PBL Netherlands Environmental Assessment Agency

Assessing Intended Nationally Determined Contributions to the Paris Climate Agreement – what are the projected global and national emission levels for 2025–2030?

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International Institute for Applied Systems Analysis
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MAIN FINDINGS

Main findings

By 29 October 2015, 156 Parties (representing approximately 90% of global greenhouse gas emissions in 2012) had submitted their Intended Nationally Determined Contributions (INDCs) to the UNFCCC in preparation for the adoption of the Paris Agreement in December 2015 (UNFCCC, 2015). In this report, we assess the mitigation components of the INDCs of 102 of these Parties (representing approximately 89% of global greenhouse gas emissions in 2012), including the EU28 Member States. The main findings of this assessment are:

Findings regarding global emissions: The collective ambition of the INDCs put forward in 2030 falls short of what is needed to put the world directly on a cost-effective pathway to keep the global temperature increase below 2 °C; however, if fully implemented, the INDCs will deliver significant emission reductions from business-as-usual trends.

- Full implementation of all unconditional INDCs is projected to reduce yearly global greenhouse gas emissions by approximately 9 (5–10) $GtCO_2eq$ by 2030, relative to the PBL business-as-usual scenario of about 65 $GtCO_2eq$ in 2030.
- Additional implementation of all conditional INDCs (which would require some form of international climate finance or international cooperation mechanisms) would increase this projected reduction to about 11 (7–13) $GtCO_2eq$ in 2030 below PBL business-as-usual levels.
- Despite these projected reductions relative to business-as-usual levels, global emissions are projected to increase until at least 2030, to about 56 (54–60) $GtCO_2eq$ if the unconditional INDCs are implemented, or to about 54 (52–58) $GtCO_2eq$ if the conditional INDCs are implemented as well. The median estimates for 2030 are 13% to 18% above 2010 emission levels.
- Implementation of the unconditional INDCs would still leave an emission gap of 14 (13–18) $GtCO_2eq$ relative to the global emission level needed for keeping the temperature increase below 2 °C with a likely chance (42 $GtCO_2eq$ in 2030, as estimated in the UNEP Gap Report of 2014). Implementation of the conditional INDCs would further reduce this gap to 12 (10–16) $GtCO_2eq$.

Findings regarding national INDCs (G20 members): the presented analysis of individual INDCs shows how INDC implementation could enable a transition from business-as-usual trends to lower emission levels, lower emissions per capita and lower emission intensities at both national and global levels.

- Based on national INDCs, emissions in middle-income countries such as Mexico, Indonesia, Brazil and South Korea are expected to peak before 2025. Emissions in China, India and South Africa are expected to peak by 2030 or later. Emissions in most high-income countries have already peaked in the past.
- The largest emission reductions in 2030 relative to the PBL business-as-usual scenario (which assumes that no new climate policies will be implemented) are projected for Australia, Brazil and Canada.
- Full implementation of submitted INDCs (unconditional and conditional) would decrease global net land-use (LULUCF) emissions by 2.6 $GtCO_2eq$ in 2030 compared to national business-as-usual projections, which is approximately one third of the total global emission reduction that would result from the full implementation of all unconditional INDCs. The largest absolute reductions in land-use emissions are expected for Brazil and Indonesia, followed by the United States, China, Ethiopia, Gabon and Democratic Republic of the Congo.
- Based on the submitted INDCs, per capita emission levels are projected to decline between 2010 and 2030 in all G20 countries except Argentina, China, India, the Russian Federation and Turkey.
- Similarly, emission intensities (emissions per GDP) are projected to decline between 2010 and 2030 in all G20 countries except Turkey, indicating a relative decoupling of economic growth and greenhouse gas emissions. Decoupling – implying absolute emission reductions in a growing economy – is projected for 13 to 15 of the G20 countries, depending on the conditionality of their INDCs.
- While the aggregate effect of submitted INDCs is projected to be insufficient to close the global emission gap, INDCs of some countries are nevertheless consistent with national cost-optimal below-2 °C pathways (EU28, United States) and/or below-2 °C pathways based on converging per capita emissions (United States).

Executive summary

From March 2015 all Parties to the UNFCCC could submit their Intended Nationally Determined Contributions (INDCs) to the UNFCCC Secretariat in preparation for the adoption of the Paris Agreement in December 2015. This report provides an overview of the INDCs submitted by 29 October 2015 and analyses their level of ambition. The INDCs are compared to emission projections based on i) implementation of current climate policies and ii) business-as-usual developments (not taking into account climate policies that have been put in place after 2004). The results of this study are presented below according to the following nine questions:

Global assessment

Q1) What are the announced reduction proposals of the INDCs submitted to date?
Q2) What are the projected global greenhouse gas emission levels by 2030 if all submitted INDCs are implemented?
Q3) What is the projected impact of the INDCs on reducing the global 2 °C emission gap by 2030?
Q4) What is the projected impact of the INDCs on emissions and removals from land use, land-use change and forestry (LULUCF) in the context of high uncertainties?

National assessment (G20 members)

Q5) How do emission reductions as projected for national INDCs compare to different historical base years?
Q6) How do emission reductions as projected for national INDCs compare to PBL business-as-usual projections?
Q7) Are national INDCs in line with below-2 °C pathways?
Q8) What do national INDCs imply for the timing and level of greenhouse gas emission peaks?
Q9) Are per capita emissions and emission intensities, as projected from national INDCs, converging between countries?

Q1: What are the announced emission reduction proposals of the INDCs submitted to date?

– *By 29 October 2015, 156 Parties out of 195 Parties to the UNFCCC had submitted their INDCs to the UNFCCC Secretariat* (see Figure ES.1). Together, these Parties were responsible for approximately 90% of global greenhouse gas emissions in 2012. Our analysis focuses on 74 INDCs (representing 102 Parties, including the 28 EU Member States[1]), covering all major emitting countries and including all Parties with a 2012 emission share of more than 0.1%. Some smaller countries for which adequate data was available for calculating the effect of their INDC targets were also included. The selected Parties together were responsible for 89% of global greenhouse gas emissions in 2012. Table ES.1 summarises the announced mitigation efforts of the G20 countries.

Q2: What are the projected global greenhouse gas emission levels by 2030 if all submitted INDCs are implemented?

– *Under full implementation of all unconditional INDCs, global greenhouse gas emissions are projected to be reduced by approximately 9 (5–10) $GtCO_2eq$ by 2030, relative to the PBL business-as-usual scenario of 65 $GtCO_2eq$ (which assumes no new policies after 2004, see Box 3.1).* If all conditional INDCs are implemented as well, this reduction would increase to approximately 11 (7–13) $GtCO_2eq$ in 2030. Compared to the current policies scenario (emission development under current and planned pre-2020 policies), projected reductions are 3 (0–5) $GtCO_2eq$ for the unconditional INDCs and 5 (1–7) $GtCO_2eq$ for the conditional INDCs. The uncertainty ranges are a result of uncertainties in the INDC projections for Australia, the Russian Federation, the United States, China and India.
– *Global emissions are projected to increase until at least 2030.* Based on the unconditional INDCs the global emission level for 2030 is projected at about 56 (55–60) $GtCO_2eq$. If the conditional INDCs are implemented as well, this level would be about 54 (52–58) $GtCO_2$. The median estimates are 13% to 18% above 2010 emission levels (Figure ES.2).
– *Global emissions could be reduced by an additional 1 (0–2) $GtCO_2eq$ by 2030 if, for some countries, current policies are assumed rather than INDCs.* In some countries, INDC implementation could result in *higher* emission levels than projected under current policies (according to our analysis, e.g. in Argentina, Chile, Ghana, Kazakhstan, Lebanon, Peru, Russian Federation, Turkey, Ukraine and Vietnam). If emission levels of these countries are projected under current policies rather than INDCs, the global emission projection for 2030 under the conditional INDC scenario (53 (52–57) $GtCO_2$) would be 1 (0–2) $GtCO_2eq$ lower.

Table ES.1

Summary of the unconditional and conditional mitigation targets for 2025 and 2030, as proposed in the INDCs of the G20 countries

Country[1]	Unconditional INDC (conditional)		Base year and Business-as-Usual[2] emission level ($MtCO_2eq$)		Emission target ($MtCO_2eq$) based on calculations of this study[3]	
	2025	2030			2025	2030
Argentina	-	-15% (-30%)	BAU 2030	670	-	570 (469)
Australia	-	-26% to -28%	2005	601	-	433 to 445
Brazil	-37%	-43%	2005	2,100	1,300	1,200
Canada	-	-30%	2005	749	-	524
China	-	Peaking CO_2 emissions around 2030; 60% to 65% CO_2 emission intensity reduction; 20% non-fossil fuels in primary energy consumption & increased forest stock volume	2005	7,038	-	13,957 [12,602; 16,835]
EU28	-	-40%	1990	5,626	-	3,376
India	-	Conditional: 33% to 35% emission intensity reduction; 40% non-fossil fuel electricity; Increase carbon sink volume	2005	1,809	-	4,168 [4,168; 6,733]
Indonesia	-	-29% (-41%)	BAU 2030	2,881	-	2,046 (1,700)
Japan	-	-26%	Fiscal Year 2013	1,408	-	1,042
Mexico	-	-22% (-36%)	BAU 2030	973	-	759 (623)
Russian Federation	-	-25% to -30%	1990	3,363	-	2,354 to 2,523
South Africa	-	-	BAU 2030	-	398 to 614	398 to 614
South Korea	-	-37%	BAU 2030	851	-	536
Turkey	-	-21%	BAU 2030	1,175	-	928
United States	-26% to -28%	-	2005	6,439	4,636 to 4,765	(3,992 to 4,121)[4]

1) The country-specific emission levels stated above include all greenhouse gas emissions from energy, industry and services, as well as emissions and removals from activities related to land use, land-use change and forestry (LULUCF) for the following countries: the United States, Turkey, Mexico, Indonesia, Brazil, India, China, Australia, and Argentina. The land-use emissions and removals from the remaining countries were aggregated as part of the global estimates of effects on land-use emissions and removals.
2) Projected business-as-usual emission levels, as reported by the submitted INDCs (UNFCCC, 2015).
3) Successful implementation of the INDCs is contingent upon an ambitious global agreement including additional means of implementation to be provided by developed country parties, technology transfer and capacity building following Articles 3.1 and 4.7 of the Convention.
4) The US INDC target for 2025 may be extrapolated to 2030 by assuming a linear pathway to the national long-term target (83% reduction below 2005 levels by 2050).

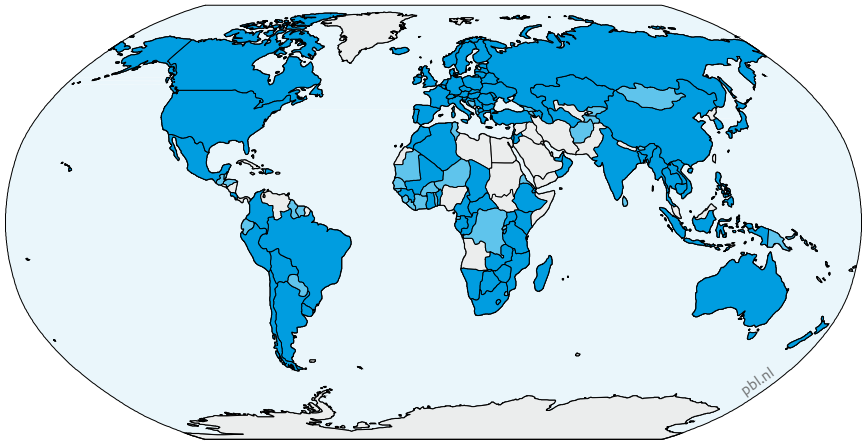
– *The above-mentioned estimates are subject to large uncertainties (in the range of 5 $GtCO_2eq$), as a result of uncertainties in the projections for some of the INDCs.* A large uncertainty is due to the dependence of several INDCs on economic growth. For instance, a 1% change in China's average annual economic growth would already result in a change in the emission target of approximately 2.5 $GtCO_2eq$ in the estimates of China's INDC. There are major uncertainties on the projections of land-use emissions and removals (see relevant section).

Q3: What is the projected impact of the INDCs on reducing the global 2 °C emission gap by 2030?

– *According to the UNEP Gap Report (2014), global emission levels consistent with a likely chance of staying within the 2 °C limit are projected at 42 (30–44) $GtCO_2eq$ in 2030* (median and 20th – 80th percentile range).
– *This leaves a gap of 14 (13–18) $GtCO_2eq$ between the global emissions projected to result from the unconditional INDCs (56 (55–60) $GtCO_2eq$) and the median emission level in the below-2 °C scenario of UNEP.* If the conditional INDCs are implemented as well, this gap would be 2 $GtCO_2eq$ smaller.

Figure ES.1

Countries that have submitted INDCs to the UNFCCC



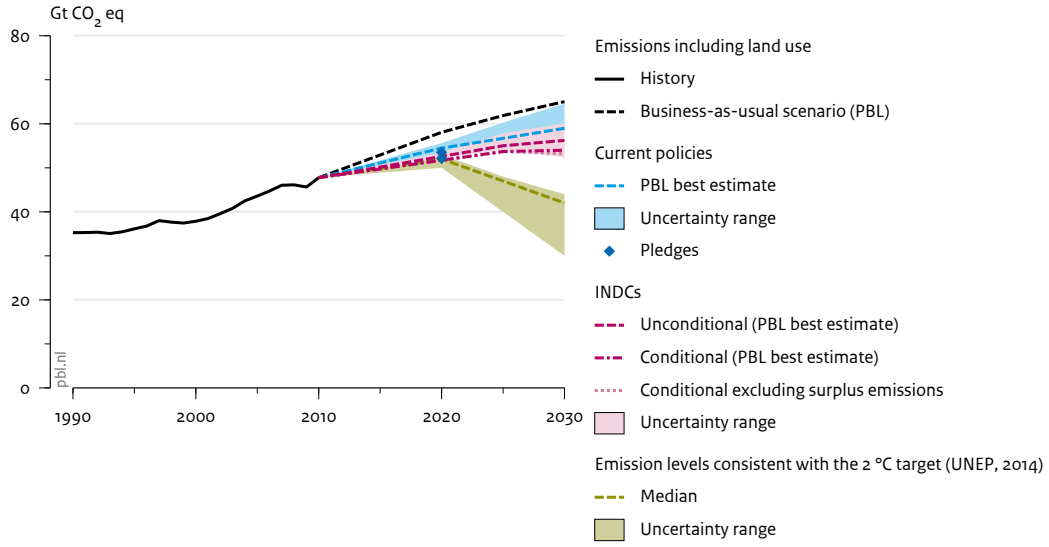
Situation 29 October 2015

- INDC submitted, analysed
- INDC submitted, not analysed
- No INDC submitted

Source: PBL

Figure ES.2

Impact of INDCs and climate policies on global greenhouse gas emissions



Source: PBL FAIR/TIMER model; IIASA GLOBIOM/G4M model; UNEP 2014

The global 2 °C emission gap is defined as the difference between the 2030 emission levels that would be consistent with keeping global warming below 2 °C (UNEP, 2014) and the 2030 emission levels that would result from implementation of the INDCs. Emission levels in the PBL business-as-usual scenario (which assumes that no new policies will be implemented after 2004) are based on PBL/IIASA model calculations; emission levels in the current policies scenario are based on Den Elzen et al. (2015). Historical global greenhouse gas emissions (excluding LULUCF) are based on EDGAR (JRC/PBL, 2015); historical LULUCF emissions on FAOSTAT (2015).

Q4: What is the projected impact of the INDCs on emissions and removals from land use, land-use change and forestry (LULUCF) in the context of high uncertainty?

- *Of the 156 Parties that had submitted an INDC by 29 October 2015, 95 Parties explicitly state that emissions and removals from LULUCF are included in their mitigation targets. However, only 36 of them provide quantifiable details of measures or specific targets for the LULUCF sector.* Of the remaining INDCs, 42 INDCs explicitly state that LULUCF emissions and removals are not included in their mitigation targets but nevertheless propose measures or policies to reduce net LULUCF emissions. The other 19 INDCs state that LULUCF emissions and removals are not covered and do not propose measures or policies for reducing net LULUCF emissions.
- *There is high uncertainty on the historical levels of emissions and removals, as well as on the projections of future emissions and removals. There is also only partial information in the INDCs on how INDCs will address these emission sources.*
- *Taking into account these uncertainties, we could estimate that the full implementation of all unconditional and conditional INDCs would decrease net LULUCF emissions in 2030 compared to national business-as-usual projections.* By contrast, under national business-as-usual scenarios and independent baseline scenarios, it is expected that net LULUCF emissions would increase by 2030. This shows that implementing INDCs is important for addressing these emission sources. However, the quantified impact of the INDCs on these emissions and removals is sensitive to the data and methodologies used. This study used national business-as-usual projections based on data provided by countries in their INDCs, complemented with information from National Communications or other published information sources where needed.
- *The largest absolute reductions in net LULUCF emissions are expected in Brazil and Indonesia, followed by the United States, China, Ethiopia, Gabon and Democratic Republic of the Congo.*

Q5: How do emission reductions as projected for national INDCs compare to different historical base years?

