to take actions to "hold the increase in global temperature below 2 degrees Celsius". Meeting these targets requires deep reductions in GHG emissions in the long-term. However, the INDC's reach mostly only to 2030, although some countries have set also indicative targets to 2050.

The long-term temperature change is obviously affected, but not entirely determined by the INDC's or the level of greenhouse gas emissions in 2030. It has been shown that the expected increase in global mean temperature is closely correlated with the cumulative emissions, though allowing for uncertainty in how sensitive the climate is for increased greenhouse gas concentrations. Therefore there exists some latitude for the 2030 emission level that would enable to reach e.g. the 2°C target in the long-term. In principle, a higher emissions level in 2030 can be in principle compensated – up to a point – by deeper cuts in emissions later during the century.

However, the inertia in the energy system and emissions – e.g. the long lifetime of power plants – sets limits for how fast nations can realistically ramp down their emission pathways. Highest emission reduction rates found in the mitigation scenario literature are in the order of 4% to 6% per year, although these rates have been observed only on relatively short intervals[1]. On a longer timeframe of 50 years, the maximal reduction rates observed in scenarios reach only from 3% to 4%. Therefore it seems unlikely that a country could sustain a long-term reduction rate exceeding 4% in the future.

The INDC's and the global emission level in 2030 therefore influence the long-term temperature change in two ways. First, the level of emissions affect directly the cumulative emissions, and therefore how much of the "carbon budget" would be available for the post-2030 period. Second, the 2030 level affects also the achievable future emission levels: being on a higher level initially makes it more difficult to reach a low emission level in the future, as the rate at which emissions can be realistically reduced is limited. The 2030 level can exclude from reaching the target if the further cuts necessary to meet the 2°C target have to be scaled up

[1] van Vuuren and Stehfest, 2013. If climate action becomes urgent: The importance of response times for various climate strategies. Climatic Change 121, pp. 473–486.

so fast that it seems infeasible from the perspective of inertia in the energy system and other emission sources.

Here, the analysis of INDC's impacts to the long-term 2°C target is split to two subsections. First, we provide an estimate for the level of global GHG emissions in 2030, based on the submitted INDCs. After this, two hypothetical scenarios on the post-2030 emission pathways are presented to explore the long-term impacts on global mean temperature change, and the possibilities for remaining below 2°C.

3.1 Global GHG emissions in 2030

The current set of submitted INDC's does not cover all countries, and not all of the submitted INDC's indicate an explicit emission level around year 2030. Further, the INDC's do not cover all anthropogenic GHG emissions – e.g. some INDC's exclude land-use or non-CO_2 emissions; and on the other hand some headline targets exaggerate the country's projected emissions. Therefore, the global emission level in 2030 cannot be completely determined based on the INDC's.

Although the countries whose INDC includes a quantified emission level cover roughly 80% of global GHG emissions in 2010, the emission pathway up to 2030 for the remaining 20% needs to be estimated in order to assess the long-term impact of the INDCs.

Even if a country's INDC omitted an explicit GHG target (or omitted the BAU level from which the reduction was determined), the INDC's included policies and measures to reduce GHG emissions. Also those countries who have not yet submitted an INDC might do so in the future. Therefore a deviation from BAU can be expected from all countries.

Based on this, the following procedure was used to estimate each country's GHG emissions in 2030 (or other year, if indicated as the target year of the INDC):

- Use a quantified emission level from the INDC, if possible.
- If the INDC's target level exceeds the reference scenario, use the reference scenario instead (INDC emission level is unrealistically high).
- If no INDC or quantified emission level exists for the country, use the relative change from 2010 to 2030 from a similar reference country.

With this approach

- INDC target level was used for 76 countries;
- reference scenario was used for India, Russia and Ukraine (reference scenario's emission are lower than those implied by INDC);
- for China, reference scenario was used as the higher emission estimate, and an optimistic assumption on the non-fossil target's impact as the lower emission estimate for 2030 (see Section 4.1);
- for other countries, emission projection up to 2030 was tied to a reference country with similar characteristics (mostly smaller countries, representing in total 20% of 2010 emissions).

As a result of this estimation procedure, the global GHG emissions were estimated to be between 50 and 54 Gt CO_2-eq in 2030, based on whether countries implement their lower or higher INDC targets.

The reductions from the reference emission scenario implied by the INDCs are presented regionally in Figure 3. Broad contribution across the globe is achieved particularly with the higher ambition level of submitted INDC targets. Significant emission reductions are carried out particularly by Brazil in Latin America, and Indonesia and South Korea in Asia. For China, the INDC targets imply emission reductions only if energy consumption growth is moderate and the increase in non-fossil energy will primarily substitute coal in the power sector, which is assumed in the higher contribution.

However, it is worth to note that the reductions from reference scenario presented in Figure 3 do not capture the full mitigation contribution of parties. Most developing countries have stated that their reductions are contingent on external funding, and relatedly the contributions of more-developed countries comprise also the provision of this funding. In addition, for some parties – particularly the EU – the reference scenario involves mitigation measures that are already in place, and these reductions are therefore not reflected in Figure 3. The total amount of emission reductions carried out by Annex I parties is therefore higher than presented in Figure 3.

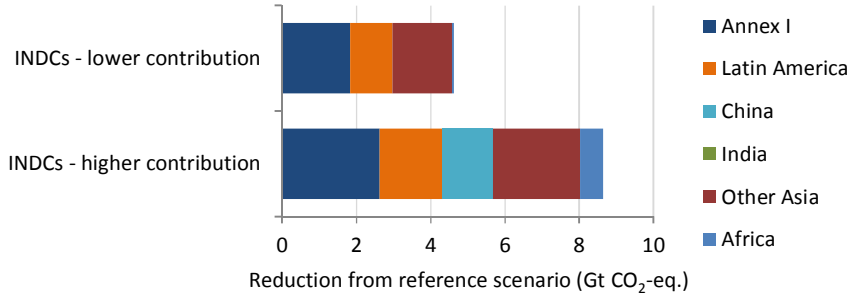

Figure 3. GHG emission reductions by region in 2030 from the reference scenario as implied by the higher and lower level of parties' INDCs.

A global carbon budget consistent with 2°C warming has been estimated to be around 1000 GtC[2], of which roughly 530 GtC has been emitted by 2010. With the range of 2030 emissions implied by the INDC's – and accounting only CO_2 emission to the carbon budget – the budget use-up would be between 749 and 755 GtC in 2030.

[2] Allen, Frame, Huntingford, Jones, Lowe, Meinshausen & Meinshausen, 2009. Warming caused by cumulative carbon emissions towards the trillionth tonne. Nature 458, pp. 1163–1166.

3.2 What happens in the post-2030 period?

The long-term climatic impacts depend also largely on what happens after the now-proposed INDC targets around 2030. Do countries increase their level of ambition considerably e.g. through the proposed progression of ambition mechanism, or does the current set of INDCs represent the also long-term ambition of parties? As the answer to this question is essentially hypothetical in its nature, alternative scenarios on the long-term will be presented to illustrate a range of possible outcomes.

In order to apply a consistent methodology for all countries – irrespective of whether a given country has indicated a long-term target in its INDC – annual reduction rates are assigned for each country for the post-2030 period. To accommodate the CBDR and capability-to-act principles, the reduction rates are based on the countries' projected level of economic development in 2030.

The two scenarios assumed here are:

- INDC's mark the trend:
  The current set of INDC's marks the long-term trend, and the increase in ambition after 2030 will be limited. Developed countries will remain on a slowly declining emission pathway, while developing countries will primarily stabilize their emissions on the 2030 level. INDC's will be implemented on the higher emission level (54 Gt CO_2-eq in 2030).

- INDC's pave the way:
  The increase of ambition is gradual, and countries will increase their efforts after 2030, based on their level of ability. Developed countries will take a lead with a high annual reduction rate, limited by the inertia in their energy system transformation; while also developing countries will turn their emissions into decline, based on their level of development. INDC's will be implemented on the lower emission level (50 Gt CO_2-eq in 2030).

The annual emission reduction rates assumed are based on countries' level of economic development – GDP/capita – projected for year 2030. In the "*INDC's mark the trend*" scenario, the high-end is fixed to United States and the reduction rate between 2010 and 2025 implied by its INDC (-1.6% annual change in emissions); while the low-end is fixed to India with a stabilization of emissions (0% annual change in emissions). In the "*INDC's pave the way*" scenario, the high-end is limited to -5% and applies for all countries with GDP/capita at or above the level of EU in 2030, and low-end is fixed to India with -1% annual reduction. The reduction rates of other countries are interpolated between these extremes based on the countries' GDP/capita level. Emissions from international transportation were based on scenarios from IMO and ICAO up to 2050, after which these emissions were assumed to decline by -1% and -3% per year in the two scenarios.

The resulting emission pathways are presented for the 8 highest emitters of 2010 in Figure 4, and regionally in Figure 5. The figures also portray a reference scenario, which includes only the current policies already implemented by the countries.

On the country-level the starkest change is for China, whose sharp rise in emissions between 2000 and 2030 is turned to a moderate or almost-as-sharp decline after 2030 in the mitigation scenarios. In the "*mark the trend*" scenario, the emissions of India and Indonesia stabilize at the 2030 level, while Brazil's continues the slow decline implied by its INDC. In the "*pave the way*" scenario, also India and Indonesia carry out considerable emission reductions over the post-2030 period, while more developed countries de-carbonize much more rapidly than in the pre-2030 period.

On the global level, the scenarios lead to emissions of 39 Gt CO_2-eq and 10 Gt CO_2-eq in 2100. In the "*mark the trend*" scenario, the reduction rate of Annex I projected from the 2010-2030 development leads to only moderate reductions over the century. Adding the slow or zero reduction rates from developing countries, the global emissions do not reach even the 2000 levels by 2100.

In the "*pave the way*" scenario, however, the deep cuts implemented throughout the globe – though balanced by each country's capacity to act – lead to a fast decline in global emissions after 2030. By 2050, the emission level recedes below 1990 levels. From this, further emission cuts are implemented mainly by developing countries, as the developed countries emissions are close to zero during the latter half of the century.

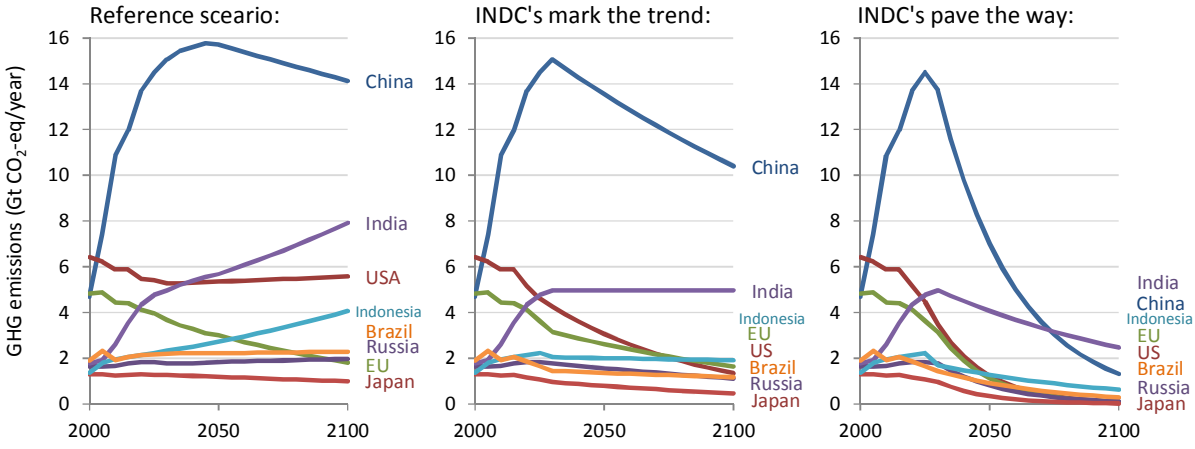

Figure 4. GHG emission projections for the eight highest emitters of 2010 in the three post-2030 scenarios.

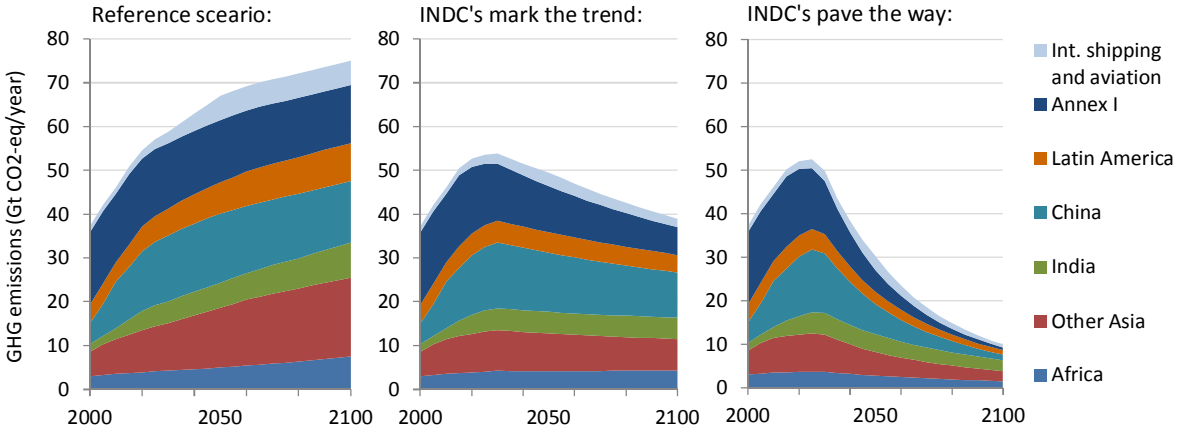

Figure 5. Global GHG emissions by region in the three post-2030 scenarios.

The increase in global mean temperature was calculated for the three emissions scenarios, including an uncertainty range for climate sensitivity. The temperature projections presented in Figure 6 indicates that in the "*INDC's mark the trend*" scenario the temperature increase would exceed 3°C and be increasing in 2200. In the "*INDC's pave the way*", the best-guess temperature increase would remain barely below 2°C, but concurrently include a significant possibility of exceeding 2°C due to the uncertainty in climate sensitivity.

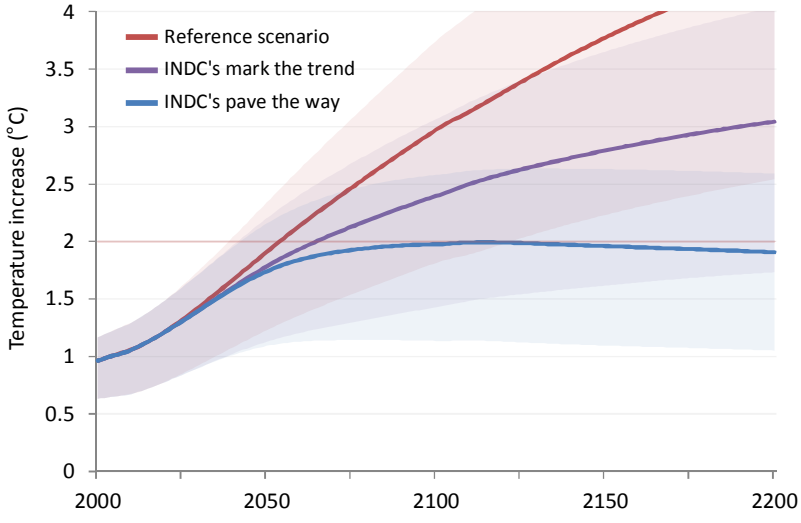

Figure 6. Increase in global mean temperature since the pre-industrial period in the three post-2030 emission scenarios. The line indicates the best-guess value for climate sensitivity (3°C), the shaded areas represent a "likely" range of climate sensitivity from IPCC AR5 (1.5°C – 4.5°C).

The conclusion from these calculations therefore is that the current set of INDC's are compatible with the 2°C target only if steep, global emission reductions are undertaken in the post-2030 period. The scenario "INDCs pave the way" assumed an annual reduction rate of 5% for the developed countries and 1% for the least developed, with other countries between these, starting from year 2030. A reduction rate as high as 5% in the long-term is not supported by past mitigation scenario studies. Reaching the 2°C might therefore require stronger contribution from developing countries than what was assumed here. Further, even this scenario would remain below 2°C only with 50% probability.

Achieving a lower emission level in 2030 would both decrease the cumulative emissions to 2030 – which directly affects the emission budget available for the post-2030 period – and also lower the starting point from which further emission reductions are carried out. Given that countries' possibility to reach high annual emission reduction rates is likely to be limited, a lower emission level in 2030 point would reduce this risk significantly. It would therefore be critical to increasing the level of ambition for the 2030 targets in order to ensure a more robust possibility to remain below 2°C.

4. Country-level analyses

This section provides short country-level analyses of 12 highest-emitting parties. These parties cover 32.7 Gt CO_2-eq, or 73% of global GHG emissions in 2010, and therefore are a significant factor alone in the climate change context.

The analyses state the main features of each country's INDC, give an assessment on the INDC's level of ambition, portray past emission development and analyse the INDC through future scenarios.

The data sources are indicated in Appendix A, and in the analyses themselves for country-level sources.

4.1 China

Main findings and conclusions:

- China's INDC target for 2030 includes four separate components.
- The peaking-of-emissions target doesn't quantify the level at which peaking might occur, and therefore doesn't allow evaluation of the ambition level.
- The CO_2 intensity target is not ambitious: a faster reduction in emission intensity is expected without additional effort.
- The target for non-fossil energy is ambitious, and might result in additional emission reductions from the reference development of emissions. However, the emission impact depends e.g. on the growth of energy consumption.

The main details of the INDC

China has four separate targets:

- Peak CO_2 emissions by 2030 and making best efforts to peak earlier
- Lower CO_2/GDP by 60 to 65% by 2030. Current target 40 to 45% by 2020.
- Non-fossil primary energy to 20% by 2030. Current target 15% by 2020.
- Increase forest stock by 4.5 billion m^3 by 2030 compared to 2005 levels

The target has following further definitions:

- Conditionality: Unconditional
- Coverage: CO_2 only. CO_2 equals 80% of total GHG emissions.
- Use of markets: not defined.
- Metric: not defined, not necessary (covers only CO_2)
- LULUCF accounting: not defined.
- Target period: up to 2030.

National measures supporting the implementation of the target:

- National GHG inventories: China has submitted two National Communications. Intends to prepare greenhouse gas inventories at the national and provincial level on a regular basis.
- Reference development: Emissions increase in the reference scenario.
- Planned additional measures: China's INDC highlights measures e.g. in low-carbon energy, energy efficiency, carbon sinks, emission markets and increased financial and policy support.
- Long term target set: No long-term target.
- Intermediate targets support long term target: CO_2 intensity target does not support the 2°C path; the target for non-fossil energy does, although with some precautions.

GHG emissions 1990–2013

Figure 7 shows China's greenhouse gas emissions from 1990 to 2013, which have increased with an extremely rapid pace – almost 10% per year between 2000 and 2010. By 2013, the CO_2 emissions of China have increased 360% from 1990 and 85% from 2005. The LULUCF sector is a net sink in China, but it is a small share of total emissions.

In 2004, China became larger emitter than the USA; and in 2009, China became larger emitter than the USA and EU combined. Finally in 2013, China's GHG emissions were larger than USA's, EU's and India's together. China's share of global GHG emissions has increased from 10% in 1990 to 26% in 2013.

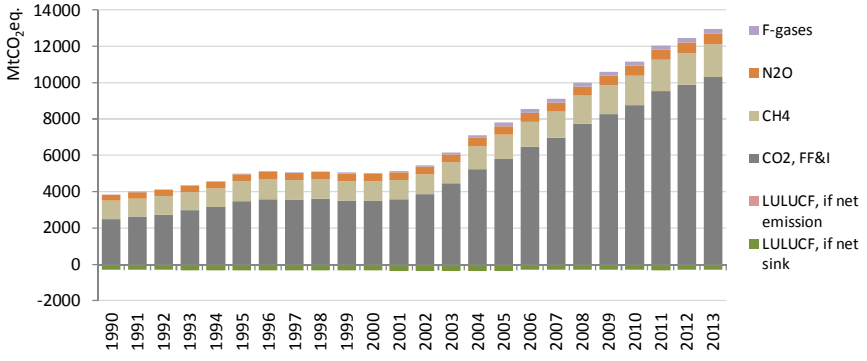

Figure 7. China's greenhouse gas emissions from 1990 to 2013.

Emission scenarios vs. INDC targets

Two of the main targets of China's INDC are to lower CO_2/GDP ratio by 60% to 65% between 2005 and 2030, and to increase the non-fossil primary energy share to 20% by 2030. Figure 8 presents these two targets along with the CO_2 intensity change from 2005 and the share of non-fossil primary energy in three emission scenarios.

Regarding the development of China's CO_2 intensity, the INDC target of 60% to 65% in 2030 is less ambitious than what is expected to happen in the reference scenario without additional effort. The observed improvement from 2005 is already -34%. The reference scenario achieves -55% in 2020 and -67% in 2030. The observed development from 2005 to 2013 supports the scenarios. In order to be consistent with the 2°C scenarios, the intensity target should be between 75% and 80% in 2030. Assuming an average growth rate between 7% and 8% for the Chinese economy between 2005 and 2030, even an 80% reduction in CO_2 intensity would imply an emission level that is considerably higher than in 2005.

The target for non-fossil energy share, however, is much more ambitious. The share has declined consistently since 1990, and is expected to decline further in the reference scenario. The INDC targets are very close to the more ambitious mitigation scenario, and require significant and rapid break from the past trend.