- *The national INDCs can be converted into reduction targets for 2030, compared to various historical years.* For example, the EU28's target of 40% reduction relative to 1990 levels is equivalent to 29% reduction relative to 2010 levels, due to the fact that emissions in the EU declined between 1990 and 2010. The target of the United States (26%–28% reduction relative to 2005 levels, by 2025) may be extrapolated to a 36% to 38% reduction by 2030, assuming a linear pathway towards the country's long-term goal of 83% reduction by 2050. Relative to 2010 levels, however, the reduction estimated for 2030 would be 30% to 32%.

Q6: How do emission reductions as projected for national INDCs compare to PBL business-as-usual projections?

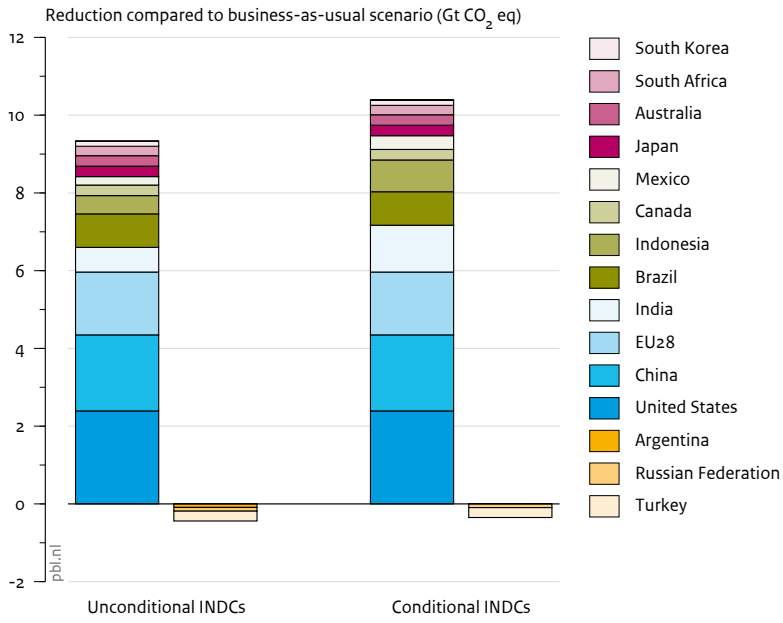
- *The INDCs of the G20 countries are projected to reduce emissions relative to PBL business-as-usual levels by approximately 9 to 10 $GtCO_2eq$ by 2030. The INDCs of other (non-G20) countries are projected to reduce emissions by an additional 0 to 1 $GtCO_2eq$.* Among the G20, substantive absolute emission reductions from PBL business-as-usual levels can be expected for the United States, followed by China, the EU28, India and Brazil. Together, these five countries would achieve approximately 80% of the total global emission reduction projected (Figure ES.3).
- *The largest relative emission reductions compared to PBL business-as-usual emission levels in 2030 are projected for Australia, Brazil, Canada and the United States.*

Q7: Are national INDCs in line with below-2 °C pathways?

- *While the aggregate effect of the submitted INDCs is projected to be insufficient to close the global emission gap, INDCs of some countries are nevertheless consistent with below-2˚C emission pathways based on either cost-effectiveness or per capita emission convergence.*
- *The INDC of the EU28 is projected to reduce emissions to a level close to the domestic reduction of 40% to 45% required in a least-costs below-2 ˚C scenario.* However, the projected reduction is not consistent with a below-2 °C pathway based on convergence of per capita emissions from 2010 levels to 2.4 tonnes CO_2eq per capita by 2050 (Figure ES.4).
- *The INDC of the United States is projected to reduce emissions to well below current policies levels.* If the reduction target for 2025 is extrapolated to 2030 (based on the national long-term 2050 target), the resulting emission reduction would be in line with both the least-costs below-2 °C emission pathway and the per capita emissions convergence trajectory for this country. The latter is particularly noteworthy, considering the relatively high per capita emissions in the United States in 2010 (22 tonnes CO_2eq per capita, more than twice the level of the EU in that year). However, both pathway estimates (least-costs and per capita convergence) are subject to large uncertainties related to LULUCF CO_2 emission projections for this country (Figure ES.5).
- *The INDCs of China and India are projected to result in emissions well above levels required for below-2 °C scenarios.* However, the INDC projections for these countries are subject to many uncertainties, including uncertainties related to GDP growth rate projections and the implementation of policies announced in the submitted INDCs (Figures ES.6 and ES.7).

Figure ES.3

National emission reductions in G20 countries based on their INDCs, 2030

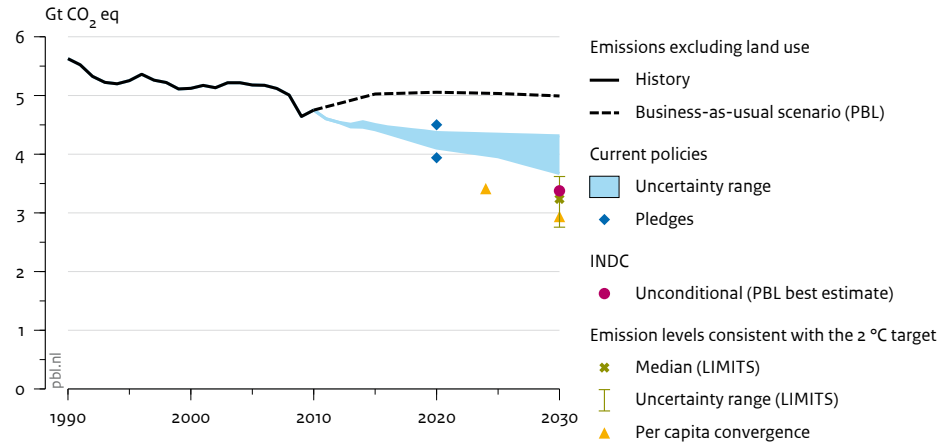


Source: PBL FAIR/TIMER model

Absolute reductions relative to the PBL business-as-usual emission level in 2030 (positive numbers indicate emission reductions, negative numbers indicate emission increases). For countries with a reduction target range, projected reductions were based on the average of the range.

Figure ES.4

Impact of the EU28's INDC and climate policies on its greenhouse gas emissions

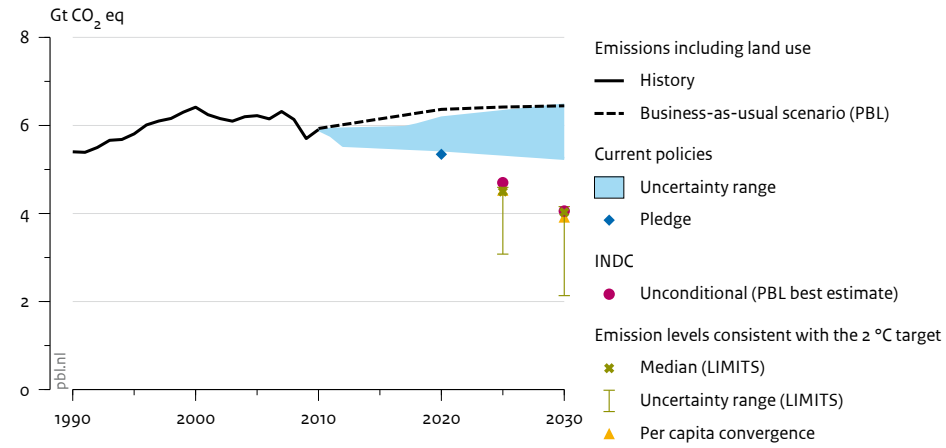


Source: PBL FAIR/TIMER model

Historical greenhouse gas emissions are based on national inventories submitted to the UNFCCC. Current policy projections are based on Den Elzen et al. (2015). The per capita convergence (2 °C) target is based on a convergence from 2010 levels to 2.4 tCO_2eq per capita by 2050, consistent with the global 2050 levels required for meeting the below-2 °C target (UNEP, 2014). The least-costs 2 °C target is based on the LIMITS study ('Low climate Impact scenarios and the Implications of required Tight emission control Strategies') (Tavoni et al., 2014).

Figure ES.5

Impact of the US' INDC and climate policies on its greenhouse gas emissions

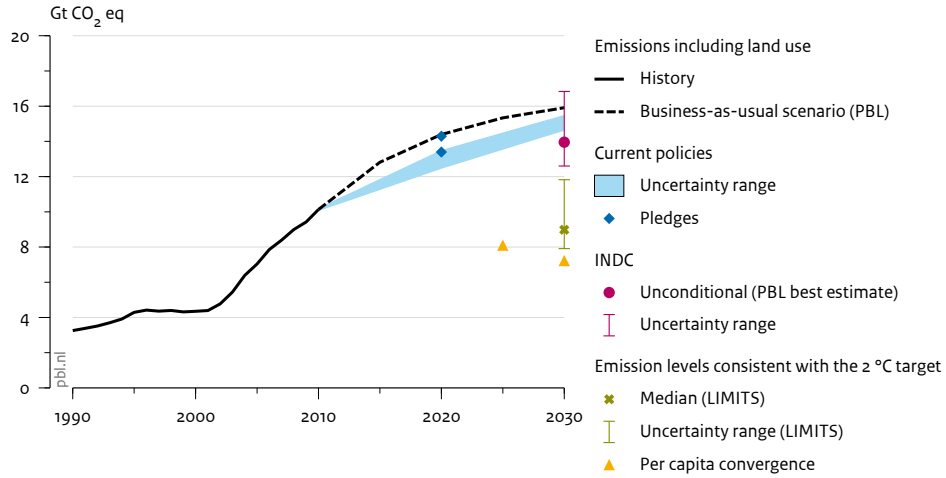


Source: PBL FAIR/TIMER model

Historical greenhouse gas emissions are based on national inventories submitted to the UNFCCC. LULUCF emission history and projections are based on the Sixth National Communication (US Department of State, 2014). Current policy projections are based on Den Elzen et al. (2015). The per capita convergence (2 °C) target is based on a convergence from 2010 levels to 2.4 tCO_2eq per capita by 2050, consistent with the global 2050 levels required for meeting the below-2 °C target (UNEP, 2014). The least-costs 2 °C target is based on the LIMITS study (Tavoni et al., 2014). The INDC emission projection for 2025 is calculated using the 2005 base year from the national inventories; the 2030 emission level is based on a linear extrapolation between the projection for the 2025 target and the national long-term target for 2050.

Figure ES.6

Impact of China's INDC and climate policies on its greenhouse gas emissions

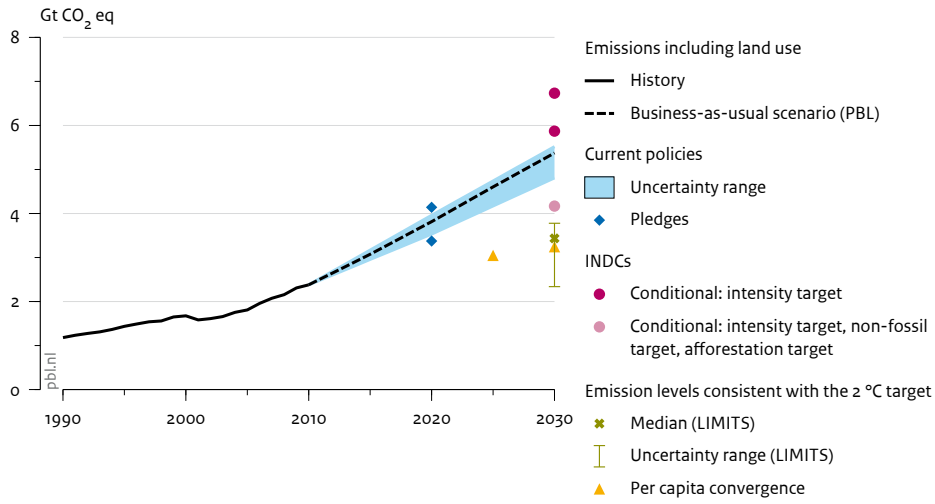


Source: PBL FAIR/TIMER model; IIASA GLOBIOM/G4M model

Uncertainties in the numbers presented are related to the peak emission level, GDP and population growth rates, and the final emission intensity levels by 2030. Historical greenhouse gas emissions (including LULUCF) are based on energy-related emissions (IEA, 2013a), non-energy-related emissions (EDGAR 4.2) (JRC and PBL, 2012) and LULUCF emissions (FAOSTAT). LULUCF emission projections are based on IIASA model calculations. Current policy projections are based on Den Elzen et al. (2015). The per capita convergence (2 °C) target is based on a convergence from 2010 levels to 2.4 tCO_2eq per capita by 2050, consistent with the global 2050 levels required for meeting the below-2 °C target (UNEP, 2014). The least-costs 2 °C target is based on the LIMITS study (Tavoni et al., 2014). The INDC emission projection for 2030 assumes a GDP growth rate of 5% between 2021 and 2030. The uncertainty range for this projection reflects a range in GDP growth of 4.3% to 6.3% (IEA, 2014; 2021–2030 GDP assumption with +1% and -1%).

Figure ES.7

Impact of India's INDC and climate policies on its greenhouse gas emissions

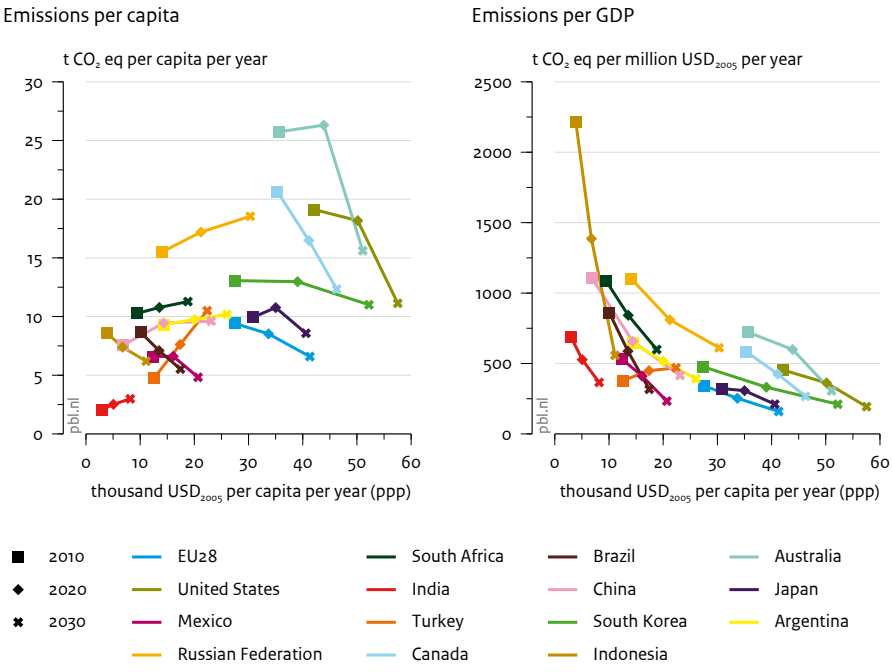


Source: PBL FAIR/TIMER model; IIASA GLOBIOM/G4M model

Historical greenhouse gas emissions (including LULUCF) are based on energy-related emissions (IEA, 2013a), non-energy-related emissions (EDGAR 4.2) (JRC and PBL, 2012) and LULUCF emissions (FAOSTAT). LULUCF emission projections are based on IIASA model calculations. Current policy projections are based on Den Elzen et al. (2015). The per capita convergence (2 °C) target is based on a convergence from 2010 levels to 2.4 tCO_2eq per capita by 2050, consistent with the global 2050 levels required for meeting the below-2 °C target (UNEP, 2014). The least-costs 2 °C target is based on the LIMITS study (Tavoni et al., 2014). The range in INDC projections is based on the range in GDP growth rates taken from WEO (IEA, 2014) and PBL model estimates of respectively 6.8% and 7.4% annual growth between 2005 and 2030.

Figure ES.8

Greenhouse gas emissions versus GDP per capita



Source: PBL FAIR/TIMER model; SSP database

Symbols represent emissions per capita and per GDP (y-axis) as a function of per capita GDP (PPP) (x-axis) in 2010, 2020 and 2030. Population and GDP data are from PBL business-as-usual calculations, based on the SSP2 scenario database (SSP database, 2015). The SSP database uses the population and GDP history until 2008 from The World Bank (2015) with SSP growth projections onwards. The 2020 emission levels are based on PBL projections for current policies; 2030 emission levels are based on PBL projections for the submitted INDCs.

Q8: What do national INDCs imply for the timing and level of greenhouse gas emission peaks?