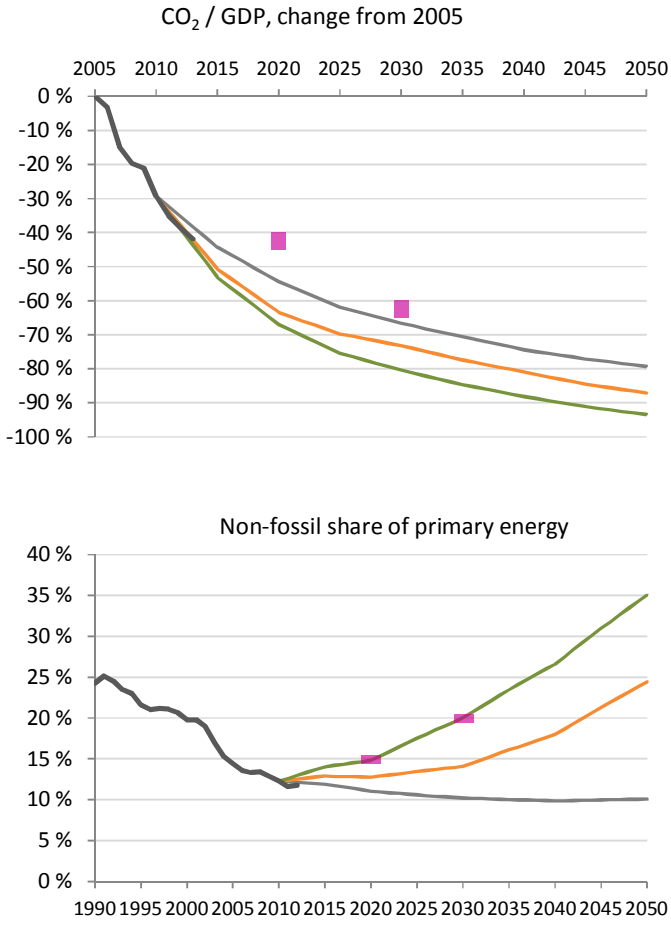

Figure 8. China's CO_2 intensity (top) and share of non-fossil energy in the total primary energy supply (bottom). Black line presents past years from 1990 to 2013. Grey line shows the GHG reference scenario. The orange and green lines represent scenarios with respectively 50% and 66% possibility of remaining below 2°C. Purple bars represent the INDC targets for 2020 and 2030.

All three main targets in China's INDC leave the emission level in 2030 open. The peaking target does not define the level of the peak; emissions implied by the intensity target depend on economic growth; and the non-fossil primary energy target depends on the growth of primary energy demand and the composition of fossil primary energy consumed – i.e. how large shares coal, oil and gas each have in the 80% of primary energy in 2030.

Approximate quantification of China's emissions, based on the intensity and non-fossil targets for 2030, is presented in Figure 9. The emission range based on

the intensity target assumes economic growth based on the SSP2 scenario, and corresponds to the analysis of headline targets, presented in Section 2 and Table 1.

The emission range based on the non-fossil energy target makes two assumptions – on the total primary energy consumption and on the shares of fossil energy sources – based on the existing energy scenarios for China. Primary energy consumption is assumed to grow from 106 EJ/a in 2010, to between 160 and 180 EJ/a in 2030. With the INDC target, non-fossil energy will account for 20% from this total amount. Two assumptions are again made, that non-fossil energy will substitute evenly all fossil primary energy, or that it will substitute coal use in the power sector. These four assumptions – on total primary energy consumption and the substitution by non-fossil energy – lead to a range of fossil emissions between 10.8 and 13.3 Gt CO_2.

Adding the 2030 projection for other emissions, the total emissions implied by the INDC's non-fossil energy target, range from 13.7 to 16.3 Gt CO_2-eq, as depicted in Figure 9. China's reference scenario – which was used in Section 3 – falls in the middle of this range. Therefore, although the non-fossil target requires a clear break from the current declining trend of non-fossil energy's share in the total primary energy mix, the target's impact for CO_2 emissions depends heavily on the growth of energy consumption, and might not effectively constrain China's 2030 emission level.

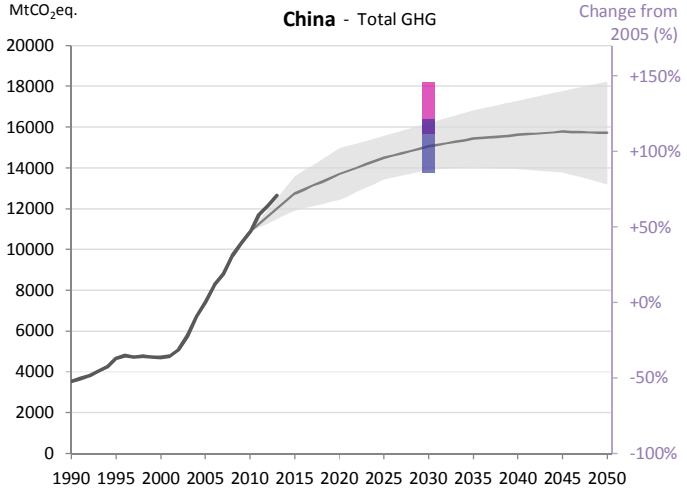

Figure 9. China's GHG emissions, in absolute amounts and relative to the 2005 level. Black line presents past years from 1990 to 2013, and grey line shows the GHG reference scenario. Purple bar represents the emission range from the INDC's intensity target for 2030. Blue bar represents the emission range from the INDC's non-fossil energy target for 2030.

4.2 United States

Main findings and conclusions:

- The US INDC target is ambitious.
- US emissions have declined slightly from the 2007 peak, and the INDC target for 2025 requires a clear break from the past trends.
- The climate policy situation of USA is challenging. The INDC targets of the USA are unconditional, but there is certain political risk in implementation and continuity.
- Some measures have been put in place, and new measures are planned. However, e.g. EPA is facing court cases as it is enforcing GHG policies through environmental regulation.

The main details of the INDC

To reduce total GHG emissions 17% below 2005 level by 2020, and 26–28% below 2005 level by 2025.

The target has following further definitions:

- Conditionality: Unconditional
- Coverage: All GHGs.
- Use of markets: No contribution from international credits.
- Metric: GWP100 from IPCC 4th Assessment Report.
- LULUCF accounting: Net-Net approach for land use, production approach for wood products
- Target period: up to 2025.

National measures supporting the implementation of the target:

- National GHG inventories: Annual inventory reports.
- Reference development: Stable emission level in the reference scenario.
- Planned additional measures: US have existing and planned regulations for implementing emission reductions, particularly the Clean Air Act.
- Long term target set: No long-term target.
- Intermediate targets support long term target: The 2025 INDC target supports the 2°C target.

GHG emissions 1990–2013

Figure 10 shows US' greenhouse gas emissions from 1990 to 2014, which have been on a slow decline since 2007, following the financial crisis. Prior to this, emissions have risen with a slow pace. Emissions are currently slightly above 1990 levels.

The LULUCF sector is a considerable sink. Emission removals from LULUCF have been from 13% to 15% of the total emissions excluding LULUCF.

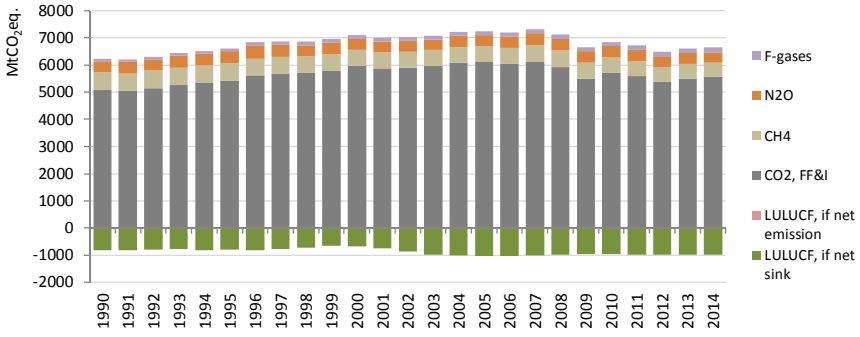

Figure 10. Unites States' greenhouse gas emissions from 1990 to 2014.

Emission scenarios vs. INDC targets

Figure 11 presents United States' INDC targets and GHG emissions in three emission scenarios. The INDC targets fall within the range of 2°C scenarios, and in that respect are in line with the 2°C. However, to meet reductions in the order of 80% by 2050, a higher rate of reductions is required after 2025.

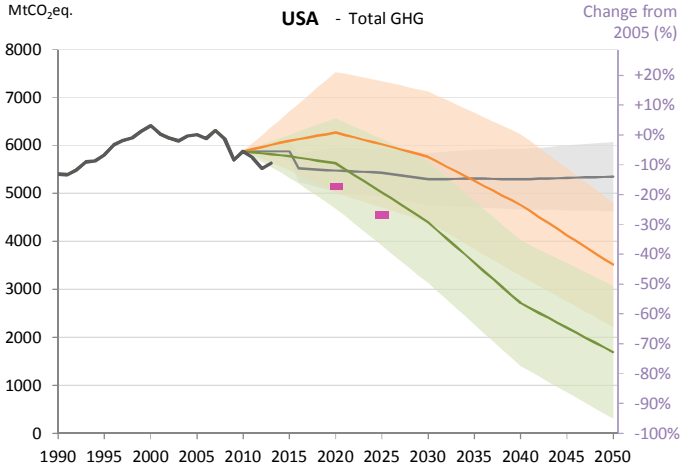

Figure 11. United States' GHG emissions, in absolute amounts and relative to the 2005 level. Black line presents past years from 1990 to 2013. Grey line shows the GHG reference scenario. The orange and green lines represent scenarios with respectively 50% and 66% possibility of remaining below 2°C. Purple marks represent the INDC targets for 2020 and 2025.

4.3 European Union

Main findings and conclusions:

- EU has climate legislation already in place (e.g. the ETS and ESD), and GHG emissions have been decreasing. The INDC target follows this trend.
- EU is the only party for which the reference development up to 2030 is below the 2°C path
- A higher rate for emission reductions is required after 2030 in order to meet the low-carbon roadmap's 80–90% reduction target from 1990 by 2050.

The main details of the INDC

To reduce GHG emissions at least 40% from 1990 level by 2030. Target for 2020 is 20% below 1990 level.

The target has following further definitions:

- Conditionality: Unconditional
- Coverage: All GHGs.
- Use of markets: No contribution from international credits.
- Metric: GWP100 from IPCC 4th Assessment Report.
- LULUCF accounting: Not defined yet.
- Target period: up to 2030.

National measures supporting the implementation of the target:

- National GHG inventories: Annual inventory reports.
- Reference development: Gradually declining emissions in the reference scenario.
- Planned additional measures: Emission Trading System (ETS) for the power sector and heavy industry, Effort Sharing Decision (EDS) for emissions excluded in the ETS (excl. LULUCF), additional reduction measures in transport sector[3], waste sector[4] and F-gases[5].
- Long term target set: EU low-carbon roadmap and indicative target of 80%-90% from 1990 level for 2050.
- Intermediate targets support long term target: The 2030 INDC target supports the 2°C target.

GHG emissions 1990–2013

Figure 12 shows EU's greenhouse gas emissions from 1990 to 2013, which have been on a nearly-constant decline for the whole timeframe. CO_2 emissions from fossil fuels and industrial processes have been reduced almost 20% since 1990, while CH_4 and N_2O emissions have been reduced by one third. The net carbon sink in the LULUCF sector has increased gradually, being currently 15% higher than in 1990. Total net GHG emissions are 21% below the 1990 level.

[3] http://ec.europa.eu/clima/policies/transport/index_en.htm
[4] http://ec.europa.eu/environment/waste/
[5] http://ec.europa.eu/clima/policies/f-gas/index_en.htm

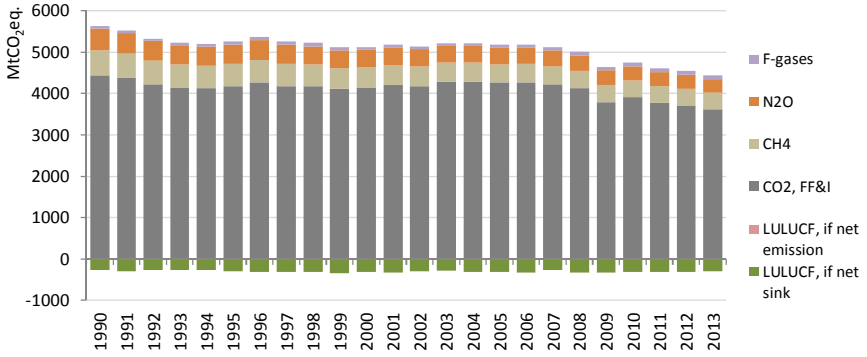

Figure 12. EU's greenhouse gas emissions from 1990 to 2013.