- *Based on national INDCs, emissions in middle-income countries such as Mexico, Indonesia and Brazil are expected to peak before 2025.*
- *Emissions in China, India and South Africa are expected to peak by 2030 or later.* These countries have relatively high emission intensities due to carbon intensive economies. Based on China's INDC, CO_2 emissions in this country are projected to peak by 2030 at the latest, but its *total* greenhouse gas emissions are projected to peak after 2030.
- *Emissions in most high-income countries have already peaked in the past.* Emissions in the EU peaked around 1980; of the Russian Federation (then Soviet Union), around 1990; of Australia, Canada, Japan and the United States, around 2005; and of South Korea, around 2010.

Q9: Are per capita emissions and emission intensities, as projected from national INDCs, converging between countries?

- *Based on national INDCs, per capita emission levels are projected to decline between 2010 and 2030 in all G20 countries, except Argentina, China, India, the Russian Federation and Turkey.* Furthermore, the positive correlation between income and emissions per capita will largely disappear by 2030, as emissions per capita are converging between countries with different income levels (Figure ES.8, left panel).
- *Similarly, emission intensities (emissions per GDP) are projected to decline substantially between 2010 and 2030 in all G20 countries (except Turkey), with levels converging by 2030.* The largest reductions are projected for countries with the highest emission intensities in 2010, such as Indonesia, China and Brazil. Emission intensities are converging to levels between 250 and 750 tonnes CO_2eq per million USD in all G20 countries by 2030, independent of their emission intensity levels in 2010 and income levels in 2030 (Figure ES.8, right panel).
- *The convergence of both emission intensities and emissions per capita between G20 countries, despite their different income levels, reflects a decoupling of economic growth and greenhouse gas emissions.*

Note

1 In our analysis, the EU28 is considered as a single Party, and EU Member States are not considered individually. To ease reading, this report uses 'countries' and 'national' to refer to all 'Parties', including the EU28.

FULL RESULTS

Introduction

During the international climate negotiations under the umbrella of the United Nations Framework Convention on Climate Change (UNFCCC), Parties have agreed to collectively reduce greenhouse gas emissions with the aim to limit global mean temperature increase to less than 2 ˚C above pre-industrial levels, in order to avoid dangerous anthropogenic climate change (UNFCCC 2009; UNFCCC 2010). In this context, many countries have formulated emission reduction proposals (pledges) for the year 2020, which are anchored in the Cancun Agreements. These pledges focus on mitigation, and a distinction is made between the effort level required from Annex I countries versus non-Annex I countries. Assessments of these pledges have shown that the associated emission reductions fall short of those consistent with the 2 ˚C climate target (Hof et al., 2013; UNEP, 2014).

The Conference of the Parties (COP) therefore invited all Parties to initiate or intensify domestic actions before 2020 and submit post-2020 goals, in order to achieve the below-2˚C objective of the Convention. Parties were asked to submit their post-2020 goals, formally known as Intended Nationally Determined Contributions (INDCs), well in advance of the COP21 in Paris in December 2015, where a legal agreement is planned to be adopted. These post-2020 INDCs differ from the 2020 pledges in that they do not only cover mitigation: Parties are also requested to address adaptation, fairness and ambition. Where necessary, INDCs may also include a call for financial support for mitigation and adaptation measures. Among the 156 Parties that had submitted an INDC by 29 October 2015, most Parties have included both adaptation and mitigation targets (UNFCCC, 2015). Another difference with the pre-2020 pledges is that, in order to encourage ambition among all Parties, the distinction between Annex I and non-Annex I countries has been abandoned.

In this report, we provide an assessment of a selection of the INDCs submitted to the UNFCCC by 29 October 2015 (Figure 1.1). We analyse the aggregate effect of these selected INDCs on projected global greenhouse gas emissions up to 2030, and compare the result to emission projections based on implementation of current climate policies and on business-as-usual developments. Furthermore, we assess the emission gap between the global emission levels required for keeping global temperature increase within 2°C, and those that would result from implementation of the submitted INDCs, by 2025 and 2030. Uncertainties in emission projections are also discussed. For G20 countries (including the EU28), we present several emission indicators to compare the ambition levels of their INDCs. We address the following questions:

Global assessment

1. What are the announced reduction proposals of the INDCs submitted to date? (Chapter 2)
2. What are the projected global greenhouse gas emission levels by 2030 if all submitted INDCs are implemented? (Section 3.1)
3. What is the projected impact of the INDCs on reducing the global 2 °C emission gap by 2030? (Section 3.2)
4. What is the projected impact of the INDCs on emissions and removals from land use, land-use change and forestry (LULUCF) in the context of high uncertainties? (Section 3.3)

National assessment (G20 members)

5. How do emission reductions as projected for national INDCs compare to different historical base years? (Section 4.1)
6. How do emission reductions as projected for national INDCs compare to PBL business-as-usual emission projections? (Section 4.2)
7. Are national INDCs in line with below-2 °C pathways? (Section 4.3)
8. What do national INDCs imply for the timing and level of greenhouse gas emission peaks? (Section 4.4)
9. Are per capita emissions and emission intensities, as projected from national INDCs, converging between countries? (Section 4.5)

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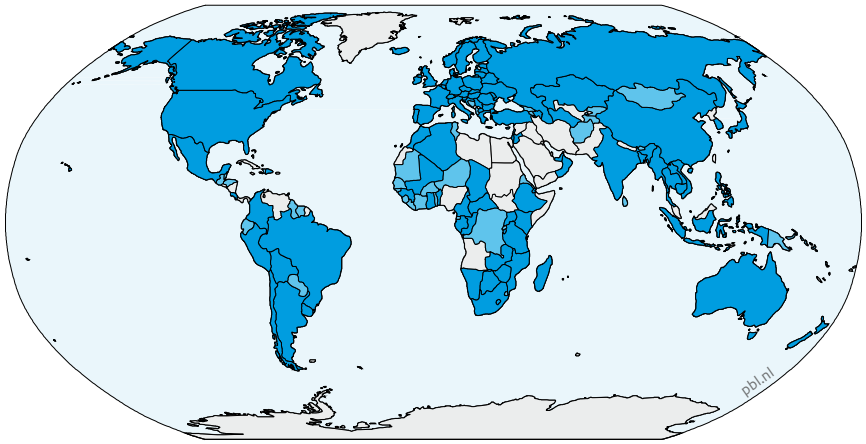
Figure 1.1

Countries that have submitted INDCs to the UNFCCC



Situation 29 October 2015

- INDC submitted, analysed
- INDC submitted, not analysed
- No INDC submitted

Source: PBL

Overview of the mitigation contribution of submitted INDCs

2.1 What are the announced emission reduction proposals of the INDCs submitted to date?

By 29 October 2015, 128 INDCs had been submitted to the UNFCCC in preparation for the adoption of the Paris Agreement in December 2015. These INDCs (including the INDC submitted by the EU, on behalf of its 28 Member States) cover emissions from 156 out of 195 Parties to the UNFCCC[1]. Together, these 156 Parties were responsible for approximately 90% of global greenhouse gas emissions in 2012 (Figure 1.1 and Table 2.1). In this report, we provide a quantitative assessment of the INDC mitigation targets of Parties with a 2012 global emission share of more than 0.1%. Some smaller countries for which adequate data were available for calculating the effect of their INDC targets were also included. Based on this selection we analysed a total of 102 Parties (including the EU28 Member States), which together were responsible for 89% of global greenhouse gas emissions in 2012 (see Table 2.1).

Table 2.1 presents an overview of the mitigation targets of all 128 INDCs submitted. Almost all parties committed to an unconditional reduction target. Among countries with emissions exceeding 100 $MtCO_2eq$ in 2012, India is the only country whose INDC targets are conditional, whereas targets set by Algeria, Argentina, Bangladesh, Chile, Colombia, Indonesia, Kazakhstan, Mexico, Philippines, Turkmenistan and Thailand are partially conditional. Conditional means that the implementation of reduction measures is conditional on international support, economic and technological developments, or other factors. Most countries defined their INDC targets for the year 2030, except for some countries (for example Brazil and the United States), who defined targets for 2025.

Table 2.2 quantifies the mitigation components of the INDCs submitted by G20 members[2], showing their reduction targets, the base year relative to which these targets are defined, and the calculated absolute emission targets. The latter emission levels were calculated using either national data from the INDC submission (if provided by the submitting party) or the national inventories (historical data or business-as-usual projections depending on how the INDC reduction targets were defined). More specifically, the base year and historical emissions for Australia, Canada, the EU28, Japan, the Russian Federation and the United States were based on UNFCCC national inventories, whereas base year emissions for Argentina, Brazil, Indonesia, Mexico, South Korea and Turkey were provided in the INDC submissions of these countries. It should be noted that our calculations do not account for credits or debits from land use, land-use change and forestry (LULUCF), surplus emission units, and double counting and additionality of offsets.

Among the G20, China and India are the only countries that did not propose an emission reduction target; instead, they propose a combination of climate policies and emission intensity reduction targets. The combined effect of their emission intensity targets, non-fossil targets and afforestation targets was calculated using the PBL TIMER energy model (Van Vuuren et al., 2014) for energy-related emissions and the IIASA GLOBIOM/G4M model (Havlik et al., 2014; Kindermann et al., 2008) for the LULUCF emissions. Based on these calculations, greenhouse gas emission levels in 2030 (including LULUCF) are projected at 13,955 $MtCO_2eq$ for China and 4,170 $MtCO_2eq$ for India (for details on China, see Den Elzen et al., 2015).

Notes

1 In our analysis, the EU28 is considered as a single Party, and EU Member States are not considered individually. To ease reading, this report uses 'countries' and 'national' to refer to all 'Parties', including the EU28.

2 Except Saudi Arabia, as this country submitted an INDC after 29 October 2015. France, Italy, Germany and the United Kingdom are covered by the INDC of the EU.

Table 2.1

Overview of the mitigation targets of the 128 INDCs submitted by 29 October 2015, including the share of each party in 2012 global greenhouse emissions (parties listed in alphabetical order)

Country/party	Share GHG emissions 2012[1]	Included in the analysis[2]	GHG emission reduction target[3]		
Afghanistan	0.03%		Conditional: 13.6%	By 2030	Below BAU
Albania	0.02%		11.5%	By 2030	Below BAU
Algeria	0.33%	X	Conditional: 7% to 22%	By 2030	Below BAU
Andorra	<0.01%		37%	By 2030	Below BAU
Antigua and Barbuda	<0.01%		List of policies and measures	By 2030	Below 2006
Argentina	0.71%	X	15% (conditional: 30%)	By 2030	Below BAU
Armenia	0.02%		189 tonnes per capita, 633 million tons carbon in 2015–2050	By 2050	Reduction of per capita emissions
Australia	1.42%	X	26% (conditional: 28%)	By 2030	Below 2005
Azerbaijan	0.11%	X	35%	By 2030	Below 1990
Bangladesh	0.34%	X	5% (conditional: 15%)	By 2030	Below BAU
Barbados	<0.01%		44% (23% below 2008)	By 2030	Below 2008
Belarus	0.20%	X	28%	By 2030	Below 1990
Belize	<0.01%		No explicit target for emission reduction	-	-
Benin	0.06%	X	3.5% (conditional: 17.9%)	By 2030	Below BAU
Bhutan	0.01%		Intends to remain carbon neutral	-	-
Bolivia	1.16%	X	No explicit target for emission reduction	-	-
Bosnia-Herzegovina	0.05%		2%	By 2030	Below BAU
Botswana	0.15%	X	15%	By 2030	Below 2010
Brazil	5.58%	X	37% below 2005 in 2025 (indicative: 43% below 2005 levels in 2030)	By 2025 (By 2030)	Below 2005
Burkina Faso	0.08%		6.6% (conditional: 11.6%)	By 2030	Below BAU
Burundi	0.01%	X	3% (conditional 20%)	By 2030	Below BAU
Cape Verde	<0.01%		30% renewables, 10% energy savings (conditional 100% renewables, 20% energy savings)	By 2025	Increasing the share of renewable energy and energy savings
Cambodia	0.24%	X	Conditional 27% and a LULUCF contribution of 4.7 $tCO_2eq/ha/year$	By 2030	Below BAU
Cameroon	0.19%	X	Conditional: 32%	By 2035	Below BAU
Canada	1.92%	X	30%	By 2030	Below 2005
Central African Republic	0.96%	X	Conditional: 5% by 2030, 25% by 2050	By 2030 (By 2050)	Below BAU
Chad	0.21%	X	18.2% (conditional: 71%)	By 2030	Below BAU
Chile	0.23%	X	Reduce carbon intensity by 30% per unit of GDP (conditional: 35% to 45% per unit of GDP)	By 2030	Below 2007
China	23.27%	X	CO_2 peaking around 2030; 60% to 65% CO_2 intensity improvements, 20% non-fossil fuels in primary energy consumption, increase the forest stock volume; list of policies and measures.	By 2030	Below 2005

Country/party	Share GHG emissions 2012[1)]	Included in the analysis[2]	GHG emission reduction target[3]		
Colombia	0.40%	X	20% (conditional: 30%)	By 2030	Below BAU
Comoros	<0.01%		84% (conditional: reductions beyond 10% of implementation costs)	By 2030	Below BAU
Congo	0.07%		Conditional: at least 48% (55%)	By 2025 (By 2035)	Below BAU
Costa Rica	0.02%	X	44%	By 2030	Below BAU
Côte d'Ivoire	0.06%		28%	By 2030	Below BAU
DR Congo	1.50%	X	Conditional: 17%	By 2030	Below BAU
Djibouti	0.01%	X	40% (conditional: 60%)	By 2030	Below BAU
Dominica	<0.01%		45%	By 2030	Below 2014
Dominican Republic	0.06%	X	Conditional: 25%	By 2030	Below 2010
Ecuador	0.09%		40% in per capita emissions and 20.4% to 25% in the energy sector	By 2025	Below BAU
Equatorial Guinea	0.01%		20% (with a view to 50% by 2050). Conditional on (unspecified) technical & financial support	By 2030 (By 2050)	Below 2010
Eritrea	0.01%		39.2% (conditional: 80.6%)	By 2030	Below BAU
Ethiopia	0.35%	X	64% (conditional on agreement enabling support and investments)	By 2030	Below BAU
EU28	8.74%	X	At least 40% domestic	By 2030	Below 1990
Former Yugoslav Rep. of Macedonia	0.02%	X	30% to 36% from CO_2 fossil fuels combustion	By 2030	Below BAU
Gabon	0.06%	X	50%	By 2025	Below BAU
Gambia	0.01%		45.4% (44.4% by 2025)	By 2030	Below 2010
Georgia	0.03%		15% (conditional: 25%)	By 2030	Below BAU
Ghana	0.20%	X	15% (conditional: 45%)	By 2030	Below BAU
Grenada	<0.01%		30% (indicative: 40% below 2010 levels by 2030)	By 2025 (By 2030)	Below 2010
Guatemala	0.06%		11.2% to 22.6%	By 2030	Below BAU
Guinea	0.19%	X	13%	By 2030	Below 1994
Guinea Bissau	0.01%		No explicit target for emission reduction	-	-
Guyana	0.01%		Up to 52Mt CO_2 (20% renewables)	By 2025	Below BAU
Haiti	0.02%		5% to 26%	By 2030	Below BAU
Honduras	0.04%		15%	By 2030	Below BAU
Iceland	0.01%	X	40%	By 2030	Below 1990
India	5.61%	X	Conditional: 33% to 35% emission intensity improvement; renewable energy to increase to 40% of total power capacity and an additional carbon sink of 2.5 to 3 Mt CO_2eq through additional forest and tree cover	By 2030	Below 2005
Indonesia	1.46%	X	29% (conditional: 41%)	By 2030	Below BAU
Israel	0.16%	X	26%	By 2030	Below 2005
Japan	2.76%	X	26%	By 2030	Below Fiscal year 2013
Jordan	0.05%	X	1.5% (conditional: 14%)	By 2030	Below BAU
Kazakhstan	0.68%	X	15% (conditional: 25%)	By 2030	Below 1990

Country/party	Share GHG emissions 2012[1)]	Included in the analysis[2]	GHG emission reduction target[3]		
Kenya	0.10%	X	Conditional: 30%	By 2030	Below BAU
Kiribati	<0.01%		12.8% (13.7% by 2025)	By 2030 (By 2025)	Below BAU
Kyrgyzstan	0.03%		11.49% to 13.75% (conditional: 29% to 30.89%) (also includes 2050 goals)	By 2030	Below BAU
Lao People's Democratic Republic	0.30%	X	No explicit target for emission reduction	-	-
Lebanon	0.04%	X	15% (conditional 30%)	By 2030	Below BAU
Lesotho	0.01%	X	10% (conditional 35%)	By 2030	Below BAU
Liberia	0.01%		Conditional 15%	By 2030	Below BAU
Liechtenstein	<0.01%		40%	By 2030	Below 1990
Madagascar	0.22%	X	14% emission sinks enhanced by 32%	By 2030	Below BAU
Malawi	0.04%	X	No explicit target for emission reduction	-	-
Maldives	<0.01%		10% (conditional: 24%)	By 2030	Below BAU
Mali	0.14%	X	27% (29% from agriculture, 31% from energy and 21% from LULUCF)	By 2030	Below BAU
Marshall Islands	<0.01%		32% (indicative: 45% below 2010 levels by 2030)	By 2025	Below 2010
Mauritania	0.02%		22.3% (33.6 $MtCO_2eq$) of which 88% conditional	By 2030	Below BAU
Mauritius	0.01%		Conditional: 30%	By 2030	Below BAU
Mexico	1.24%	X	22% (conditional: 36%), emissions peaking after 2026	By 2030	Below BAU
Monaco	<0.01%		50%	By 2020	Below 1990
Mongolia	0.05%		List of policies and measures	-	-
Montenegro	<0.01%		30% (preliminary target; could revisit after AFOLU rules agreed)	By 2030	Below 1990
Morocco	0.20%	X	13% (conditional: 32%)	By 2030	Below BAU
Mozambique	0.71%	X	No explicit target for emission reduction	-	-
Myanmar	0.99%	X	REDD+ goals otherwise not quantified	-	-
Namibia	0.07%	X	Conditional: 89%	By 2030	Below BAU
New Zealand	0.15%	X	30%	By 2030	Below 2005
Niger	0.02%		3.5% by 2030 and 2.5% by 2020. Conditional: 25% by 2020, 34.6% by 2030.	By 2030	Below BAU
Norway	0.12%	X	At least 40%	By 2030	Below 1990
Oman	0.12%	X	2%	By 2030	Below BAU
Papua New Guinea	0.02%		No explicit target for emission reduction	-	-
Paraguay	0.09%		10% to 20%	By 2030	Below BAU
Peru	0.14%	X	20% (conditional: 30%)	By 2030	Below BAU
Philippines	0.31%	X	Conditional: 70%	By 2030	Below BAU
Republic of Korea (South Korea)	1.25%	X	37%	By 2030	Below BAU
Republic of Moldova	0.02%	X	64% to 67% (conditional: 78%)	By 2030	Below 1990
Russian Federation	5.24%	X	25% to 30%	By 2030	Below 1990
Rwanda	0.01%		No explicit target for emission reduction	-	-
Samoa	<0.01%		No explicit target for emission reduction	-	-

Country/party	Share GHG emissions 2012[1]	Included in the analysis[2]	GHG emission reduction target[3]		
San Marino	<0.01%		20%	By 2030	Below 2005
Sao Tome and Principe	<0.01%		24%	By 2030	Below 2005
Senegal	0.09%		5% (conditional: 21%) (with targets for 2020 and 2025)	By 2030	Below BAU
Serbia	0.13%	X	9.8%	By 2030	Below 1990
Seychelles	<0.01%	X	29% (21.4%)	By 2030 (2025)	Below BAU
Sierra Leone	0.02%		No explicit target for emission reduction	-	-
Singapore	0.10%	X	Reduce emission intensity by 36%, emissions peaking around 2030	By 2030	Below 2005
Solomon Islands	0.01%		45% (27%)	By 2030 (2025)	Below BAU
South Africa	0.84%	X	By 2025 and 2030, emissions will be in a range between 398 and 614 $MtCO_2eq$, peaking between 2020 and 2025	By 2030	Below BAU
Sri Lanka	0.06%		No explicit target for emission reduction	By 2030	Below BAU
Suriname	<0.01%		No explicit target for emission reduction	By 2025	Below BAU
Swaziland	0.01%		No explicit target for emission reduction	By 2030	-
Switzerland	0.10%	X	50%	By 2030	Below 1990
Tajikistan	0.03%		10% to 20%	By 2030	Below 1990
Thailand	0.82%	X	20% (conditional: 25%)	By 2030	Below BAU
Togo	0.04%		11.14% to 31.14%	By 2030	Below BAU
Trinidad and Tobago	0.11%	X	30% in public transport; plus conditional 15% in power generation, transport and industrial sectors	By 2030	Below BAU
Tunisia	0.07%		13% decrease in carbon intensity (conditional: 41%; for energy sector 46%)	By 2030	Below 2010
Turkey	0.83%	X	21%	By 2030	Below BAU
Turkmenistan	0.17%	X	No explicit target for emission reduction	-	-
Uganda	0.15%	X	Conditional 22%	By 2030	Below BAU
Ukraine	0.76%	X	60%	By 2030	Below 1990
United Arab Emirates	0.38%	X	List of policies and measures, including an increase of renewable energy to 24% of the total energy mix by 2021	By 2021 and 2030	Below BAU
United Republic of Tanzania	0.44%	X	Conditional 10% to 20%	By 2030	Below BAU
Uruguay	0.06%	X	A list of sectorial targets sorted by GHG gas	-	-
United States of America	11.85%	X	26% to 28%	By 2025	Below 2005
Vanuatu	<0.01%		Conditional: 30% reduction in energy sector, 15% in all other sectors except agriculture and forestry (100% renewables for electricity)	By 2030	Below BAU
Vietnam	0.58%	X	8% (conditional: 25%)	By 2030	Below BAU
Zambia	0.60%	X	Conditional: 47%	By 2030	Below 2010
Zimbabwe	0.13%	X	33%	By 2030	Below BAU
Total share	**90%**	89%			

1) Including emissions from international transport. Source: EC-JRC EDGAR (JRC & PBL, 2012).
2) Covered in the analysis of this report (together representing 89% of global 2012 emissions). Other countries are not included in this analysis because of too much uncertainty in the quantification of their INDCs, or because their 2012 emission share was less than 0.1%.
3) As submitted to http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx (UNFCCC, 2015)

Table 2.2

Summary of the unconditional and conditional mitigation targets for 2025 and 2030, as stated in the INDCs of the G20 countries

G20 Country/party*	Unconditional INDC target (Conditional INDC target)		base year/emission level ($MtCO_2eq$)		Emission target ($MtCO_2eq$)[8,9] based on calculations of this study	
	2025	2030			2025	2030
Argentina	-	-15% (-30%)	BAU 2030	670[1]	-	570 (469)
Australia	-	-26% to -28%	2005	601[2]	-	433 to 445
Brazil	-37%	-43%	2005	2,100[1]	1,300	1,200
Canada	-	-30%	2005	749[2]	-	524
China	-	CO_2 emission peak around 2030; 60% to 65% CO_2 emission intensity reduction; 20% non-fossil fuels in primary energy consumption & increase of the forest stock volume	2005	7,038[3]	-	13,957[4] [12,602; 16,835][5]
EU28	-	-40%	1990	5,626[2]	-	3,376
India	-	Conditional: 33% to 35% emission intensity reduction; 40% non-fossil fuel electricity; Increase of carbon sink volume	2005	1,809[3]	-	4,168[4] [4,168; 6,733][7]
Indonesia	-	-29% (-41%)	BAU 2030	2,881[1]	-	2,046 (1,700)
Japan	-	-26%	Fiscal Year 2013	1,408[2]	-	1,042
Mexico	-	-22% (-36%)	BAU 2030	973[1]	-	759 (623)
Russian Federation	-	-25% to -30%	1990	3,363[2]	-	2,354 to 2,523
South Africa	-	-	BAU 2030	-	398 to 614[1]	398 to 614[1]
Rep. of Korea	-	-37%	BAU 2030	851[1]	-	536
Turkey	-	-21%	BAU 2030	1,175[1]	-	928
United States	-26% to -28%	-	2005	6,439[2]	4,636 to 4,765	(3,992 to 4,121)[6]

*) The country-specific emission levels stated above include all greenhouse gas emissions from energy, industry and services, as well as emissions and removals from activities related to land use, land-use change and forestry (LULUCF) for the following countries: the United States, Turkey, Mexico, Indonesia, Brazil, India, China, Australia, and Argentina. The land-use emissions and removals from the remaining countries were aggregated as part of the global estimates on effects of land-use emissions and removals.

1) Source: http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx.
2) Source: national inventories, UNFCCC, including Common Reporting Formats (2015).
3) Source: energy-related CO_2 emissions from IEA (2013a), non-energy-related emissions from EDGAR 4.2 (JRC and PBL, 2012) and LULUCF. emissions from FAOSTAT data (http://faostat3.fao.org/faostat-gateway).
4) For China and India the combined effect of emission intensity targets, non-fossil targets and afforestation targets was calculated using the PBL TIMER energy model and the IIASA GLOBIOM/G4M models. Based on these calculations, greenhouse gas emissions in 2030 (including LULUCF) are projected at 13,957 $MtCO_2eq$ for China and 4,168 $MtCO_2eq$ for India (for China, see details in Den Elzen et al., 2015).
5) The effect of China's CO_2 intensity target was calculated using annual GDP growth rates of 4.3% to 6.3% between 2021 and 2030 (as based on WEO 2014 and PBL model estimates). Hence the range in projected emissions.
6) The emission target for the United States for 2030 was estimated by extrapolating the 2025 emission level (calculated from the INDC) towards the 2050 emission level as based on the national long-term target (reducing emissions by 83% below 2005 levels by 2050, as is also described in the INDC).
7) The lower end of the range includes the effects of India's greenhouse gas intensity target, the non-fossil electricity target, as well as the carbon sink target. The upper end of the range only includes the effect of the greenhouse gas intensity target.
8) Calculated emission levels do not account for LULUCF carbon credits.
9) Successful implementation of the INDCs is contingent upon an ambitious global agreement including additional means of implementation to be provided by developed country parties, technology transfer and capacity building following Articles 3.1 and 4.7 of the Convention.

Global impact of the INDCs

3.1 What are the projected global greenhouse gas emission levels by 2030 if all INDCs are implemented?

To estimate the aggregate effect of INDCs on global emission levels, we distinguished two scenarios: one in which only the unconditional targets are implemented ('the unconditional INDC scenario'), and one in which both unconditional and conditional targets are implemented ('the conditional INDC scenario'). For countries whose INDC included unconditional targets only, we assumed that their emission level would be the same in both the unconditional and conditional scenarios. For countries whose INDC included only conditional targets, we assumed current policies emission levels (based on Den Elzen et al., 2015; Roelfsema et al., 2013), or, if not available, PBL business-as-usual levels when calculating total global emissions in the unconditional scenario.
Secondly, we assumed that emission levels of countries that had not submitted an INDC by 29 October 2015 would either follow current policies emission levels (Den Elzen et al., 2015; Roelfsema et al., 2013) or PBL business-as-usual levels based on the OECD Environmental Outlook (OECD, 2012). Total global emissions were calculated by adding international aviation emissions (ICAO, 2013) and international shipping emissions (IMO, 2014) (both harmonised to EDGAR 2010 emissions) and LULUCF emissions based on various sources (including FAOSTAT, national communications and model projections)[1] for those countries whose INDC did not address LULUCF.
The resulting global emission level in 2010 is estimated at 45.9 $GtCO_2eq$, which is about 2 $GtCO_2eq$ lower than the 47.8 $GtCO_2eq$ estimated from the total sum of global greenhouse gas emissions (excluding LULUCF CO_2) from the EDGAR database (JRC/PBL, 2012) and the global LULUCF CO_2 emissions from FAOSTAT. Both sources were used for historical greenhouse gas emissions. Therefore, global emission projections were harmonised to the 2010 emission level of 47.8 Gt CO_2eq, using a constant harmonisation factor over time from 2010 onwards. The difference between the global emission estimates is completely due to differences in the estimates for LULUCF emissions: the EDGAR data base reports higher LULUCF emissions than the estimates from FAOSTAT and national communications (see Chapter 11, IPCC Fifth Assessment Report).

Table 3.1 presents global and national greenhouse gas emissions in 2030, as projected from the submitted INDCs. As these projections show, global emissions will keep increasing until at least 2030, even if all INDCs are fully implemented. The projected global emission level in 2030 is about 56 (55–60) $GtCO_2eq$ if all unconditional INDCs are implemented, and about 54 (52–58) $GtCO_2eq$ if the conditional INDCs are implemented as well. The median estimates are 13 – 18% above 2010 emission levels. The range in these estimates is a result of the uncertainties in the INDC projections for Australia, the Russian Federation, South Africa, the United States, China and India.

The aggregate effort proposed by the INDCs is shown by comparing the 2030 global emission level projected for the INDCs with the 2030 global emission level projected for the PBL business-as-usual scenario (Box 3.1) and the current policies scenario[2], based on Den Elzen et al. (2015) and Roelfsema et al. (2013). The first comparison gives an indication of the total effort proposed relative to business-as-usual scenarios. This effort is projected at 9 to 11 $GtCO_2eq$ globally by 2030. The second comparison gives an indication of the effort proposed in addition to already implemented climate policies; this additional effort is projected at 3 to 5 $GtCO_2eq$ globally by 2030.

Although most of the individual INDCs are projected to lead to a decrease in national emission levels before 2030, compared to their current policies scenario (largely due to accelerated decarbonisation after 2020), total

Table 3.1

Greenhouse gas emissions in G20 countries and global emission levels, projected for 2030 for the PBL business-as-usual scenario, the current policies scenario, the unconditional INDC scenario and the conditional INDC scenario (the effect of INDCs of non-G20 countries is covered in the category 'other countries')

Greenhouse gas emissions, including LULUCF ($MtCO_2eq$)[1]			PBL BAU scenario	PBL current policies scenario[3]	Unconditional INDC scenario	Conditional INDC scenario
G20 countries	**1990[2]**	**2010[2]**	**2030**	**2030**	**2030**	**2030**
Argentina[6]	320	374	479	479	570	469
Australia[7]	555	560	708	666	439[10] [433; 445]	439[10] [433; 445]
Brazil[6]	1,611	1,688	2,062	1,524	1,200	1,200
Canada	613	707	796	671	524	524
China[6]	3,254	10,130	15,914	14,646	13,957[10] [12,602; 16,835]	13,957[10] [12,602; 16,835]
EU28	5,626	4,751	4,992	3,992	3,376	3,376
India[6]	1,180	2,379	5,374	4,739	4,739 [4,168; 6,733]	4,168[10] [4,168; 6,733]
Indonesia[6]	1,063	2,059	2,516	2,094	2,046	1,700
Japan	1,234	1,258	1,310	1,105	1,042	1,042
Mexico[7]	559	748	976	843	759	623
Russian Federation	3,363	2,221	2,342	2,174	2,438[10,13] [2,354; 2,523]	2,438[10,13] [2,354; 2,523]
South Africa	380	515	747	700	506[10] [398 ; 614]	506[10] [398 ; 614]
South Korea	289	629	673	545	536	536
Turkey[7]	144	346	675	545	928	928
United States[7]	5,402	5,907	6,447	5,572	4,056[10] [3,992; 4,121]	4,056[10] [3,992; 4,121]
Other countries[5]	6,223	9,172	14,766	14,895	14,861	13,769
Remaining LULUCF CO_2 emissions[8]	2,596	1,385	657	657	657	657
International marine & aviation emissions[4]	678	1,117	1,792	1,792	1,792	1,792
Harmonisation factor[9]	173	1,811	1,811	1,811	1,811	1,811
World, harmonised[11]	**35,265**	**47,757**	**65,032**	**59,339**	**56,235** [54,613; 60,091]	**53,990** [52,368; 58,416]
Excluding the impact of new surplus emissions[12]					-1,083	-797
World, harmonised excl. hot air					**55,152** [53,614; 58,214]	**53,193** [51,655; 56,825]

1) The country-specific emission levels stated above include all greenhouse gas emissions from energy, industry and services, as well as emissions and removals from activities related to land use, land-use change and forestry (LULUCF) for the following countries: the United States, Turkey, Mexico, Indonesia, Brazil, India, China, Australia, and Argentina. The land-use emissions and removals from the remaining countries were aggregated as part of the global estimates on effects of land-use emissions and removals. Only including LULUCF CO_2 emissions in countries with a high share of land-use emissions in their total emissions (including emissions from peatlands) and countries that explicitly addressed LULUCF in their INDC.
2) Source: Historical emissions in China, India and Indonesia are based on energy-related emissions (IEA, 2013), non-energy-related emissions (EDGAR 4.2, http://edgar.jrc.ec.europa.eu/overview.php?v=42FT2012#) (JRC/PBL, 2012) and LULUCF emissions (FAOSTAT). Historical emissions from other countries are based on UNFCCC national inventory submissions or the INDC submissions. Business-as-usual emissions are based on the OECD Environmental Outlook (OECD, 2012) as calculated by the IMAGE modelling framework.
3) Emission projections for the current policies scenario are based on Roelfsema et al. (2013) and Den Elzen et al. (2015).
4) Source: EDGAR 4.2 history, http://edgar.jrc.ec.europa.eu/overview.php?v=42FT2012#, and ICAO and IMO projections from 2010 through 2030.
5) Source: EDGAR 4.2 history, http://edgar.jrc.ec.europa.eu/overview.php?v=42FT2012#, and IMAGE projections from 2010 through 2030. This category covers the INDCs of non-G20 countries.
6) LULUCF source: FAOSTAT history, http://faostat3.fao.org/download/G2/*/E, and IIASA projections from 2010 through 2030.
7) LULUCF source: national communications as reported in the UNFCCC national inventory submissions.