Emission scenarios vs. INDC targets

Figure 13 presents EU's past emissions, INDC targets and three emission scenarios. Based on past trends and the reference scenario, EU's emissions will be well below the 2020 target, and on track towards the 2030 target. Further reductions with a higher rate will be required after 2030 to reach the low-carbon roadmap's target: from 80% to 90% reduction target from 1990 level by 2050.

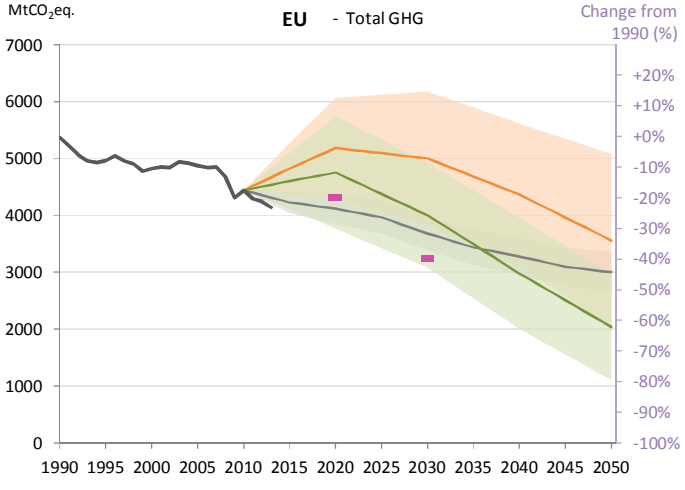

Figure 13. EU's GHG emissions, in absolute amounts and relative to the 1990 level. Black line presents past years from 1990 to 2013. Grey line shows the GHG reference scenario. The orange and green lines represent scenarios with respectively 50% and 66% possibility of remaining below 2°C. Purple bars represent the INDC targets for 2020 and 2030.

4.4 India

Main findings and conclusions:

- India is a developing country with major deficit in energy supply. Development seems to be a larger priority for India than climate change mitigation.
- India's INDC is comprised of a GHG intensity target, non-fossil electricity target and an afforestation target for 2030. The intensity target is not ambitious, and is expected to be met without any additional measures. The electricity target is ambitious and requires significant scaling up of non-fossil generation capacity; but despite this, India's emissions from electricity generation would more than double by 2030 from current levels.
- India expects significant external support in the form of funding, technology transfer and capacity building. The INDC notes a need for 834 billion USD funding for "moderate low-carbon development" up to 2030.

The main details of the INDC

India's mitigation target is 1) to reduce emission intensity by 33% to 35% below 2005 levels by 2030; 2) achieve 40% share of non-fossils in electricity production capacity; 3) achieve 2.5 to 3 Gt CO_2 sink (possibly cumulative) through afforestation by 2030.

The target has following further definitions:

- Conditionality: Conditional on funding, technology transfer and capacity building.
- Coverage: all GHGs.
- Use of Markets: Not specified
- Metric: Not specified
- LULUCF accounting: Not specified
- One year / period: intensity target for 2030, with additional cumulative elements

National measures supporting the implementation of the target:

- National GHG inventories: India has submitted two National Communications, latest in 2012.
- Reference development: As a developing country, emissions increase strongly in the reference scenario.
- Planned additional measures: India's INDC highlights plans for promoting renewable energy, energy efficiency and afforestation.
- Long term target set: No long-term target.
- Intermediate targets support long term target: India's intensity target would lead to tripling of emissions by 2030. The non-fossil electricity target is ambitious, but significant fossil capacity would be also added by 2030.

GHG emissions 1990–2013

Figure 14 shows India's greenhouse gas emissions from 1990 to 2013. CO_2 emissions have increased steadily during this period, leading to a total increase of 115% in GHG emissions since 1990. Despite this considerable growth, India's emissions are low compared to its size: emissions per capita are currently around 2.3 t/capita.

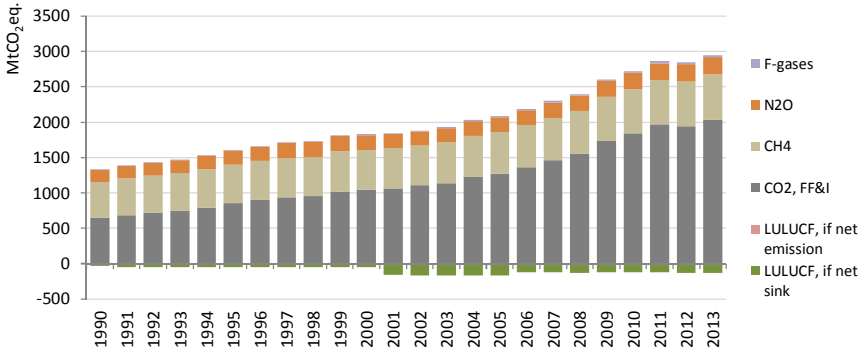

Figure 14. India's greenhouse gas emissions from 1990 to 2013.

Emission scenarios vs. INDC targets

Figure 15 presents emission statistics and emission scenarios for India. In the reference scenario, India's total GHG emissions increase by 175% from 2005 levels by 2030, driven by increase in fossil energy use. In the two 2°C scenarios, the emissions either increase by 100% by 2030, or remain only slightly higher than in 2005.

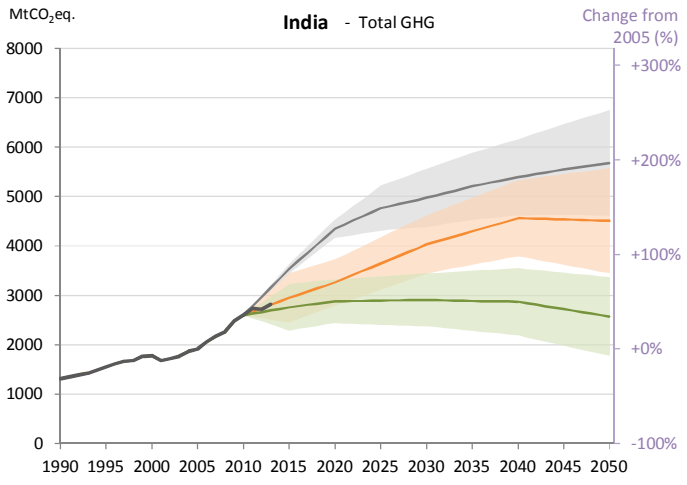

Figure 15. Black line presents India's GHG emissions from 1990 to 2013. Blue line shows the GHG reference scenario. The orange and green lines represent India's emissions in global scenarios with respectively 50% and 66% possibility of remaining below 2°C.

India's headline targets include an emission intensity target, a non-fossil electricity target and a forest sink target. The emission intensity target translates to an emission path contingent on future GDP growth. As an emerging economy, India's GDP is expected to grow with a fast pace during the next decades. Assuming an average annual growth rate of 6% for India's GDP between 2005 and 2030, the intensity target of 30% to 35% from 2005 level would equal an increase of 180% to 200% in emissions by 2030, which is slightly stronger growth in emissions than presented in the reference scenario of Figure 15.

Emission intensity development in the scenarios is presented in Figure 16. The scenarios assume an average, annual GDP growth of 7% between 2005 and 2030, and the emission paths presented in Figure 15. Compared to these, the emission intensity target would correspond to far more slower improvement of emission intensity than the reference scenario, and therefore is unlikely to be a binding constraint for India's emissions.

The target for 40% of electricity production capacity being non-fossil in 2030 requires considerable investment to clean generation technologies. Currently, the share of non-fossil capacity is nearly at 30%. Over half of the non-fossil capacity is hydropower, one fourth of wind power, while solar and nuclear have roughly 5% shares in the non-fossil production mix.

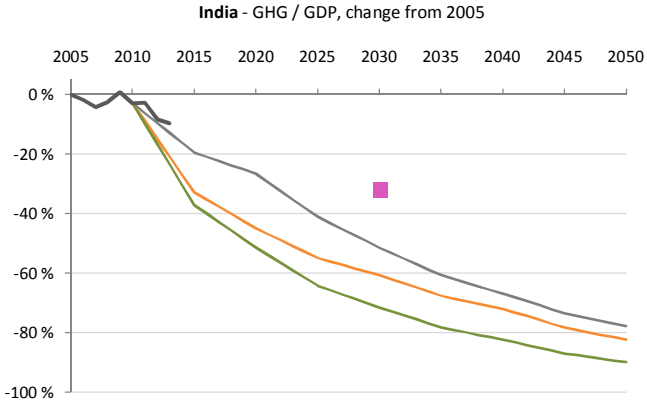

Figure 16. India's GHG intensity relative to the level in 2005. Black line presents the development up to 2013. Grey line shows the GHG reference scenario. The orange and green lines represent India's emissions in global scenarios with respectively 50% and 66% possibility of remaining below 2°C. The purple bar represents the emission intensity target of the INDC.

India has expanded the production capacity with approximately 10% per year during the last years in order to meet its increasing demand for energy. Although investments to non-fossil capacity have been considerable, the increase coal power plant capacity has been over three times larger, resulting in that the share of coal in the generation mix has increased since 2007. Therefore, in order to meet the non-fossil electricity target, the pace of non-fossil electricity investments needs to be increased considerably.

However, because of the large need for increased electricity capacity in India, a major expansion of fossil generation capacity is expected, leading to increased emissions (cf. Figure 15). Electricity generation is expected to triple between 2010 and 2030 in the scenarios for India. With the non-fossil target in place, this would equal more than doubling of fossil (coal) based electricity by 2030, and consequently doubling of emissions in the electricity sector, which is in line with the reference scenario of Figure 15.

The target of enhancing carbon sinks by 2.5 to 3 Gt CO_2 through afforestation is assumed to be cumulative up to 2030, translating it to an average 170 to 200 Mt CO_2 per year for 15 years. This is slightly higher than the estimated sink during recent years and roughly 10% of current emissions. While the enhanced sink is a welcome addition, it doesn't change the overall level of India's emissions.

India has indicated the INDC to be provisional of external funding, technology transfer and capacity building. The INDC notes a need for 834 billion USD funding for "moderate low-carbon development" up to 2030. Because the INDC's targets do not include well-defined emission reductions, it is not possible to estimate the cost-efficiency implied by this funding estimate.

4.5 Indonesia

Main findings and conclusions:

- Indonesia has pledged significant, voluntary cuts to 2020 emissions already in 2009, and the INDC target for 2030 follow the 2020 pledge.
- The BAU level for 2030 in the INDC is somewhat inflated, but the unconditional INDC target is ambitious enough to put Indonesia's 2030 emissions on a 2°C track.
- Indonesia's emissions are to a large extent from deforestation and peat fires, and both the unconditional and conditional 2030 INDC targets could be met with land-use measures alone.

The main details of the INDC

Indonesia's unconditional mitigation target is a reduction of 29% against BAU by 2030, which is projected to 2881 Gt CO_2-eq. Conditional on international support; the mitigation contribution can be increased to 41% from BAU.

The target has following further definitions:

- Conditionality: Unconditional, with an additional conditional target.
- Coverage: CO_2, CH_4 and N_2O from all sectors.
- Use of Markets: Unconditional targets met without mechanisms, but mechanisms are welcome.
- Metric: GWP100 from IPCC 4th assessment report
- LULUCF accounting: LULUCF included, based on IPCC GPG for LULUCF
- One year / period: targets for 2020 and 2030

National measures supporting the implementation of the target:

- National GHG inventories: Two National Communications submitted, biennial updates.
- Reference development: As a developing country, emissions increase strongly in the reference scenario.
- Long term target set: No long-term target.
- Intermediate targets support long term target: Unconditional target for 2030 would bring emissions close to the 2°C path, and the conditional target even to lower levels.

GHG emissions 1990–2013

Figure 17 shows Indonesia's greenhouse gas emissions from 1990 to 2013. Land-use is by far the largest source of emissions, and also contributed the most to the increase since 1990. Fossil CO_2 emissions have also increased steadily, but are relatively modest at 2 t/capita.

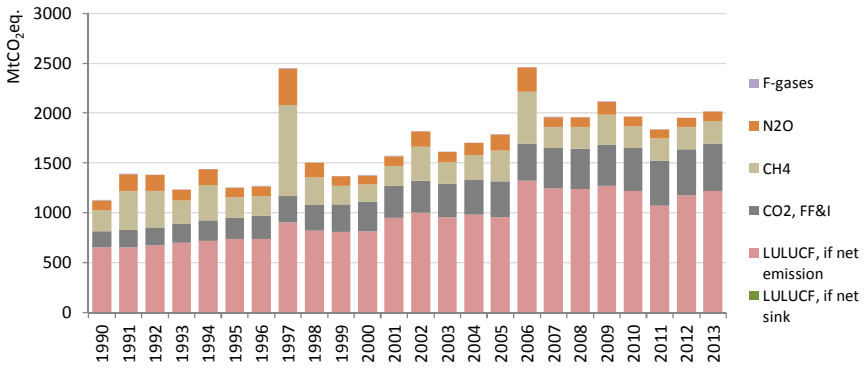

Figure 17. Indonesia's greenhouse gas emissions from 1990 to 2013.

Emission scenarios vs. INDC targets

Figure 18 presents emission statistics, official BAU projection, INDC targets and emission scenarios for Indonesia. The BAU projection is slightly higher than what the trend from 1990–2013 emissions would imply. The reference scenario projects more moderate increase in emissions, notably due to the assumption that deforestation would decrease slightly from current levels by 2030. The BAU level would require significant rise in both fossil and land-use emissions, and imply per-capita emissions of 10.5 t/capita.

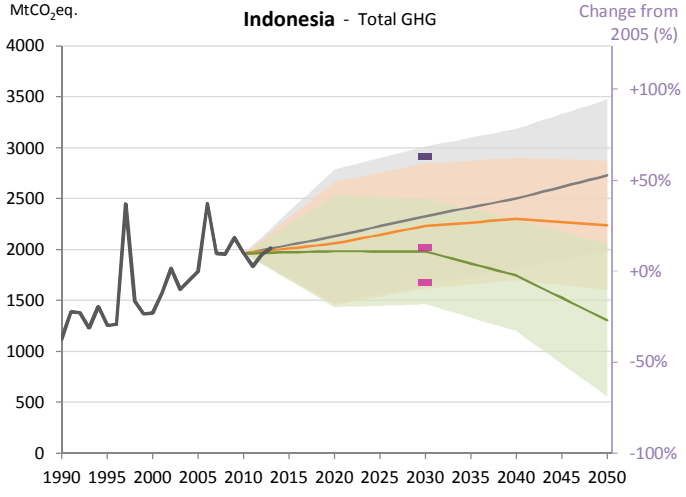

Figure 18. Black line presents Indonesia's GHG emissions from 1990 to 2013. Blue, orange and green lines show GHG emissions in the reference and two 2°C scenarios. The blue bar presents the INDC BAU projection, while purple bars show the unconditional and conditional INDC targets for 2030.

The conditional target would keep Indonesia's 2030 emissions at current levels. The target can be met by reducing deforestation emissions alone – e.g. by halving land-use emissions from the current level, while allowing fossil CO_2 emissions to double. As Indonesia is a developing country, this effort already puts Indonesia's emissions to the 2°C track, provided that emissions are cut further after 2030.

The conditional target of 41% from BAU would set 2030 emissions already below the 2°C paths, and set Indonesia on a long-term emission reduction track. Also the conditional target could be met with land-use emission reductions alone, while allowing other emissions to rise according to the reference scenario.

4.6 Brazil

Main findings and conclusions:

- Brazil's INDC target for 2025 involves emission reductions from 2005 that are comparable to the targets of many developed countries. An indicative target for 2030 follows the same trend.
- Almost half of Brazil's emissions are from land-use, and Brazil has already carried out significant reductions in deforestation emissions since 2005. However, the estimates for land-use emissions are uncertain, and based on different estimates, Brazil's emissions are already between 12% and 41% below 2005 levels.
- The INDC targets cannot be met by land-use measures only, but require reductions of fossil emissions even if land-use emissions would be reduced to zero. The INDC list planned measures e.g. for increasing renewables and energy efficiency.
- Brazil's INDC sets the country solidly on a long-term 2°C pathway.

The main details of the INDC

Brazil targets to reduce emissions by 37% below 2005 levels in 2025, with an additional, indicative target of 43% below 2005 levels in 2030.
The target has following further definitions:

- Conditionality: Unconditional
- Coverage: all GHGs
- Use of markets: the use of market mechanisms established under the Paris agreement is possible
- Metric: GWP100 from IPCC 5th assessment report
- LULUCF accounting: full accounting
- Target period: one year target for 2025, indicative target for 2030

National measures supporting the implementation of the target:

- National GHG inventories: Brazil has submitted two National Communications. Annual emission estimation and reporting has been commenced.
- Reference development: Emissions increase slightly in the reference scenario.
- Planned additional measures: Brazil's INDC highlights measures in increasing biofuels, renewable energy, energy efficiency, forestry measures and low carbon agriculture.
- Long term target set: No long-term target.
- Intermediate targets support long term target: Brazil's targets (including the indicative 2030 target) are on a linear -70% reduction path from 2005.

GHG emissions 1990–2013

Figure 19 shows Brazil's greenhouse gas emissions from 1990 to 2013. Brazil's emissions increased from sharply from 1990 to 2005, after which considerable emission reductions have taken place in deforestation, accompanied by continuing increase in fossil CO_2 and CH_4 emissions. As a result, Brazil's emissions are al-

ready some 12% below 2005 levels, which is the reference year in Brazil's INDC. However, the emission estimates on LULUCF vary considerably between sources. Brazil's own 2014 emission inventory[6] estimated that emissions have been reduced by 41% between 2005 and 2012.

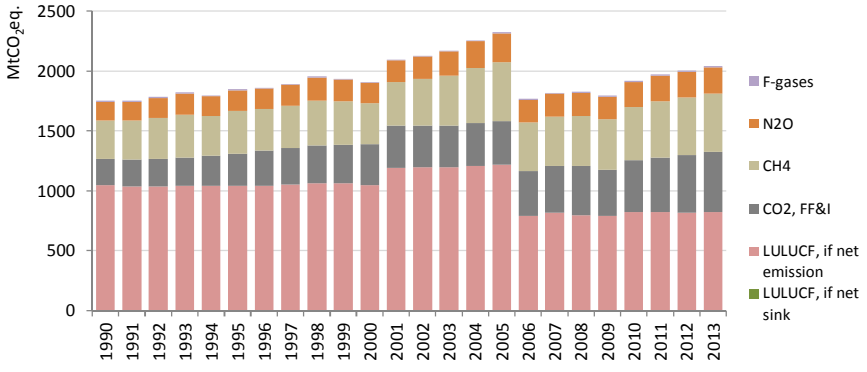

Figure 19. Brazil's greenhouse gas emissions from 1990 to 2013.

Emission scenarios vs. INDC targets

Figure 20 compares emission statistics, emission scenarios and INDC targets. Following the decline in deforestation emissions after 2005, Brazil's emissions have increased somewhat due to fossil CO_2 and CH_4 emissions. The reference path follows this trend, with emissions increasing slightly but stabilizing by 2050.

[6] http://www.mct.gov.br/upd_blob/0235/235580.pdf

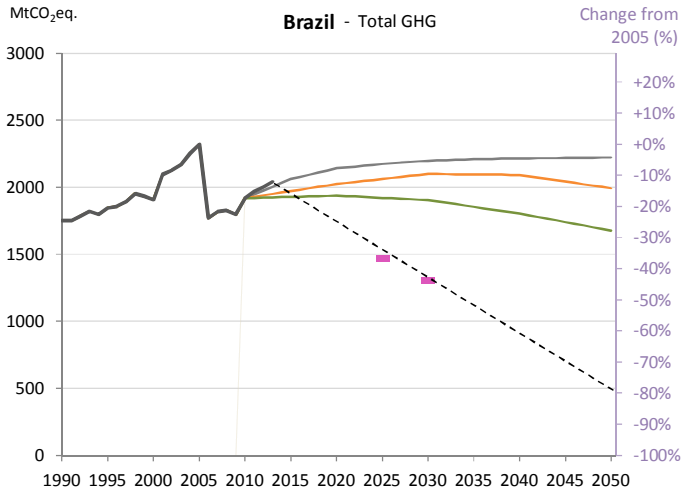

Figure 20. Black line presents Brazil's GHG emissions from 1990 to 2013. Grey line shows the GHG reference scenario. The orange and green lines represent Brazil's emissions in global scenarios with respectively 50% and 66% possibility of remaining below 2°C. Purple bars mark the 2025 INDC target and the indicative 2030 target. Dashed line shows linear trend with of present emissions and the targets.

Based on the emission estimates used here, the INDC would require ambitious emission reductions, comparable even to the most ambitious INDC's of more developed countries. The reductions required for the 2025 target are roughly equal to the current CO_2 emissions from deforestation. Further reductions would require also other measures, e.g. energy efficiency and renewable energy that are mentioned in Brazil's INDC. Reaching these targets would put Brazil on a path to a -80% reduction from 2005 levels by 2050.

However, given that Brazil's 2014 emission inventory estimated the emission reductions between 2005 and 2012 to be already 41%, with stronger reductions in deforestation than those presented in Figure 19; the INDC's true level of ambition remains somewhat contestable. However, despite whether the target has been met already or not, the reduction from 2005 levels is significant and compatible with the 2°C scenarios.

4.7 Russian Federation

Main findings and conclusions:

- Russia's emissions decreased sharply after the collapse of the Soviet Union. Russia uses the 1990 as a reference year to achieve less stringent emission reduction targets.
- Russia's INDC target is at much higher level than estimated reference development up to 2030.
- Russia's INDC targets are inadequate to support the global 2°C target.

The main details of the INDC

Russia targets emissions reductions between 25% and 30% from 1990 by 2030.