8) LULUCF source: FAOSTAT history, http://faostat3.fao.org/download/G2/*/E, and IIASA projections from 2010 through 2030, except for Canada, the EU28, Japan, the Russian Federation and South Korea. For these regions we used data from national communications.
9) Global emission projections are harmonised to the 2010 emission level of 47.8 $GtCO_2eq$ (See Section 3.1).
10) For the INDC reduction target ranges of the United States (26% to 28%) and Australia (26% to 28%) we assumed an average reduction of 27%, and for the Russian Federation (25% to 30%) an average reduction of 27.5%. For South Africa we assumed an average emission level of 506 $MtCO_2eq$ in 2030, based on the target range in its INDC. For China and India the combined effect of emission intensity targets, non-fossil targets and afforestation targets was calculated using the PBL TIMER energy model and the IIASA GLOBIOM/G4M models. Based on these calculations, 2030 emission levels (including LULUCF) of these countries are projected at 13,957 $MtCO_2eq$ and 4,168 $MtCO_2eq$, respectively (for China, see details in Den Elzen et al., 2015). For India, the upper end of the INDC range is limited to the upper end of the current policies emission level.
11) Emission projections for the INDCs do not account for national LULUCF carbon credits, and are not corrected for possible double counting or surplus emission units. All greenhouse gas emissions in this report refer to emissions relevant under the Kyoto Protocol (Annex A), i.e. the global warming potential-weighted sum of the six Kyoto greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6), with the exception of emissions from LULUCF.
12) Surplus emissions may arise if the emission levels projected from INDCs are above the emission levels in the current policies scenario. In our analysis, INDCs of the following countries are projected to lead to surplus emissions: Argentina, Chile, Ghana, Kazakhstan, Lebanon, Peru, Russian Federation, Turkey, Ukraine and Vietnam.
13) LULUCF emissions not covered by INDCs were aggregated in the 'Remaining LULUCF CO_2 emissions'.

global emissions are still projected to increase until 2030. Interestingly, INDC emission levels of some countries are projected to be *higher* than their current policy emission levels or business-as-usual emission levels (in our analysis, this is the case for Argentina, Chile, Ghana, Kazakhstan, Lebanon, Peru, Russian Federation, Turkey, Ukraine and Vietnam). If for these countries we assume current policy emission levels rather than INDC emission levels, total global emissions in the INDC scenario would be 1 (0–2) $GtCO_2eq$ lower by 2030: 55 $GtCO_2eq$ (54–58) for the unconditional INDCs and 53 $GtCO_2eq$ (52–57) if the conditional INDCs are implemented as well (Table 3.1).

Our global emission projections for the INDC scenarios (Table 3.1) are surrounded with considerable uncertainties, as for some of the INDCs precise estimates are not possible. For instance, emission levels of countries with per capita or per GDP intensity targets (such as China and India) strongly depend on future GDP and population trends, which are subject to large uncertainties. Furthermore, we assumed that emissions in sectors not explicitly covered in the INDCs follow the current policies trend, which may have led to an overestimation of the projected emission levels. Finally, our calculations do not account for credits or debits from LULUCF accounting rules, because there is too much uncertainty on which rules will be applied, and specific LULUCF information and projections are often lacking. The presented ranges are an attempt at quantifying the above uncertainties. The largest uncertainty is due to the dependence of China's emissions on economic growth: a 1% change in this country's average annual economic growth would already result in a target emission level change of approximately 2.5 $GtCO_2eq$.

3.2 What is the projected impact of the INDCs on reducing the global 2 °C emission gap by 2030?

Global emission levels consistent with a likely chance of staying below the 2 °C climate target are projected at 42 (30–44) $GtCO_2eq$ for the year 2030 (median and 20th – 80th percentile range presented in the UNEP Gap report, 2014). In December 2014, the Lima Call for Climate Action noted a significant gap between the aggregate effect of the pledges for 2020 and the above-mentioned emission level required to meet the 2 °C target. This report analyses the aggregate effect of the submitted INDCs on narrowing this global 2 °C emission gap.

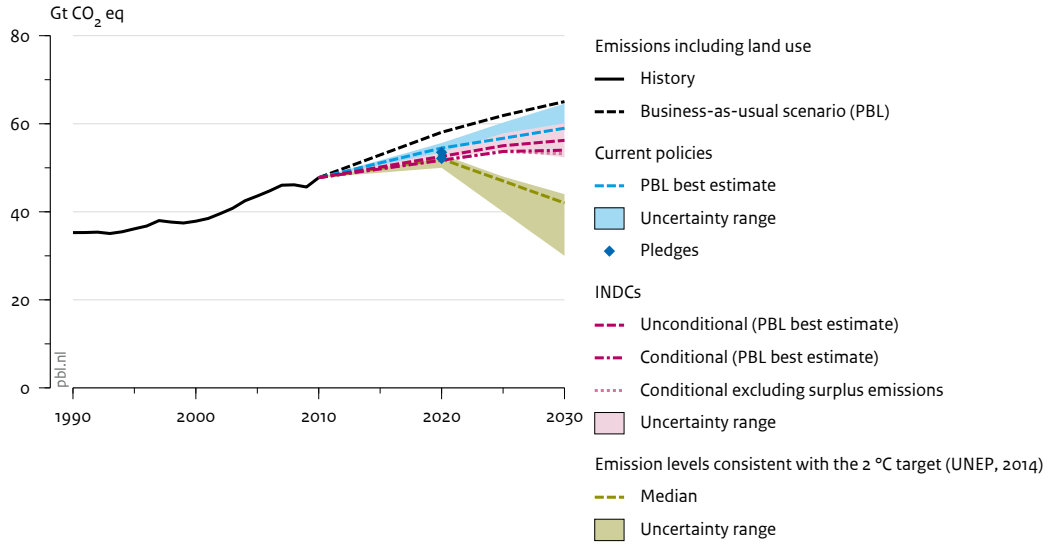
Based on our calculations, implementation of the unconditional INDCs is projected to result in global emission levels of approximately 56 (55–60) $GtCO_2eq$ in 2030 (Figure 3.1 and Table 3.2), leaving a gap of 14 (13–18) $GtCO_2eq$ relative to the median emission level required in 2 °C scenarios. According to our projections, this gap will be 2 $GtCO_2eq$ smaller if the conditional INDCs are implemented as well, leaving a remaining gap of 12 (10–16) $GtCO_2eq$. Assuming business-as-usual or current policy scenario emission levels for countries whose INDCs are projected to lead to *surplus* emissions (see Table 3.1, Footnote 12), the emission gap would be further reduced by 1 $GtCO_2eq$, to a level of approximately 11 (10–15) $GtCO_2eq$ by 2030.

Box 3.1 PBL business-as-usual (BAU) projections

Our assessment makes use of the PBL/IIASA business-as-usual (BAU) projections for energy and emissions of all Kyoto greenhouse gases, except CO_2 emissions from land-use change. These projections are an update of the business-as-usual scenario in the OECD Environmental Outlook (OECD, 2012), and were calculated using the PBL energy model TIMER (Van Vuuren et al., 2014) and the PBL land-use model IMAGE (Stehfest et al., 2014), based on GDP projections of the OECD (2012). Data on CO_2 emissions from LULUCF (e.g. deforestation) were based on the IIASA forestry model G4M (Kindermann et al., 2008). The resulting projections were harmonised to historical 1990–2010 emission data from the UNFCCC National Inventory Submissions (Common Reporting Format Tables) for those countries for which this information is available; for other countries, data were derived from the EDGAR database (JRC/PBL, 2012) and the National Communications. Modelling was done on the scale of 26 IMAGE world regions. For countries not covered by a single IMAGE region, a downscaled baseline was used (Van Vuuren et al., 2007b). In this study this applies to Australia, Argentina, South Korea and Turkey.

The PBL business-as-usual scenario serves as a baseline, aiming to describe a plausible trajectory for emissions given medium population and income projections and assuming that no new climate policies are introduced after 2004. The PBL business-as-usual scenario only includes national domestic energy policies as implemented before 2010. The projections are based on the GDP projections by the OECD ENV-Linkages model (Burniaux and Chateau 2010) developed for the OECD Environmental Outlook (OECD 2012). Furthermore, the scenario assumes the UN medium population growth trajectory (OECD 2012).

Figure 3.1
Impact of INDCs and climate policies on global greenhouse gas emissions



Source: PBL FAIR/TIMER model; IIASA GLOBIOM/G4M model; UNEP 2014

The global 2 °C emission gap is defined as the difference between the 2030 emission levels that would be consistent with keeping global warming below 2 °C (UNEP, 2014) and the 2030 emission levels that would result from implementation of the INDCs. Emission levels in the PBL business-as-usual scenario (which assumes that no new policies will be implemented after 2004) are based on PBL/IIASA model calculations; emission levels in the current policies scenario are based on Den Elzen et al. (2015). Historical global greenhouse gas emissions (excluding LULUCF) are based on EDGAR (JRC/PBL, 2015); historical LULUCF emissions on FAOSTAT (2015).

Table 3.2
Global impact of INDCs on reducing the global 2˚C emission gap by 2030

Emissions (Gt CO_2eq)	2030 value	Emission gap[1] from 2 °C		
2 °C pathway (UNEP, 2014 median estimate)	42	-		
PBL current policies scenario	59 (58–65)	17 (16–23)		
PBL business-as-usual scenario	65	23		
	2030 value	**Reduction relative to BAU**	**Reduction relative to current policies**	**Emission gap[1] from 2 °C**
Unconditional INDC scenario	56 (55–60)	9 (5–10)	3 (0–5)	14 (13–18)
Conditional INDC scenario	54 (52–58)	11 7–13)	5 (1–7)	12 (10–16)
Conditional INDC scenario (excluding surplus emissions)[2]	53 (52–57)	12 (8–13)	6 (3–8)	11 (10–15)

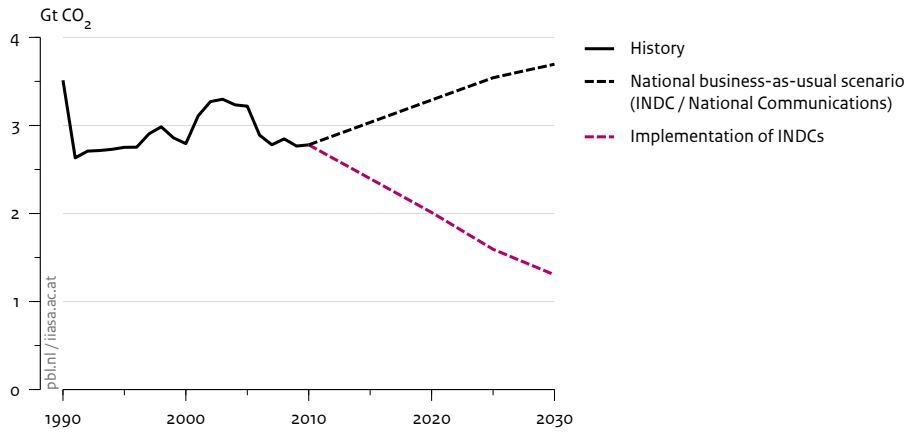
1) The emission gap is defined as the difference between the emission levels projected for BAU/current policies/INDCs and the median emission level required to meet the 2 °C target. The ranges in the emission gap are a result of the range in expected emission levels from the current policies and the INDCs, as shown in Figure 3.1. Here, the range in INDC emission levels reflects the ranges in INDC emission levels projected for Australia, the Russian Federation, the United States, China and India.
2) Excluding the potential impact of surplus emissions in countries where achieving INDC targets is projected to lead to higher emissions than the current policy trajectory. In our analysis, this is the case for Argentina, Chile, Ghana, Kazakhstan, Lebanon, Peru, Russian Federation, Turkey, Ukraine and Vietnam (See Section 3.1)

3.3 What is the projected impact of the INDCs on emissions and removals from land use, land-use change and forestry (LULUCF) in the context of high uncertainties?

Of the 156 Parties (including the EU28 Member States) that submitted an INDC by 29 October 2015, 95 countries explicitly state that emissions and removals from land-use activities are included in their mitigation component (see Annex I). However, only 36 of these 95 INDCs provide quantifiable details of measures or specific targets for the LULUCF sector. Furthermore, 42 INDCs explicitly state that LULUCF emissions and removals are *not* included but nevertheless propose measures or policies to reduce LULUCF emissions. The remaining 19 INDCs state that LULUCF emissions and removals are not covered and do not propose measures or policies for reducing LULUCF emissions (see Annex I for more information).
There is high uncertainty on the historical levels of emissions and removals, as well as on the projections of future emissions and removals. There is also partial information in the INDCs on how INDCs will address these emission sources.
Taking into account these uncertainties, we could estimate that the full implementation of all unconditional and conditional INDCs would decrease net LULUCF emissions in 2030, compared to national business-as-usual projections. By contrast, under national business-as-usual scenarios and independent baseline scenarios, it is expected that net LULUCF emissions would increase by 2030. This shows that implementing INDCs is important for addressing these emission sources. However, the quantified impacts of the INDCs on these emissions and removals is sensitive to the data and methodologies used.
The aggregate impact of these 95 INDCs on LULUCF emissions is shown in Figure 3.2, which compares LULUCF CO_2 emissions as projected for these INDCs to emission levels as projected for the national business-as-usual scenario. Both the national business-as-usual and INDC projections are based on data provided in the INDCs, complemented with information from National Communications where needed. (see Annex I for more information as to how the national business-as-usual and INDC projections were constructed).
According to our calculations, full implementation of these 95 INDCs would decrease LULUCF emissions by 2.6 $GtCO_2$eq in 2030 compared to national business-as-usual projections. Compared to historical emissions, implementation of the INDCs would lead to a reduction in LULUCF emissions, whereas in the national business-as-usual scenario LULUCF emissions are projected to increase (Figure 3.2).

Figure 3.3 shows the absolute net LULUCF emission reductions projected from INDCs of the G20 countries, compared to the national business-as-usual LULUCF emission levels. The largest absolute LULUCF net emission reductions are expected in Brazil and Indonesia, followed by the United States, China, Ethiopia, Gabon and Democratic Republic of the Congo. The INDCs of the Russian Federation and, to a lesser extent, Switzerland and Colombia are expected to result in an *increase* in net

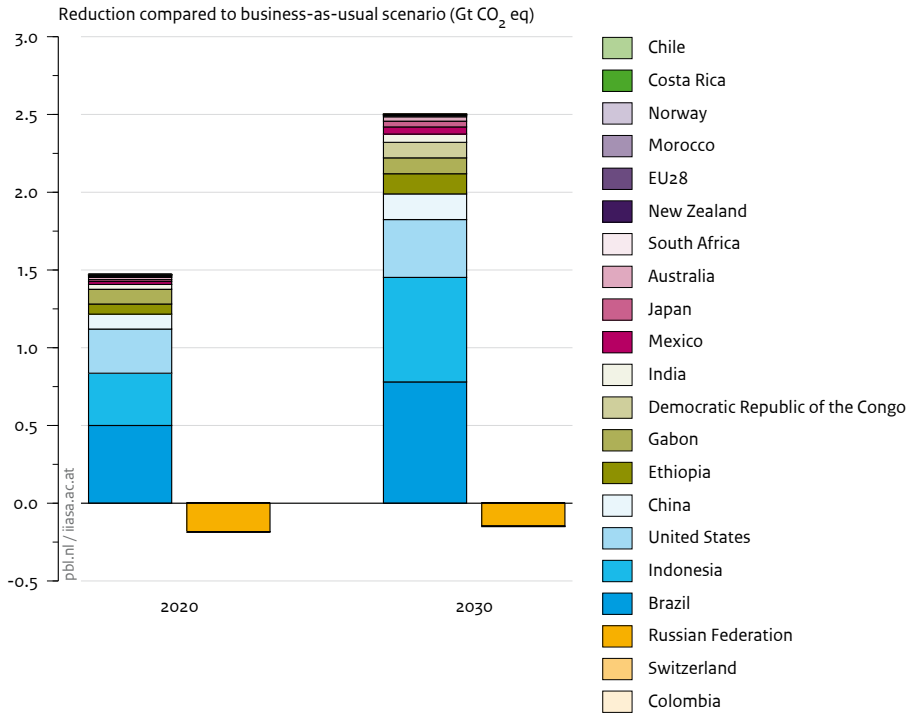
Figure 3.2
Global CO_2 emissions from land use



Source: IIASA

LULUCF emissions expected to result from INDC implementation, compared to national business-as-usual projections based on official national data as provided in the INDCs and National Communications (in other words, not based on the PBL business-as-usual development). (see Annex I for further details).