The target has following further definitions:

- Conditionality: The target is conditional.
- Coverage: All GHGs.
- Use of markets: No contribution from international credits.
- Metric: GWP100 from IPCC 4th Assessment Report.
- LULUCF accounting: Not defined.
- Target period: up to 2030.

National measures supporting the implementation of the target:

- National GHG inventories: Annual inventory reports.
- Reference development: Stable emissions in the reference scenario.
- Planned additional measures: Legislative acts for, inter alia, organization of GHG emissions forecasting; further legislative and regulatory acts based on the provisions of the Climate Doctrine and the Energy Strategy.
- Long term target set: No long-term target.
- Intermediate targets support long term target: The 2030 INDC target doesn't support the 2°C target.

GHG emissions 1990–2013

Figure 21 shows Russia's greenhouse gas emissions from 1990 to 2013. Emissions – primarily fossil CO_2 – collapsed dramatically after 1990, following the fall of the Soviet Union. Emissions have risen very modestly after 1997, while the forest sink has increased significantly. As a result, the emissions have been nearly 50% below the 1990 level during the past twenty years.

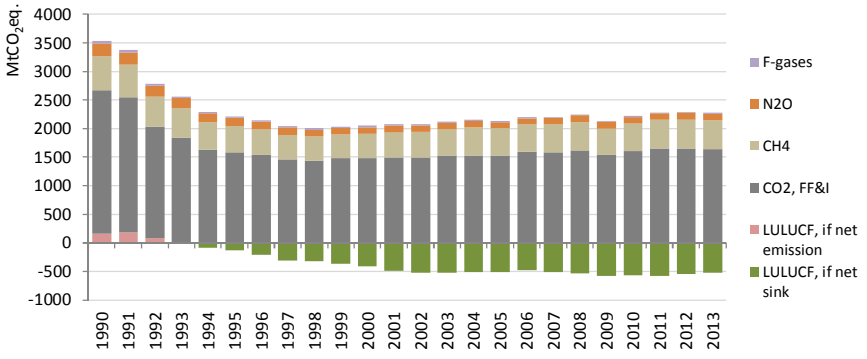

Figure 21. Russia's greenhouse gas emissions from 1990 to 2013.

Emission scenarios vs. INDC targets

Figure 22 presents Russia's emissions, INDC targets and two emission scenarios from the Greenhouse Gas Targets 2020 study[7] and 6th National communication[8]. In the reference scenario the emissions remain at current levels, while in the 'additional measures' scenario emission decline slightly after 2020. The INDC targets are far above these scenarios, and unrealistically high given the past trend.

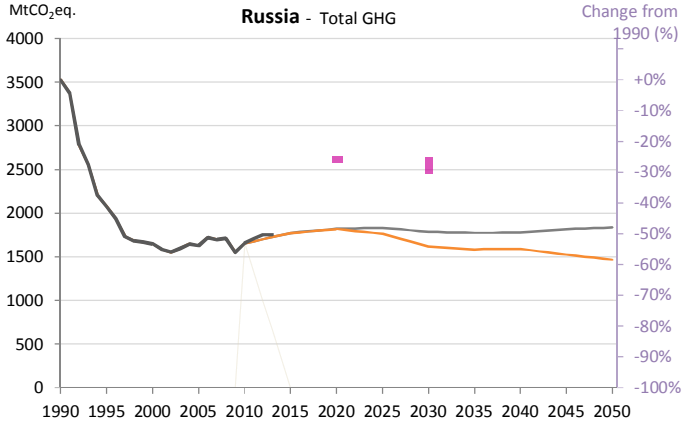

Figure 22. Russia's GHG emissions, in absolute amounts and relative to the 1990 level. Black line presents past years from 1990 to 2013. Grey line shows the GHG reference scenario, and the orange line an 'additional measures' scenario. Purple bars represent the INDC targets for 2020 and 2030.

[7] http://library.fes.de/pdf-files/id-moe/10632.pdf

[8] http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/6nc_rus_final.pdf

4.8 Japan

Main findings and conclusions:

- Japan's energy and climate policy is both cautious and searching for viable low-carbon options after the East Japan Earthquake.
- The INDC target for 2030 would reduce emissions but less than what is expected from developed countries.
- Japan seems to have the additional emission reduction measures required for the INDC target already planned.
- The INDC target for 2030 is not on a long-term low-carbon pathway.

The main details of the INDC

Japan targets emissions reductions from 25.4% from 2005 level by 2030 (alternatively stated as 26% from 2013 level).

The target has following further definitions:

- Conditionality: Unconditional
- Coverage: All GHGs. LULUCF likely not fully accounted.
- Use of markets: From 50 to 100 Mt CO_2 of international units.
- Metric: GWP100 from IPCC 4th Assessment Report.
- LULUCF accounting: Uncertain. Defined as "in line with approaches equivalent to those under the Kyoto Protocol."
- Target period: up to 2030.

National measures supporting the implementation of the target:

- National GHG inventories: Annual inventory reports.
- Reference development: Slightly declining emissions in the reference scenario.
- Planned additional measures: Japan's INDC has a long list of planned measures, primarily on energy efficiency.
- Long term target set: No official long-term target.
- Intermediate targets support long term target: Japan's 2030 target is moderately ambitious towards the 2°C target, putting Japan on a linear path towards a 60% reduction by 2050.

GHG emissions 1990–2013

Figure 23 shows Japan's greenhouse gas emissions from 1990 to 2013. CO_2 emissions from fossil fuels are clearly the largest emission source. Other sources are relatively small, while the LULUCF sector provides a modest sink. Japan's emissions have been relatively stable since 1990, with only a modest increase from 1990 and a dip in emissions following the financial crisis of 2008.

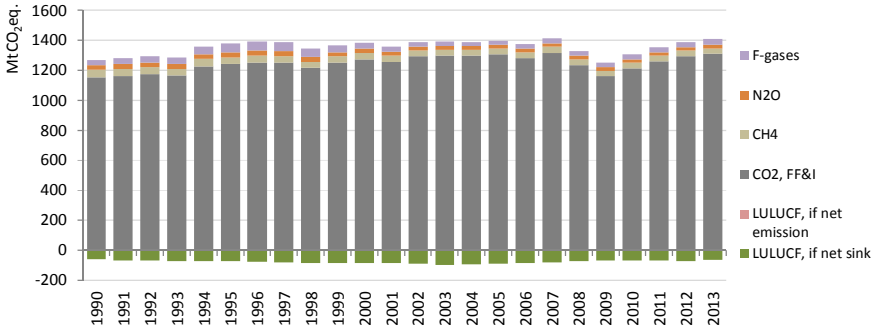

Figure 23. Japan's greenhouse gas emissions from 1990 to 2013.

Emission scenarios vs. INDC targets

Figure 24 presents Japan's past emissions, INDC target for 2030 and three emission scenarios. The INDC target is close to, but not below the green scenario (66% change to remain below 2°C) as with e.g. EU and US. The INDC target would put Japan on track towards a 60% reduction from 2005 levels by 2050. Therefore a significantly increased rate of reductions would be required after 2030 to reach reduction levels around 80% by 2050.

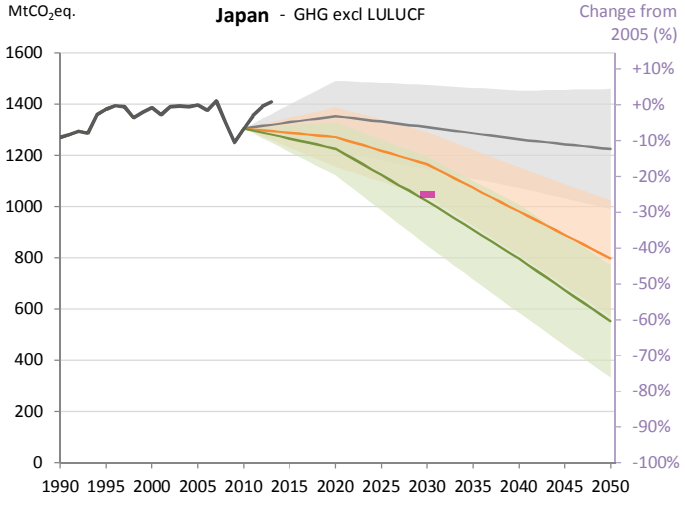

Figure 24. Japan's GHG emissions, in absolute amounts and relative to the 2005 level. Black line presents past years from 1990 to 2013. Grey line shows the GHG reference scenario. The orange and green lines represent scenarios with respectively 50% and 66% possibility of remaining below 2°C. Purple bar represents the INDC target for 2030.

4.9 Canada

Main findings and conclusions:

- The INDC of the Canada is only moderately ambitious, and less than what is expected from the developed countries.
- Canada's INDC targets are far above the linear -80% trajectory, and would put Canada on a path to -50% by 2050.
- Canada needs a considerable amount of additional mitigation measures to reach the INDC targets.
- The annual variability of LULUCF sector is large. The LULUCF accounting affects greatly on the total.
- Production approach for harvested wood products leaves a part of the LULUCF emissions unaccounted. The effect of this detail is more important to Canada than most other countries.

The main details of the INDC

Canada targets emissions reductions 30% from 2005 by 2030.

The target has following further definitions:

- Conditionality: Unconditional
- Coverage: All GHGs.
- Use of markets: Canada may use international market mechanisms
- Metric: GWP100 from IPCC 4th Assessment Report.
- LULUCF accounting: Net-Net for land use sector, but with production approach for harvested wood products and excluding the effects of natural disturbances.
- Target period: up to 2030.

National measures supporting the implementation of the target:

- National GHG inventories: Annual inventory reports.
- Reference development: Emissions increase slowly in the reference scenario
- Planned additional measures: Clean energy investments, clean power standards, vehicle fuel standards and some state level climate targets. No estimate of the total effect available.
- Long term target set: From -60% to -70% below 2005 level by 2050.
- Intermediate targets support long term target: Canada's 2030 INDC target is not sufficiently ambitious towards the 2°C target, and would put Canada on a linear path towards a 50% reduction from 2005 levels by 2050.

GHG emissions 1990–2013

Figure 25 shows Canada's greenhouse gas emissions from 1990 to 2013. CO_2 emissions from fossil fuels have increased relatively steadily since 1990. The LULUCF sector's net emissions have fluctuated strongly, and contributed as a modest sink in some years and as a considerable emission source on some years. As a result, the total net GHG level of Canada has fluctuated considerably. The current net emission level is roughly 30% higher than in 1990.

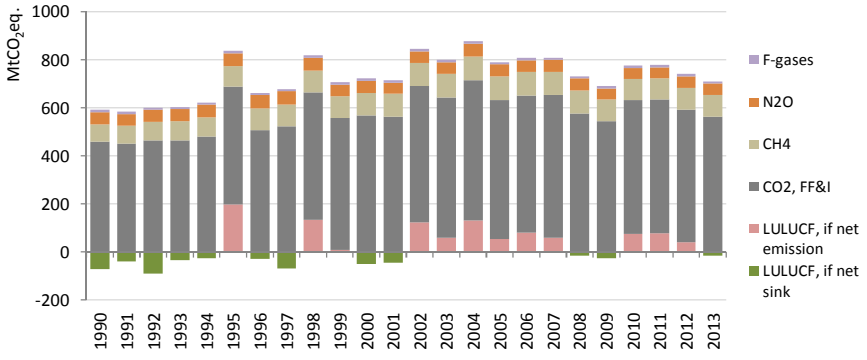

Figure 25. Canada's greenhouse gas emissions from 1990 to 2013.

Emission scenarios vs. INDC targets

Figure 26 presents Canada's past emissions, INDC target for 2030 and a reference scenario from the 6th national communication[9]. The INDC target would be a clear break from the past trend, and put Canada on path to a 50% reduction from 2005 level by 2050.

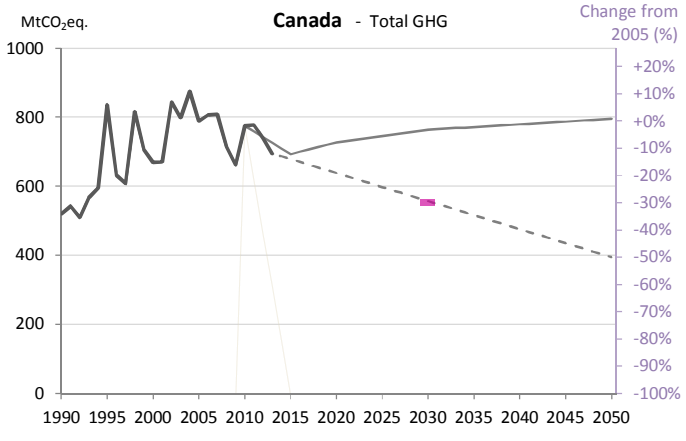

Figure 26. Canada's GHG emissions, in absolute amounts and relative to the 2005 level. Black line presents past years from 1990 to 2013. Grey line shows the GHG reference scenario. Purple mark represents the INDC target for 2030. Dashed line presents a linear trend from 2013 to a 50% reduction from 2005 in 2050.

[9] http://www.ec.gc.ca/cc/0BA54AAB-6E8E-4D48-B42C-DCBB09B27D10/6458_EC_ID1180-MainBook_high_min%20FINAL-s.pdf

4.10 Mexico

Main findings and conclusions:

- Mexico's INDC target is moderately ambitious, and requires a clear break from the past trend of increasing emissions.
- Mexico has a more ambitious indicative target for 2050, but even the conditional 2030 target would not put Mexico on the path towards the 2050 target.

The main details of the INDC

Mexico targets to reduce emissions of GHGs and black carbon 25% from baseline by 2030. Conditional reduction could increase the target up to 40% by 2030.

- Mexico has defined the baseline for both GHGs and black carbon
- For GHGs the target is unconditionally -22% from BAU and conditionally -36% from BAU. The GHG reduction targets would respectively equal 759 Mt CO_2-eq and 623 Mt CO_2-eq in 2030.

The target has following further definitions:

- Conditionality: Unconditional, with an additional conditional target.
- Coverage: All GHGs and black carbon.
- Use of markets: Not defined.
- Metric: GWP100 from IPCC 5th Assessment Report.
- LULUCF accounting: Not defined.
- Target period: up to 2030.

National measures supporting the implementation of the target:

- National GHG inventories: GHG inventory calculated every 4 years.
- Reference development: Emissions increase slowly in the reference scenario.
- Planned additional measures: General Climate Change Law, National Strategy for Climate Change, Special Programmes on Climate Change (current 2014–2018) and National Renewable Energy Program should bring required additional measures for the unconditional 2030 target.
- Long term target set: Indicative -50% target from 2000 level by 2050.
- Intermediate targets support long term target: The 2030 target is moderately ambitious, but does not meet to support the 2°C target or the indicative 2050 target.

GHG emissions 1990–2013

Figure 27 shows Mexico's greenhouse gas emissions from 1990 to 2013. CO_2 and CH4 emissions have increased steadily since 1990, while emissions from the land-use have declined. As a result, the emission level is currently roughly 40% above the 1990 level.

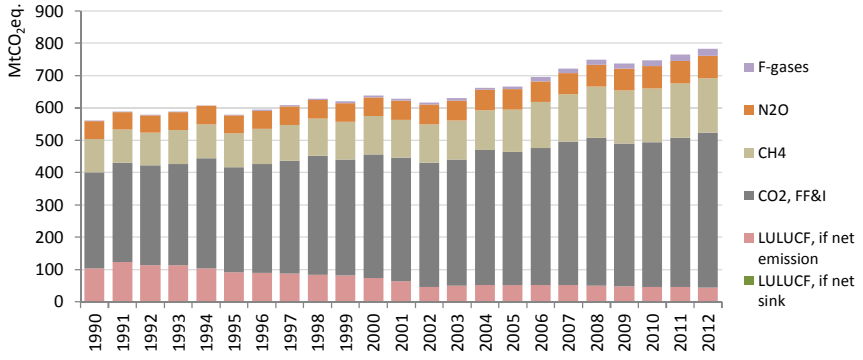

Figure 27. Mexico's greenhouse gas emissions from 1990 to 2012.

Emission scenarios vs. INDC targets

Figure 28 presents Mexico's past emissions, the unconditional and conditional INDC targets for 2030 and a reference scenario from National Climate Change Strategy[10]. The figure presents also a linear trend from the current emission level towards the indicative target for 2050. The INDC targets for 2030 require a clear break from the past trend or the reference scenario, but meeting the 2050 requires further reductions after 2030.

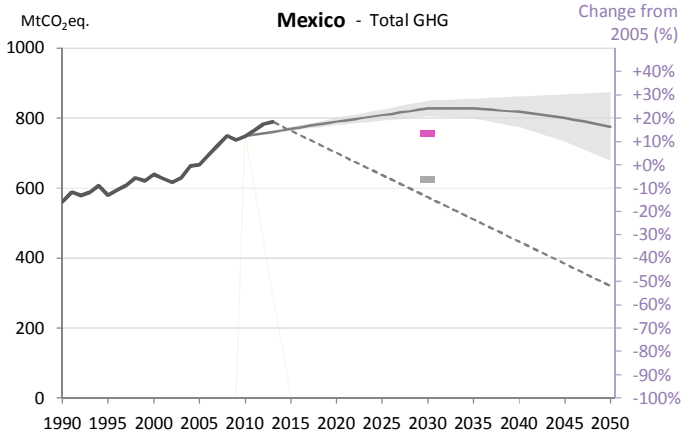

Figure 28. Mexico's GHG emissions, in absolute amounts and relative to the 2005 level. Black line presents past years from 1990 to 2013. Grey line shows the GHG reference scenario. Purple and grey marks represent the unconditional and conditional INDC targets in 2030. Dashed line presents a linear trend from 2013 to the indicative 2050 target (-50% from 2000 level).

10 http://www.semarnat.gob.mx/archivosanteriores/informacionambiental/Documents/06_otras/ENCC.pdf

4.11 Australia

Main findings and conclusions:

- Australia's INDC target for 2030 seems surprisingly strict. In the 'with measures scenario' emission remain at current level and, to achieve the 2030 target, Australia needs quite a lot of additional measures or international credits.
- The official estimates of the emission development is exaggerated and do not match statistics
- The climate policy situation is complicated in the Australia. The current government values economic growth over climate change mitigation, and thus opposes strict emission reductions. However, the public supports climate policy actions. The opposition would like to benefit from the public opinion, but would not like to upset the industry. The future actions depend highly on election results.

The main details of the INDC

Australia targets to reduce emissions by 26% to 28% below 2005 levels by 2030.

The target has following further definitions:

- Conditionality: Unconditional
- Coverage: All GHGs.
- Use of markets: Not defined.
- Metric: GWP100 from IPCC 4th Assessment Report.
- LULUCF accounting: Net-net approach excluding natural disturbances and variation.
- Target period: Target will be developed into an emission budget tat covers 2021–2030.

National measures supporting the implementation of the target:

- National GHG inventories: Annual inventory reports.
- Reference development: Emissions are stable or increase moderately.
- Planned additional measures: Australia's INDC lists only few planned measures. Australia has scrapped many mitigation measures, including CO_2 taxation in 2014.
- Long term target set: In the INDC, Australia says the Government will consider a long term target.
- Intermediate targets support long term target: Australia's 2030 INDC target is moderately ambitious, and put Australia on a linear path towards a 60% reduction by 2050.

GHG emissions 1990–2013

Figure 29 shows Australia's greenhouse gas emissions from 1990 to 2013. Emissions excluding LULUCF increased 30% from 1990 to 2008, after which they have been stable. Most of the increase was due to fossil fuel production and consumption, but also the N_2O and F-gas emissions have increased since 1990. LULUCF

sector has been a volatile but considerable emission source in Australia, with a peak of 220 Mt CO_2 in 2003.

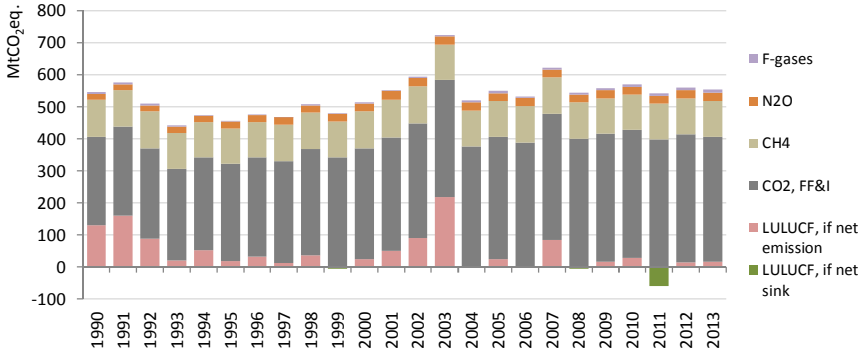

Figure 29. Australia's greenhouse gas emissions from 1990 to 2013.

Emission scenarios vs. INDC targets

Figure 30 presents Australia's past emissions, the INDC target for 2030 and two scenarios, with and without carbon pricing, from the 6th national communication[11]. The INDC target would put Australia on track towards a 60% reduction from 2005 levels by 2050.

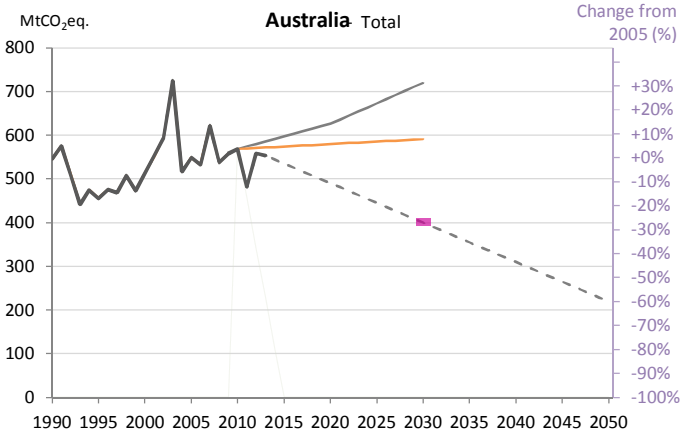

Figure 30. Australia's GHG emissions, in absolute amounts and relative to the 2005 level. Black line presents past years from 1990 to 2013. Purple mark represents the INDC target for 2030. Dashed line presents a linear trend from 2013 to a 60% reduction from 2005 in 2050.