Figure 3.3
Reduction in national greenhouse gas emissions from land use



Source: National Communications/ INDCs

Positive numbers indicate emission reductions, negative numbers indicate emission increases.

LULUCF emissions. The impact of these increased net LULUCF emissions on INDC targets for overall emission reduction is highly dependent on the way in which changes in LULUCF emissions will be accounted for. For example, the projected increase in Russia's LULUCF emissions of approximately 150 $MtCO_2eq$ in 2030 is directly related to intensification of forest management. More details on country-level LULUCF reductions are provided in Box 3.2.

It should be noted that only 36 countries have put forward quantifiable information regarding national business-as-usual LULUCF emission projections and accounting rules to be applied for the LULUCF sector. Hence, it should be kept in mind that the uncertainties surrounding the projected net LULUCF emission reductions are large. The projected *increase* in LULUCF emissions in the Russian Federation, Colombia and Switzerland are all based on the data as provided in these countries' National Communications, because their INDCs do not provide estimates of future greenhouse gas emissions in the LULUCF sector.

It should also be noted that the business-as-usual net LULUCF emission projections are derived from data provided in the INDCs and/or National Communications, i.e. not from the PBL business-as-usual development. For some countries, the projected national business-as-usual net LULUCF emissions are not entirely consistent with the projected PBL business-as-usual net LULUCF emissions. This inconsistency is observed for Brazil, China and Indonesia, and is directly related to the definition of the baseline. On a global level, the national business-as-usual projection of net LULUCF emissions in 2030 is roughly 450 $MtCO_2eq$ higher than the PBL business-as-usual projection.

Box 3.2 Countries' contributions to LULUCF emission reductions and construction of national baseline and INDC scenarios.

The INDC of *Australia* does not provide LULUCF emission projections for the business-as-usual scenario nor the INDC scenario. Consequently, our assessment is based on the business-as-usual scenario as reported in the 6th National Communication (Australian Government, 2013), updated according to 2015 UNFCCC reporting of CRF tables. Our LULUCF projections for the INDC scenario are based on the analysis of the Australian Department of the Environment, which indicates that LULUCF related emissions can be decreased by 28 $MtCO_2eq$ through sequestration efforts supported by the Australia's Emission Reduction Fund (Department of Environment, 2015). If the emission reduction as estimated in the INDC scenario is achieved, the LULUCF sector would become a net sink by 2030, instead of a net source of emissions by 2010 in the business-as-usual scenario. These projections (for both the business-as-usual and the INDC scenario) do not account for emissions/removals from natural disturbances.

The INDC of *Brazil* covers the LULUCF sector but does not provide LULUCF emission projections for the business-as-usual scenario nor the INDC scenario. Furthermore, this INDC does not account for removals within the LULUCF sector, but does contain a list of future mitigation measures in the LULUCF sector (e.g. zero illegal deforestation by 2030). Our estimate of the INDC mitigation potential is based on the recent REDD-PAC project report (Report REDD-PAC, 2015), which provides a baseline and a scenario with reduction measures for the LULUCF sector as estimated by bottom-up land-use models. To the extent of our knowledge the LULUCF data in the REDD-PAC report is consistent with the data provided in the INDC submission. Implementation of Brazil's INDC is estimated to lead to emission reductions of approximately 500 $MtCO_2eq$ by 2020 and 780 $MtCO_2eq$ by 2030, compared to the national business-as-usual scenario. Even if the full emission reduction potential of the INDC measures would be achieved, the LULUCF sector would still be a net source of emissions in 2030.

The INDC of *China* does not provide LULUCF emission projections for the business-as-usual scenario nor the INDC scenario, but does propose future mitigation measures aimed specifically at the LULUCF sector. The 2nd National Communication (Government of China, 2012) also does not provide a business-as-usual scenario. Therefore, our assessment assumes that business-as-usual LULUCF emissions stay constant over time, at the level of 2005 (-421 $MtCO_2eq$). Furthermore, China's INDC states that the forest stock in China will be increased by 4.5 billion m^3 by 2030, compared to the 2005 level. The mitigation potential of this measure is estimated to be approximately 96 $MtCO_2eq$ in 2020 and 165 $MtCO_2eq$ in 2030, compared to the LULUCF business-as-usual level in 2005. This estimate is based on the assumption of a linearly increasing build-up of the forest area and biomass stock over time and of a wood stock density of about 4 tons of biomass carbon per cubic meter.

The INDC of the *Democratic Republic of the Congo* covers the LULUCF sector, and also includes LULUCF emission projections up to 2030 for both the business-as-usual and INDC scenario. In the business-as-usual scenario as provided by the INDC, LULUCF emissions increase from 100 $MtCO_2eq$ in 2010 to roughly 400 $MtCO_2eq$ by 2030. The largest changes in LULUCF emissions as a result of INDC implementation are expected to occur after 2020, resulting in emission reductions of approximately 100 $MtCO_2eq$ in 2030 when compared to business-as-usual projections. The INDC states that this reduction in LULUCF emissions will mainly be achieved through afforestation and reforestation measures.

The INDC of *Ethiopia* provides LULUCF emission projections up to 2030, for both the business-as-usual and INDC scenario. The mitigation measures proposed by the Ethiopian government include protection of forest areas, re-establishment of forest, and an increase of carbon stocks. According to the INDC, implementation of these measures is estimated to lead to emission reductions of approximately 65 $MtCO_2eq$ in 2020 and 130 $MtCO_2eq$ in 2030, compared to business-as-usual levels. If these reductions are indeed achieved, Ethiopia's LULUCF sector would become a net carbon sink by 2030, instead of a net source of emissions by 2010 in the business-as-usual scenario.

The INDC of *Gabon* covers the LULUCF sector and also includes business-as-usual emission projections for the LULUCF sector. The mitigation potential for Gabon is expected to slightly increase over time, from 95 $MtCO_2eq$ in 2020 to 102 $MtCO_2eq$ in 2030, compared to business-as-usual projections. However, there is an inconsistency between historical LULUCF emissions as reported in the INDC (80 $MtCO_2eq$ in 2000) and historical LULUCF emissions as reported in the 2nd National Communication (Government of Gabon, 2011) (-64 $MtCO_2eq$ in 2000).

The INDC of *India* does not provide LULUCF emission projections for the business-as-usual scenario nor the INDC scenario. However, the INDC does mention future mitigation measures in the LULUCF sector (e.g. afforestation). Business-as-usual LULUCF emission levels are neither provided in the 2nd National Communication (Government of India, 2012). Therefore, our assessment assumes that business-as-usual LULUCF emissions stay constant over time, at the emission level of 2007 (-175 $MtCO_2eq$) as reported in India's 2nd National Communication. Furthermore, based on the mitigation strategies and potentials as described in the 2014 report of the Planning Commission of the Government of India (2014), we estimated the INDC mitigation potential of India at 31 $MtCO_2eq$ in 2020 and 53 $MtCO_2eq$ in 2030, compared to the business-as-usual LULUCF emission level of 2007. Implementation of India's INDC would further increase the net sink effect of this country's LULUCF sector.

The INDC of *Indonesia* covers the LULUCF sector but does not provide LULUCF projections for the business-as-usual scenario nor the INDC scenario. However, we were able to construct LULUCF projections for both scenarios based on publically available information in supporting documents[3]. It should be noted that our projections (for both scenarios) do take into account emissions from peat fires. According to Indonesia's INDC, the government will focus on mitigation actions such as ecosystem conservation and restoration, coastal zone protection, and reduction of forest degradation and deforestation. As a result, INDC implementation is estimated to lead to LULUCF emission reductions of approximately 336 $MtCO_2eq$ by 2020 and 672 $MtCO_2eq$ by 2030, compared to the business-as-usual LULUCF emissions. Overall, this implies that the LULUCF sector would still be a net source of LULUCF emissions in 2030.

The INDC of *Japan* does not provide LULUCF projections for the business-as-usual scenario nor the INDC scenario. Business-as-usual LULUCF emission levels are neither provided in the 6th National Communication (Government of Japan, 2013). Consequently, our assessment assumes that business-as-usual LULUCF emissions stay constant over time, at the level of 2010 as updated according to 2015 UNFCCC reporting of CRF tables (-69 $MtCO_2eq$). Japan's INDC does provide an emission reduction target for the LULUCF sector by 2030, stating that LULUCF emissions will be reduced by 37 $MtCO_2eq$ in 2030 compared to the emission level in 2010. This implies that the LULUCF emission reduction by 2020 would be around 12 $MtCO_2eq$. According to the INDC, approximately 75% of this reduction will be based on forest carbon sinks measures while the remaining 25% will be the result of cropland management, grazing land management and revegetation.

The INDC of *Mexico* covers the LULUCF sector and also includes mitigation targets specifically for this sector (e.g. 0% deforestation by 2030). However, no LULUCF emission projections are provided for the business-as-usual scenario nor for the INDC scenario. Therefore, our assessment uses the business-as-usual scenario as reported in the 5th National Communication (Government of Mexico, 2012). Based on the quantification of Mexico's Mitigation Portfolio as provided in the 5th National Communication, the LULUCF related mitigation potential for Mexico is expected to be approximately 18.9 $MtCO_2eq$ in 2020. This National Communication does not provide a quantification of mitigation options for the LULUCF sector for 2030. If the estimated emission reductions would be achieved, the LULUCF sector would still be a net source of emissions by 2020. However, with continued implementation of emission abatements options after 2020, the LULUCF sector could potentially become a net sink of emissions by 2030.

The INDC of the *Russian Federation* explicitly states that the LULUCF sector is included in the mitigation component of the INDC. However, this INDC does not provide LULUCF emission projections for the business-as-usual scenario nor the INDC scenario. Our projections of LULUCF emissions are therefore based on the forest management intensification scenarios as provided in the 6th National Communication of the Russian Federation (Government of the Russian Federation, 2013). Based on these projections, INDC implementation is expected to result in a LULUCF emission increase of approximately 147 $MtCO_2eq$ in 2030, compared to business-as-usual projections. As stated in the 6th National Communication, this increase in LULUCF emissions is directly related to an intensification of forest management, which would reduce the forest carbon sink. However, it should be noted that the extent and implementation of these measures is still highly uncertain.

The INDC of the *United States* explicitly states that the LULUCF sector is covered, but does not provide LULUCF emission projections for the business-as-usual scenario nor the INDC scenario. An emission reduction target for the AFOLU sector is provided by the US State Department of Agriculture in "Building blocks for Climate Smart Agriculture & Forestry" (SDA, 2014). The strategy proposed in this document is to reduce net emissions and enhance carbon sequestration by over 120 $MtCO_2eq$ per year by 2025. However, the document does not specify potential reduction in the LULUCF sector. Therefore, we did not include this target in projections for the INDC scenario. Instead, we estimated the mitigation potential for the United States using the LULUCF emission projections from the 6th National Communication (US Department of State, 2014). Based on these projections, INDC implementation is expected to lead to emission reductions of approximately 284 $MtCO_2eq$ by 2020 and 372 $MtCO_2eq$ by 2030, relative to business-as-usual projections. The business-as-usual scenario assumes a significant increase in LULUCF emissions over time, due to an expected reduction of the sequestration potential.

Notes

1 LULUCF emissions from 1990 to 2030 were calculated using various sources: national communications, FAOSTAT and the IIASA G4M model. More details are provided in the footnotes to Table 3.1.

2 These studies took into account the impact of the most effective current and planned policies on greenhouse gas emissions, as estimated by Ecofys & NewClimate Institute, IIASA and PBL (Den Elzen et al., 2015; Roelfsema et al., 2013). Ecofys & NewClimate Institute based their calculations on existing scenarios from national and international studies (e.g. IEA's World Energy Outlook 2014), as well as their own calculations of the impact of individual policies in different subsectors. PBL based its calculations on the FAIR policy model (Den Elzen et al., 2014) and the TIMER energy model (Van Vuuren et al., 2014). The PBL model results are supplemented with LULUCF CO_2 emission projections based on land use and agricultural policies using IIASA's global land use model GLOBIOM (Havlík et al., 2014) and global forest model G4M (Gusti, 2010).

3 http://apki.net/wp-content/uploads/2015/07/Presentasi-INDC-BAPPENAS-di-KLHK.pptx.

Assessment of national emission levels resulting from INDC implementation: the G20 countries

This chapter assesses national emission levels resulting from INDC implementation, focusing on G20 countries. Assessment is based on the following indicators: emission reductions relative to base year, emission reductions relative to national business-as-usual emission projections, emission reductions relative to below-2 °C pathways, timing and level of emission peak, emissions per capita and emissions per GDP. The aim of assessing individual INDCs is to understand how, in different national contexts, they may contribute over time to the reduction of national emissions, emission intensities and emissions per capita, and to determine whether these projected trajectories are consistent with below-2 °C pathways.

4.1 How do emission reductions as projected for national INDCs compare to different historical base years?

The national INDCs emission reduction targets for 2030 can be converted, compared to different historical base years (Table 4.1). For example, the EU28's target of a 40% reduction relative to 1990 levels is equivalent to a 29% reduction relative to 2010 levels, due to the fact that emissions in the EU declined between 1990 and 2010. The target of the United States (26%–28% reduction relative to 2005 levels, by 2025) may be extrapolated to 36% to 38% reduction by 2030, assuming a linear pathway towards this country's long-term goal of 83% reduction by 2050. Relative to 2010 levels, however, the reduction estimated for 2030 would be 30% to 32%.

Emission projections based on the INDCs show that, among the G20 countries, the EU would achieve its highest reductions relative to 1990 emission levels, while Brazil would achieve its highest reductions relative to 2005 levels and Canada its highest reduction relative to 2010 levels. However, the projections for Canada are uncertain because emission reductions in this country are subject to natural disturbances in LULUCF emissions. Emission reductions by 2030 in countries such as Mexico, South Africa and South Korea are projected to be smaller. Greenhouse gas emissions in countries in relatively rapid economic transition continue to increase compared to historical years; this is the case for Argentina, China, India and Turkey. Furthermore, emissions in the Russian Federation are expected to increase as well. However, all of these countries do show decreasing emission growth rates towards 2030, such that greenhouse gas emissions are expected to peak between 2020 and 2030 in most countries (see Section 4.4)

4.2 How do emission reductions as projected for national INDCs compare to PBL business-as-usual projections?

Greenhouse gas emission reductions relative to business-as-usual projections (OECD, 2012) give an indication of the effort required to meet the targets included in the INDCs. Among the G20 countries, substantive absolute emission reductions from business-as-usual levels can be expected for the United States, China, the EU28, India and Brazil (Figure 4.1). Together, the INDCs of the G20 countries are projected to reduce global emissions relative to PBL business-as-usual levels by approximately 9 to 10 $GtCO_2eq$ by 2030. The INDCs of non-G20 countries (not shown in Figure 4.1) are projected to reduce emissions by an additional 0 to 1 $GtCO_2eq$. The largest *relative* emission reductions compared to PBL business-as-usual emission levels in 2030 are projected for Australia, Brazil, Canada and the United States (Table 4.2).

Table 4.1

Emission reductions (-%) and increases (+%) by 2030 as projected from national INDCs (G20 countries), relative to different historical base years (1990, 2005 and 2010)*

G20 country	GHG emissions in Mt CO_2 e[1]			Projected change (%) by 2030, Unconditional INDC scenario (Conditional INDC scenario)[2]		
	1990	2005	2010	relative to 1990	relative to 2005	relative to 2010
Argentina	320	373	374	+78% (+47%)	+53% (+26%)	+52% (+25%)
Australia	555	601	560	-21%	-27%	-22%
Brazil	1,611	2,100	1,688	-26%	-43%	-29%
Canada	613	749	707	-14%	-30%	-26%
China	3,254	7,038	10,130	+329%	+98%	+38%
EU28	5,626	5,178	4,751	-40%	-35%	-29%
India	1,180	1,809	2,379	(+253%)	(+130%)	(+75%)
Indonesia	1,063	1,852	2,059	+92% (+60%)	+10% (-8%)	-1% (-17%)
Japan	1,234	1,350	1,258	-16%	-23%	-17%
Mexico	559	655	748	+36% (+11%)	+16% (-5%)	+1% (-17%)
Russian Federation	3,363	2,135	2,221	-27.5%	+14.2%	+9.8%
South Africa	380	498	515	+4.7% to +61.6%	-20% to +23%	-23% to +19%
South Korea	289	590	629	+85.1%	-9%	-14.8%
Turkey	144	281	346	+543%	+230%	+169%
United States	5,402	6,439	5,907	-25%[3)]	-37%[3)]	-31%[3)]

*) Values cover all greenhouse gas emissions, including emissions and removals from activities related to land use, land-use change and forestry (LULUCF), unless otherwise specified in previous tables.