[11] http://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/aus_nc6.pdf

4.12 South Korea

Main findings and conclusions:

- South Korea's INDC target would be adequate for a developing country, but does not reflect the rapid rise of South Korea's economy.
- Korea's emissions have grown rapidly between the 1990 and 2013. Some years have seen an annual growth of 10%.
- Emissions grow in the reference scenario while Korea has set ambitious regulation during the recent years. The reference scenario is outdated.
- Korea plans to use international credits up to 30% of the target. No domestic measures are planned to reach the entire target.

The main details of the INDC

Korea targets reducing emissions of GHGs 37% from baseline by 2030.

- In the baseline, 2030 emissions are 851 Mt CO_2-eq.
- In absolute emissions, the target equals 536 Mt CO_2-eq.

The target has following further definitions:

- Conditionality: Unconditional
- Coverage: all GHGs excluding LULUCF. Decision of LULUCF will be made later.
- Use of markets: Korea plans to use credits on a maximum 30% of emission reductions.
- Metric: GWP100 from IPCC 2nd Assessment Report.
- LULUCF accounting: Not defined yet.
- Target period: up to 2030.

National measures supporting the implementation of the target:

- National GHG inventories: Korea established national GHG inventory committee which will publish annual GHG inventories.
- Reference development: Emissions increase moderately in the reference scenario.
- Planned additional measures: Emission Trading Scheme started at Jan 2015, In June 2015 Korea cancelled 4 new coal power plants, generation targets for renewable electricity
- Long term target set: No long-term target.
- Intermediate targets support long term target: The INDC target is not sufficiently ambitious, given the rapid economic growth and resulting increase of affluence in South Korea.

GHG emissions 1990–2013

Figure 31 shows South Korea's greenhouse gas emissions from 1990 to 2013. The major share is from fossil CO_2. The LULUCF sector is a small net sink of CO_2 emissions. The emissions are growing fast and have increase more than 130% between 1990 and 2013.

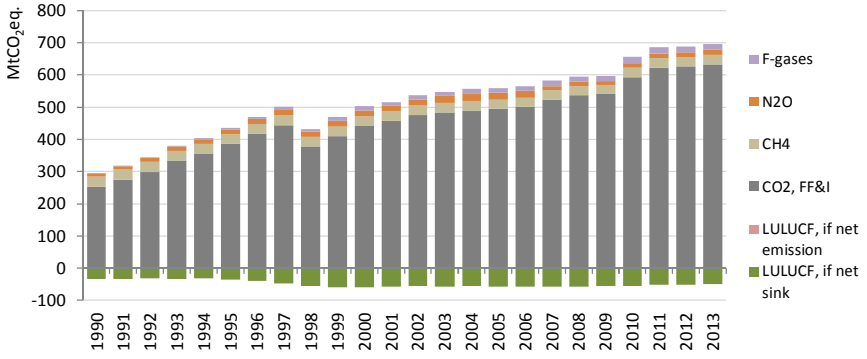

Figure 31. South Korea's greenhouse gas emissions from 1990 to 2013.

Emission scenarios vs. INDC targets

Figure 32 presents South Korea's past emissions, the INDC target for 2030 and a reference scenario based on the 3rd National communication[12]. The INDC target would make a break in the trend of past emissions or the reference scenario, but is very modest, leading to a trend of 20% reduction from 2005 by 2050.

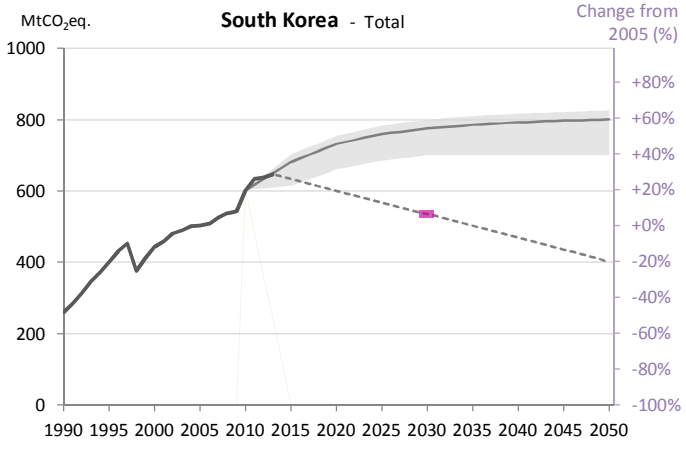

Figure 32. South Korea's GHG emissions, in absolute amounts and relative to the 2005 level. Black line presents past years from 1990 to 2013. Grey line shows the GHG reference scenario. Purple mark represents the INDC target for 2030. Dashed line presents a linear trend from 2013 to a 20% reduction from 2005 in 2050.

[12] http://unfccc.int/resource/docs/natc/kornc3.pdf

Appendix A: Data and methodology

The analysis was based on publicly available data sources, which are listed below.

GDP and population projections are from the Shared Socioeconomic Pathways (SSP) and correspond to the SSP2 scenario. The SSP scenarios are a common set of scenarios used widely in the climate change and mitigation scenario research, and comprise five scenarios with different socioeconomic development storylines. The SSP2 scenario is named "Middle of the road", and it portrays a moderate population growth and economic growth. The SSP projections are accessible in a database maintained by IIASA[13].

Emission estimates were compiled from multiple sources. For year 2010, fossil and industrial CO_2, CH_4 and N_2O emissions are from EDGAR database, and land-use change emissions and sinks are from FAO. INDC targets were based on the INDC's submitted by 20 November, 2015. Regarding future emission scenarios for the country-level analyses, the 2°C scenarios were from the AME mitigation scenario intercomparison study[14], and the reference and policy scenarios from parties' own National Communications to the UNFCCC and other sources, as indicated in the country-level analysis. Projections for international shipping and aviation emissions up to 2050 were from IMO[15] and ICAO[16].

Increase in global mean temperature, based on the projected emissions, was modelled with REFUGE3, a simplified climate-response model. The model uses atmospheric lifetimes and impulse response functions for GHG concentrations from IPCC AR4 (2007; WG1, page 212 and 213), radiative forcing formulas from IPCC TAR (2001; WG1, page 358), and a two-reservoir model for temperature (atmosphere + sea surface layer and deep oceans) based on the DICE and TIAM models. Uncertainty in climate sensitivity corresponds to the 'likely' range – between 1.5°C and 4.5°C – from IPCC AR5 (WG1, page 16).

[13] https://tntcat.iiasa.ac.at/SspDb/dsd
[14] https://secure.iiasa.ac.at/web-apps/ene/AMEDB/dsd
[15] www.iadc.org/wp-content/uploads/2014/02/MEPC-67-6-INF3-2014-Final-Report-complete.pdf
[16] www.icao.int/environmental-protection/GIACC/Giacc-4/Giacc4_ip01_en.pdf

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VTT Technology 239

Title	**An analysis of countries' climate change mitigation contributions towards the Paris agreement**
Author(s)	Tommi Ekholm & Tomi J. Lindroos
Abstract	142 "Intended, Nationally Determined Contributions" (INDCs) have been submitted to the United Nations' climate treaty (UNFCCC) towards the forthcoming Paris negotiations. In the INDCs, parties state their intended contribution for mitigating climate change in the coming decade. However, the content of the INDCs varies considerably between parties, making it difficult to estimate and compare the level of ambition by the parties, or the emission level implied by the INDCs. A critical question is whether the INDCs are collectively ambitious enough to keep the 2°C target within reach. This research • provides country-level estimates on the emissions implied by 53 INDC's, • compares the countries' contributions between each other, • presents temperature projections based on the INDCs and two post-2030 emission pathways, and • analyses 12 highest-emitting parties' INDCs in depth. The emission levels around 2030 implied by 53 INDCs were compared to each other under the "common but differentiated responsibilities and respective capabilities" principle. Most developed countries target significant emission reductions from the current level. For developing countries the level of ambition is very dispersed: while some target a stabilisation of emissions by 2030, some project more than 200% increase from 2010 level. Additionally, the mitigation effort is not quantifiable from many INDCs, e.g. because the Business-as-Usual scenario from which the reduction target is defined was not given in the INDC. Collectively, the INDCs would bring an emission reduction between 4 and 8 Gt CO2 eq from the reference scenario in 2030, with strong contribution from both developed and developing countries; and the global emissions would be between 50 and 54 Gt CO2 eq. An analysis of post-2030 emission pathways showed that this emission level is compatible with the 2°C target only if steep emission reductions are undertaken after 2030. Increasing the level of ambition of 2030 is a key priority to improve the changes of keeping global mean temperature increase below 2°C.
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Nimeke	**Pariisin ilmastosopimukseen lähetettyjen maakohtaisten ilmastonmuutoksen hillintätavoitteiden analyysi**
Tekijä(t)	Tommi Ekholm & Tomi J. Lindroos
Tiivistelmä	142 YK:n ilmastosopimuksen osapuolta on esittänyt maakohtaisten ilmastonmuutoksen hillintätavoitteen (Intended, Nationally Determined Contribution; INDC) Pariisin neuvotteluiden alla. INDC:ssä kukin maa on määritellyt oman tavoitteensa kasvihuonekaasupäästöjen vähentämiselle seuraavalle vuosikymmenelle. INDC:den sisältö vaihtelee kuitenkin huomattavasti maittain, tehden maiden kunnianhimon ja INDC:stä seuraavan päästöjen tason arvioimisen ja vertailun vaikeaksi. Kriittinen kysymys on myös ovatko INDC:t yhdessä riittävän kunnianhimoisia jotta lämpenemisen rajoittaminen enintään 2°C tasolle olisi mahdollista. Tässä tutkimuksessa • esitetään maakohtaisia päästöarvioita 53 INDC:n pohjalta, • verrataan maiden päästövähennystavoitteita toisiinsa, • esitetään INDC:den ja kahden päästöpolun mukainen projektio ilmaston lämpenemisestä, sekä • analysoidaan tarkemmin 12 suurimman päästäjän INDC:tä. 53 arvioidun INDC:n mukaista, vuoden 2030 ympärillä tavoiteltavaa päästötasoa verrattiin toisiinsa YK:n ilmastosopimuksen "common but differentiated responsibilities" -periaatteen mukaisesti. Suurin osa kehittyneistä maista on ottanut tavoitteekseen päästöjen merkittävän vähentämisen vuoden 2010 tasosta. Kehittyvien maiden tavoitteet ovat sen sijaan hyvin hajanaisia: siinä missä osa maista pyrkii tasaantuvaan päästökehitykseeen 2030 mennessä, osan tavoitetaso vastaa 200% lisäystä vuodesta 2010. Usean INDC:n tavoitetasoa ei kuitenkaan voinut kvantifioida, esimerkiksi koska "Business-as-Usual" -skenaariota, johon annettu tavoite on sidottu, ei määritelty INDC:ssä. Yhdessä INDC:t saisivat aikaan noin 4-8 Gt CO2 ekv. päästövähennyksen referenssiskenaariosta vuonna 2030, ja globaali päästötaso olisi noin 50-54 Gt CO2 eq. Yhdistettynä oletuksiin vuoden 2030 jälkeisistä päästöpoluista, analyysi osoitti että INDC:t ovat yhteensopivia 2°C -tavoitteen saavuttamisen kanssa ainoastaan mikäli vuoden 2030 jälkeen toteutetaan hyvin jyrkkiä päästö-vähennyksiä globaalisti. Siten kunnianhimon korottaminen 2030 vuoden päästötavoitteisiin on tärkeää 2°C -tavoitteen saavuttamisen todennäköisyyden parantamiseksi.
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