1) Source: Historical emissions in China, India and Indonesia are based on IEA (2012), EDGAR 4.2 (JRC/PBL, 2012) and FAOSTAT (2015). Historical emissions in other countries are based on UNFCCC national inventory submissions or INDC submissions.

2) INDC projections as presented in Table 3.1. For INDCs with a reduction target *range* (Russian Federation: -25% to -30%; United States: -26% to -28%; and Australia: -26% to -28%) we assumed an average reduction of 27.5%, 27% and 27%, respectively. For China and India, the combined effect of emission intensity targets, non-fossil targets and afforestation targets was calculated using the PBL TIMER energy model and IIASA GLOBIOM/G4M models, resulting in total emissions of 13,957 MtCO_2eq and 4,168 Mt CO_2eq for China and India, respectively, in 2030.

3) Emissions in the United States in 2030 were estimated by extrapolating the 2025 emission level (calculated from the INDC) towards the 2050 emission level as based on the national long-term target (reducing emissions by 83% below 2005 levels by 2050).

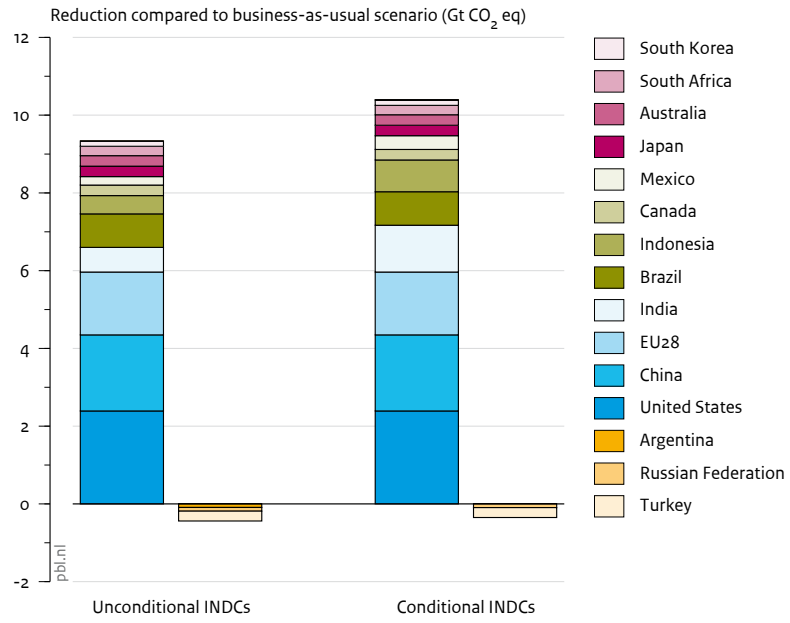
4.3 Are national INDCs in line with below-2 °C pathways?

On a global level, the emission reductions that would result from implementation of the submitted INDCs are insufficient to close the global 2 °C emission gap (see Section 3.2). On an individual country level, however, INDCs may be consistent with the global 2 °C target. Consistency with below-2 °C emission pathways at country level can be assessed by either considering burden sharing or by assuming cost-optimal domestic implementation of climate policies (Tavoni et al., 2014). In the first approach, emission allowances and reductions towards meeting the global 2 °C target are distributed across countries based on equity principles. The second approach focuses on cost-optimal implementation, where emission reductions are distributed across countries, sectors and greenhouse gases in such a way that the global costs of meeting the 2 °C target are minimised. Note that the latter approach refers to the cost-optimal geographical distribution of physical emission reductions, not to the sharing of mitigation finance; however, domestic mitigation actions still may be partly financed by international funding. We have considered both approaches as follows:

– With regard to burden sharing, we employed an effort-sharing approach that assumes per capita emission convergence. Although there is a wide range of effort-sharing approaches, in which the distribution of national reduction targets may vary significantly depending on the equity criteria used (see Höhne et al., 2013), our study focused on per capita convergence, as this is the most common, widely known approach. In this approach, countries converge to equal per capita emission allowances by 2050. Based on the global emission pathway consistent with the 2 °C target as presented in the

Figure 4.1

National emission reductions in G20 countries based on their INDCs, 2030



Source: PBL FAIR/TIMER model

Positive numbers indicate emission reductions; negative numbers indicate emission increases. For countries with a reduction target range, projected reductions are based on the average of the range.

Table 4.2

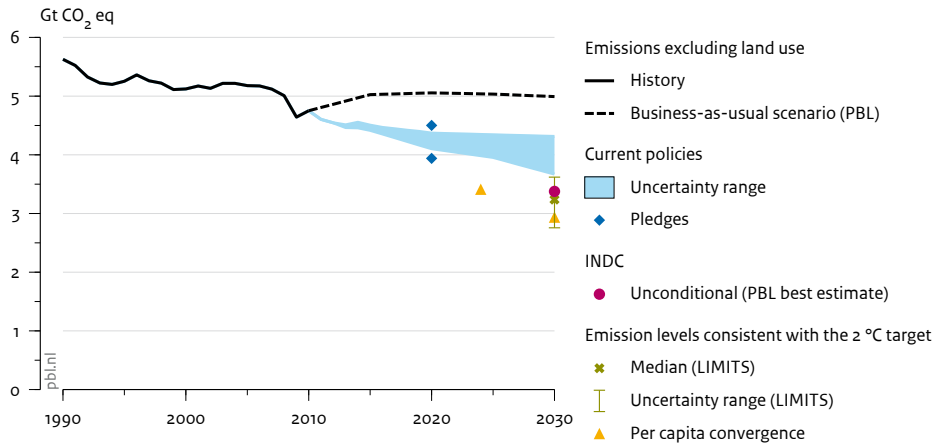
Absolute and relative emission reductions by 2030 resulting from INDC implementation in G20 countries, as shown in Figure 4.1*

Country	Emission changes relative to PBL-BAU scenario, 2030[1]			
	Unconditional INDC scenario		Conditional INDC scenario	
	Mt CO_2eq	% change	Mt CO_2eq	% change
Argentina	-91	+19%	10	-2%
Australia	270	-38%	270	-38%
Brazil	856	-42%	856	-42%
Canada	271	-34%	271	-34%
China	1,958	-12%	1,958	-12%
EU28	1,616	-32%	1,616	-32%
India	635	-12%	1,205	-22%
Indonesia	470	-19%	816	-32%
Japan	268	-20%	268	-20%
Mexico	218	-22%	354	-36%
Russian Federation	-96	+4%	-96	+4%
South Africa	241	-32%	241	-32%
Rep. of Korea	137	-20%	137	-20%
Turkey	-254	+38%	-254	+38%
United States	2,390	-37%	2,390	-37%

* Values cover all greenhouse gas emissions, including emissions and removals from activities related to land use, land-use change and forestry (LULUCF), unless otherwise specified in previous tables.

1) Emission reductions (or increases) resulting from INDC implementation relative to PBL business-as-usual projections (see Table 3.1). For countries with a reduction target range, projected reductions are based on the average of the range.

Figure 4.2
Impact of the EU28's INDC and climate policies on its greenhouse gas emissions



Source: PBL FAIR/TIMER model

Historical greenhouse gas emissions are based on national inventories submitted to the UNFCCC. Current policy projections are based on Den Elzen et al. (2015). The per capita convergence (2 °C) target is based on a convergence from 2010 levels to 2.4 tCO_2eq per capita by 2050, consistent with the global 2050 levels required for meeting the 2 °C target (UNEP, 2014). The emission level consistent with the 2 °C target and cost-effective implementation at the national or regional level is based on the "Low climate Impact scenarios and the Implications of Required Tight emission control Strategies" (LIMITS) study (Tavoni et al., 2014). The INDC emission projection for 2030 is calculated using the 1990 base year from the national inventories.

UNEP Gap report (2014) and population projections for 2050 (SSP database, 2015), we estimated these global allowances at 2.4 tCO_2eq per capita including LULUCF and 2.1 tCO_2eq per capita excluding LULUCF (median estimates) for 2050. Next, we calculated the required per capita emission levels for 2030 using linear interpolation between national per capita emission levels in 2010 and the 2050 convergence level of 2.4 tCO_2eq per capita including LULUCF.

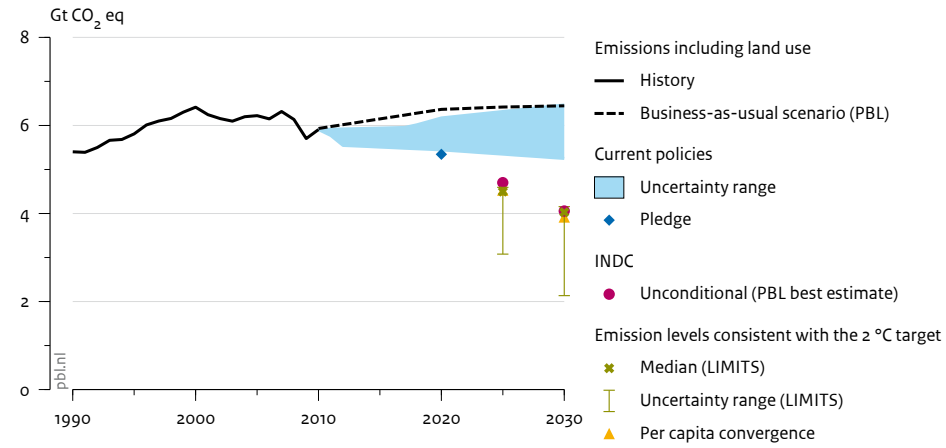
– With regard to cost-optimality, we used the 2 °C domestic emission trajectories from the LIMITS study (Tavoni et al., 2014). In this approach, emissions are mitigated in those countries or regions where this can be done at the lowest mitigation costs. The domestic emission trajectories of the LIMITS study assume that mitigation actions pledged under the UNFCCC Cancun Accord are fully implemented, and that emission reductions after 2020 are distributed across countries, sectors and greenhouse gases in such a way that the global costs of meeting the 2 °C target are minimised.

Based on the two approaches described above, our analysis shows that the majority of submitted INDCs are not in line with the 2 °C climate target. However, some of the submitted INDCs are consistent with one or both of the 2˚C emission pathways considered. For example, the INDC of the EU28, which includes a 40% domestic reduction target relative to 1990 levels by 2030, is projected to reduce emissions to a level that comes close to the least-costs 2 ˚C scenario estimate (which requires a domestic reduction of 40% to 45%). However, this reduction level is not consistent with the emission pathway towards convergence to 2.4 tonnes CO_2eq per capita by 2050 (Figure 4.2).

The INDC of the United States is projected to reduce emissions to well below current policies levels. If the reduction target for 2025 is extrapolated to 2030 (based on the national long-term 2050 target, see Table 2.2), the resulting emission reduction would be in line both with the least-costs 2 °C emission pathway and the per capita emissions convergence trajectory for this country (Figure 4.3). The latter is particularly noteworthy, considering the relatively high per capita emissions in the United States in 2010 (22 tonnes CO_2eq per capita, more than twice the level of the EU in that year). However, both pathway estimates (least-costs and per capita convergence) are subject to large uncertainties due to uncertainties around LULUCF CO_2 emission projections for this country (Figure 4.3).

The INDCs of China and India, on the other hand, are projected to result in emissions well above levels consistent with least-costs 2 °C pathways and per capita convergence trajectories (Figures 4.4 and 4.5). However, the INDC projections for these countries are surrounded with many uncertainties, including uncertainties related to GDP growth rate projections and the implementation of policies announced in the submitted INDCs.

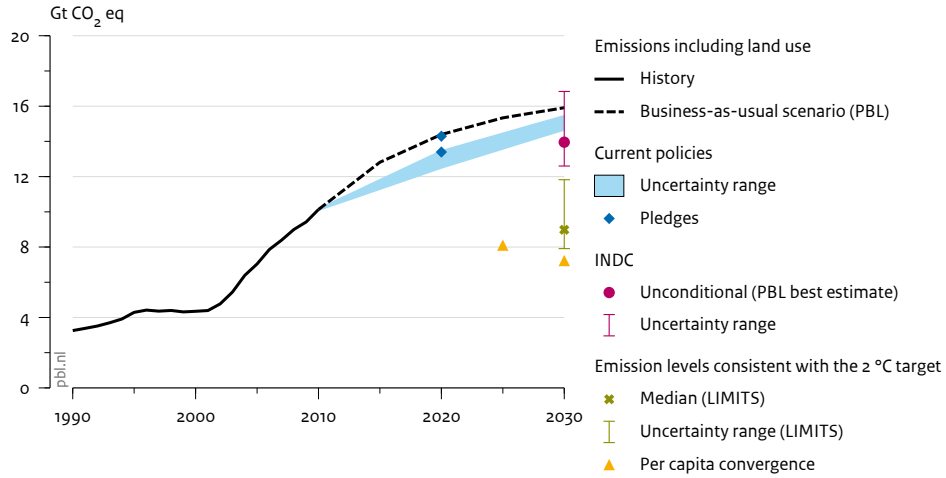
Figure 4.3
Impact of the US' INDC and climate policies on its greenhouse gas emissions



Source: PBL FAIR/TIMER model

Historical greenhouse gas emissions are based on national inventories submitted to UNFCCC. LULUCF emission history and projections are based on the Sixth National Communication (US Department of State, 2014). Current policy projections are based on Den Elzen et al. (2015). The per capita convergence (2 °C) target is based on a convergence from 2010 levels to 2.4 tCO_2eq per capita by 2050, consistent with the global 2050 levels required for meeting the 2 °C target (UNEP, 2014). The emission level consistent with the 2 °C target and cost-effective implementation at the national or regional level is taken from the LIMITS study (Tavoni et al., 2014).The INDC emission projection for 2025 is calculated using the 2005 base year from the national inventories. The 2030 emission level is based on a linear extrapolation between the projection for the 2025 target and the national long-term target for 2050.

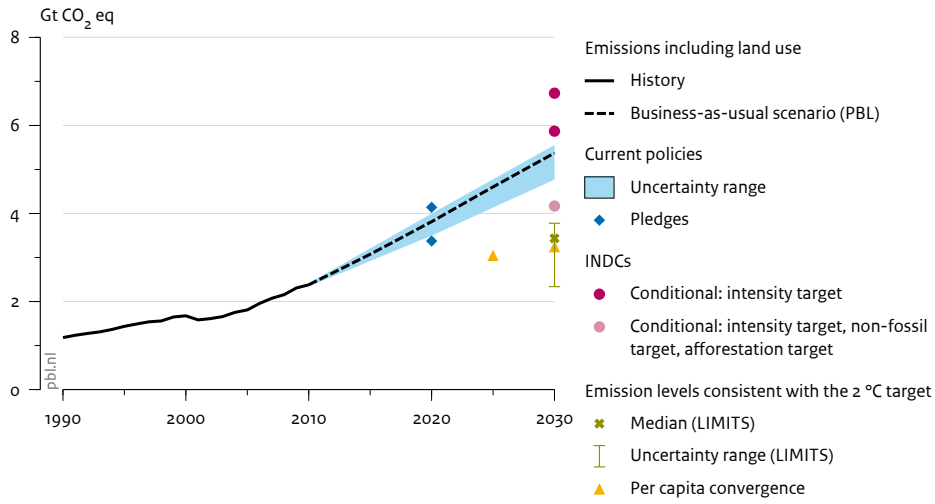
Figure 4.4
Impact of China's INDC and climate policies on its greenhouse gas emissions



Source: PBL FAIR/TIMER model; IIASA GLOBIOM/G4M model

Uncertainties in the numbers presented are related to the peak emissions level, GDP and population growth rates, and the final emission intensity levels by 2030. Historical greenhouse gas emissions (including LULUCF) are based on energy-related emissions (IEA, 2013a), non-energy-related emissions (EDGAR 4.2) (JRC and PBL, 2012) and LULUCF emissions (FAOSTAT). LULUCF emission projections are based on IIASA model calculations. Current policy projections are based on Den Elzen et al. (2015). The per capita convergence (2°C) target is based on a convergence from 2010 levels to 2.4 tCO_2eq per capita by 2050, consistent with the global 2050 levels required for meeting the 2 °C target (UNEP, 2014). The emission level consistent with the 2 °C target and cost-effective implementation at the national or regional level is taken from the LIMITS study (Tavoni et al., 2014). The INDC emission projection for 2030 assumes a GDP growth rate of 5% between 2021 and 2030. The uncertainty range for this projection reflects a range in GDP growth of 4.3% to 6.3% (IEA, 2014; 2021–2030 GDP assumption with +1% and -1%).

Figure 4.5
Impact of India's INDC and climate policies on its greenhouse gas emissions



Source: PBL FAIR/TIMER model; IIASA GLOBIOM/G4M model

Historical greenhouse gas emissions (including LULUCF) are based on energy-related emissions (IEA, 2013a), non-energy-related emissions (EDGAR 4.2) (JRC and PBL, 2012) and LULUCF emissions (FAOSTAT). LULUCF emission projections are based on IIASA model calculations. Current policy projections are based on Den Elzen et al. (2015). The per capita convergence (2°C) target is based on a convergence from 2010 levels to 2.4 tCO_2eq per capita by 2050, consistent with the global 2050 levels required for meeting the 2 °C target (UNEP, 2014). The emission level consistent with the 2 °C target and cost-effective implementation at the national or regional level is taken from the LIMITS study (Tavoni et al., 2014). The range in INDC projections is based on the range in GDP growth rates taken from WEO (IEA, 2014) and PBL model estimates of respectively 6.8% and 7.4% annual growth between 2005 and 2030.

4.4 What do INDCs imply for the timing and level of greenhouse gas emission peaks?

Full implementation of pre-2020 pledges and post-2020 INDCs is projected to lead to emission trajectories with different emission peak years and peak emission levels across countries (Table 4.3). In order to stay on track to meet the 2 °C climate target, global emissions should peak no later than around 2020. Among the G20 members, the EU was the first region where emissions peaked (around 1980). At that time, EU emission levels were about 13 tCO_2eq per capita and the per capita GDP was 17,445 USD_{2005}. Ten years later, emissions in the Russian Federation (then Soviet Union) peaked, with higher per capita emissions (22.7 tCO_2eq/cap), lower income levels (12,625 USD_{2005}/cap) and over twice the emission intensity in the EU during its peak year. Emissions in Australia, Canada, Japan and the United States peaked around 2005 at similar per capita income levels, but dissimilar per capita emissions: the latter were a factor two higher in the United States, Australia and Canada than in Japan.

Emissions in middle-income countries such as Mexico, Indonesia and Brazil are projected to peak before 2025. Emissions in South Korea already peaked in 2010. Emission levels of relatively low-income countries such as China, India and South Africa are projected to peak by 2030 or later. The latter countries have relatively high emission intensities, due to carbon intensive economies (see Section 4.5). Based on China's INDC, CO_2 emissions in this country are projected to peak by 2030 at the latest, but its *total* greenhouse gas emissions are projected to peak after 2030.

Generally, countries whose emission levels have already peaked are projected to achieve higher relative emission reductions than countries whose emission levels are still increasing (compare Table 4.1 and 4.3). A notable exception is the Russian Federation. After the peak year of 1990, greenhouse gas emissions in the Russian Federation have been increasing again since 2000. Based on its INDC, emissions in this country are expected to stabilise by 2030.

Table 4.3
Observed or projected emission peak years of the G20 countries, and (observed or projected) per capita emissions, GDP per capita and emission intensities in these peak years*

Country	Peak year	Per capita emissions (tCO_2eq/cap)	GDP (PPP) per capita (USD_{2005}/cap)	Emission intensity (tCO_2eq/ million USD_{2005}, PPP)
Argentina	2030	10.9 to 12.4	26,024	475 to 391
Australia	2005	26.0	33,806	869
Brazil	2020	7.2	13,496	530
Canada	2005	23.2	35,061	662
China[1]	2030	9.6	23,117	416
EU28	1980	13.3	17,445	759
India	2030	2.79	8,182	341
Indonesia	2025	7.46	8,846	672
Japan	2005	10.7	30,405	351
Mexico[1]	2025	6.4	18,275	275
Russian Federation[2]	1990	22.7	12,625	1,797
South Africa	2030	11.3	18,807	599
South Korea	2010	13.1	27,420	446
Turkey	2030	10.5	22,361	470
United States	2005	21.7	42,558	580

*) Values cover all greenhouse gas emissions, including emissions and removals from activities related to land use, land-use change and forestry (LULUCF), unless otherwise specified in previous tables.
1) Expected peak year, based on Pledge targets and/or INDC targets as presented in Table 2.2 (for projected emission levels, see Table 3.1).
2) Following the peak year of 1990, greenhouse gas emissions in the Russian Federation have been increasing again since 2000. Based on its INDC, emissions in this country are expected to stabilise in 2030.

4.5 Are per capita emissions and emission intensities, as projected from national INDCs, converging between countries?

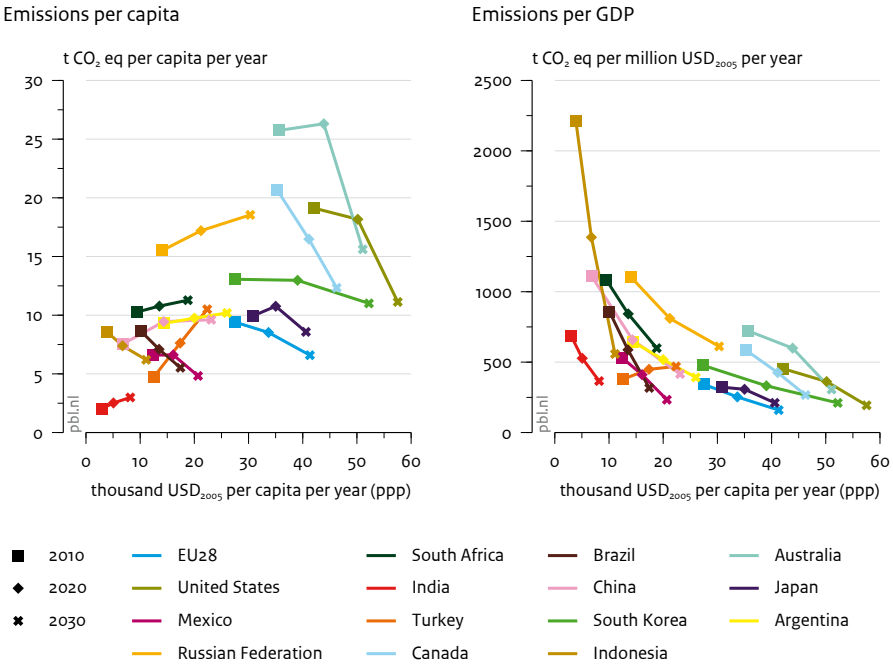
In this section, INDCs of the G20 countries are compared using two indicators of emission efficiency: emissions per unit of GDP (i.e. emission intensity) and emissions per capita. Indicator values were derived from historical data or calculated from the INDCs using projections for population and economic development (GDP in purchasing power parity, PPP) from the SSP Database (2015). The resulting values are shown in Tables 4.4 and 4.5 and Figure 4.6.

As Figure 4.6 (left panel) shows, national emission levels per capita are projected to decline between 2010 and 2030 as a result of the implementation of national INDCs, in all G20 countries except Argentina, China, India, the Russian Federation and Turkey. This figure also shows that the positive correlation between income level and per capita emissions will largely disappear by 2030. Furthermore, per capita emissions are shown to converge between G20 countries over time, despite the different income levels of these countries, indicating a decoupling of economic growth and greenhouse gas emissions.

This decoupling trend is further illustrated by Figure 4.6 (right panel), which shows a substantive reduction in emission intensity between 2010 and 2030, in tandem with increasing income levels. The reduction in emission intensity is projected for all countries (except for Turkey) and is a result of current climate policies and national INDCs. The largest reductions are observed for countries with the highest emission intensities in 2010, such as Indonesia, China and Brazil. Furthermore, emission intensities of all G20 countries are converging to levels between 250 and 750 tons CO_2eq per million USD in 2030, independent of these countries' emission intensity levels in 2010 and income levels in 2030. This convergence again reflects a decoupling of economic growth and greenhouse gas emissions.

Figure 4.6

Greenhouse gas emissions versus GDP per capita



Source: PBL FAIR/TIMER model; SSP database

Symbols represent emissions per capita and per GDP (y-axis) as a function of per capita GDP (PPP) (x-axis) in 2010, 2020 and 2030. Population and GDP data are from PBL business-as-usual scenario calculations, based on the SSP2 scenario database (SSP database, 2015). The SSP database uses the population and GDP history until 2008 from The World Bank (2015) with SSP growth projections onwards. The 2020 emission levels are based on PBL projections for current policies; 2030 emission levels are based on PBL projections for the submitted INDCs as presented in Table 3.1.

Table 4.4

Per capita emissions in G20 countries in historical years and as projected for 2030, based on submitted INDCs

Emissions per capita (tCO_2eq/cap)[1,2,3]			Unconditional INDC scenario	Conditional INDC scenario	% change relative to
	1990	2005	2030	2030	2005
Argentina	9.8	9.7	12.4	10.2	+27% to +5%
Australia[4]	31.1	29.4	15.6	15.6	-47%
Brazil	8.7	8.7	5.5	5.5	-36%
Canada	25.3	23.2	13.0	13.0	-44%
China[4]	2.8	5.4	9.6	9.6	+79%
EU28	11.8	10.5	6.6	6.6	-37%
India[4]	1.4	1.6	2.8	2.8	+76%
Indonesia	5.8	8.2	7.5	6.2	-8% to -24%
Japan	10.1	10.7	8.9	8.9	-17%
Mexico	6.6	6.2	5.9	4.8	-4% to -22%
Russian Federation [4]	22.7	14.8	18.5	18.5	+25%
South Africa	10.3	10.4	7.3 to 11.3	7.3 to 11.3	-30% to +8%
South Korea	6.7	12.5	11.0	11.0	-12%
Turkey	2.7	4.1	10.5	10.5	+155%
United States[4]	21.8	21.7	11.1	11.1	-49%

1) Values cover all greenhouse gas emissions, including emissions and removals from activities related to land use, land-use change and forestry (LULUCF), unless otherwise specified in previous tables.
2) History and projection of population, source: SSP database, 2015.
3) Emission projections based on INDCs do not account for carbon credits.
4) For INDCs with a reduction target range (Russian Federation: -25% to -30%; United States: -26% to -28%; and Australia: -26% to -28%) we assumed an average reduction of 27.5%, 27% and 27%, respectively. For China and India, the combined effect of emission intensity targets, non-fossil targets and afforestation targets was calculated using the PBL TIMER energy model and IIASA GLOBIOM/G4M models, resulting in total emissions of 13,957 $MtCO_2eq$ and 4,168 $MtCO_2eq$ for China and India respectively, in 2030.

Table 4.5

Emission intensities of G20 countries in historical years and as projected for2030, based on submitted INDCs

Emission intensity (tCO_2eq/ million USD $_{2005}$, PPP)[1,2,5]			Unconditional INDC scenario	Conditional INDC scenario	% change compared to
	1990	2005	2030	2030	2005
Argentina	1,315	890	475	391	-47% to -56%
Australia[6]	1,252	869	306	306	-65%
Brazil	1,500	1,301	317	317	-76%
Canada	935	662	282	282	-57%
China[4,6]	2,605	1,312	416	416	-68%
EU28	581	393	160	160	-59%
India[3,6]	1,137	732	341	341	-53%
Indonesia	2,878	2,633	672	558	-74% to -79%
Japan	381	351	219	219	-38%
Mexico	666	507	284	233	-44% to -54%
Russian Federation [1,6]	1,797	1,259	612	612	-51%
South Africa	1,354	1,227	389 to 599	389 to 599	-51% to -68%
South Korea	594	539	211	211	-61%
Turkey	330	360	470	470	+30%
United States[6]	690	510	193	193	-62%

1) Values cover all greenhouse gas emissions, including emissions and removals from activities related to land use, land-use change and forestry (LULUCF), unless otherwise specified in previous tables.
2) History and projection of GDP, source: SSP database, 2015.
3) India's emission intensity target of -33% to -35% relative to 2005 levels includes CO_2 only. However, the numbers in this table also cover emissions of non-CO_2 greenhouse gases, and account for India's non-fossil-fuel target and carbon sink target.
4) China's emission intensity target of -60% to -65% relative to 2005 levels includes CO_2 only. However, the numbers in this table also cover emissions of non-CO_2 greenhouse gases.
5) Emission projections based on INDCs do not account for carbon credits.
6) For INDCs with a reduction target range (Russian Federation: -25% to -30%; United States: -26% to -28%; Australia: -26% to -28%) we assumed an average reduction of 27.5%, 27%, and 27%, respectively. For China and India, the combined effect of emission intensity targets, non-fossil targets and afforestation targets was calculated using the PBL TIMER model and IIASA GLOBIOM/G4M models, resulting in total emissions of 13,957 $MtCO_2eq$ and 4,168 $MtCO_2eq$ for China and India, respectively.

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Annex I: Calculations of LULUCF emissions

What kind of information do INDCs provide on LULUCF emissions?

Of the 156 Parties (representing 155 countries) who submitted an INDC, 95 countries explicitly state that emissions and removals from land-use activities (LULUCF) are included in the mitigation component of their INDC (see Table A1). However, only 36 of these 95 countries provide quantifiable details of measures or specific targets for the LULUCF sector. Some countries provide information on the development of LULUCF emissions over time in business-as-usual and INDC scenarios (e.g. Madagascar, Mali), or refer to a complementary report where such information can be found (e.g. Brazil, South Africa). Other countries only provide LULUCF emission levels as estimated based on the effect of proposed general reduction measures. Many countries provide estimates of LULUCF emission reductions based on measures and policies specifically related to the LULUCF sectors (e.g. Japan, Guyana). Some countries provide information about the area which will be afforested or the amount of carbon that will be sequestered as a result of forest stock management (e.g. China, India).

The other 59 of these 95 countries state in their INDCs that the LULUCF sector is covered in their mitigation targets, without providing LULUCF projections or quantifiable information concerning LULUCF mitigation policies. For example, several countries provide projections for the agriculture, forestry and land-use sector (AFOLU) but without the additional data needed to distinguish LULUCF emissions (e.g. Mauritania). Some countries provide a list of measures and policies in the LULUCF sector but do not include the data needed for estimating LULUCF emission reductions (e.g. Indonesia, Jordan). Other countries state that the LULUCF sector is covered but do not specify a LULUCF reduction target or mitigation measures (e.g. Russia, New Zealand).

This leaves 60 countries who explicitly state that LULUCF emissions are *not* included in their INDC mitigation targets. In this group, 41 countries nevertheless do propose measures or policies to reduce LULUCF emissions (e.g. Chile, Georgia), with some of them stating that the decision whether or not to include the LULUCF sector in mitigation targets will be taken by 2020 (e.g. EU28, Thailand).The remaining 19 countries state that LULUCF emissions are not covered and also do not propose measures or policies for reducing LULUCF emissions. Some of these countries do not mention the LULUCF sector at all (e.g. Moldova, Andorra), or only mention the possibility that the LULUCF sector will be included at a later stage (e.g. South Korea, Montenegro).

Calculation of LULUCF emissions projections in national business-as-usual and INDC scenarios

In this study, we projected LULUCF emissions for countries who explicitly state in their INDC submission that the LULUCF sector is covered (95 Parties) (see Table A.1, two left columns). For these countries, LULUCF emissions were projected both for a national business-as-usual scenario and a scenario in which the national INDC is fully implemented (INDC scenario for short). Our LULUCF projections are based on LULUCF estimates provided in the national INDCs (where provided) and/or LULUCF emission and removal projections and estimates presented in the National Communications or in supporting documents. For countries for which no sufficient information was available to estimate LULUCF emission development over time (either in the business-as-usual or INDC scenarios), we assumed that LULUCF emissions would stay constant. As such, our projections of future LULUCF emissions and removals are based only on information as provided by countries themselves in terms of National Communications, INDCs, and/or supporting information as officially provided. This is summarised in Table A.2.

Table A.1

Categorization of countries according to whether the LULUCF sector is covered in the submitted INDCs

LULUCF is covered and measures and/or specific targets are explicit	LULUCF is covered but no measures and/or specific targets are listed	LULUCF is partly covered	LULUCF is not covered
Algeria, Australia, Azerbaijan, Benin, Bolivia, Brazil, Burundi, Cabo Verde, Cambodia, Central African Republic, Chad, China, Comoros, Congo, DR of Congo, Eritrea, Ethiopia, Gabon, Ghana, Guyana, Haiti, India, Indonesia, Japan, Lesotho, Madagascar, Malawi, Mali, Morocco, Namibia, Norway, Senegal, South Africa, Uganda, Uruguay, Zambia	Afghanistan, Antigua and Barbuda, Argentina, Armenia, Belize, Bhutan, Bosnia-Herzegovina, Burkina Faso, Canada, Colombia, Costa Rica, Djibouti, Dominica, Dominican Republic, Ecuador, Equatorial Guinea, Grenada, Guatemala, Guinea Bissau, Iceland, Jordan, Kazakhstan, Kenya, Kiribati, Kyrgyzstan, Lao People's Democratic Republic, Lichtenstein, Mauritania, Mauritius, Mexico, Mozambique, Myanmar, New Zealand, Niger, Papua New Guinea, Paraguay, Peru, Philippines, Rep. of Moldova, Russia, Rwanda, San Marino, Sao Tome and Principe, Serbia, Sierra Leone, Singapore, Solomon Islands, Sri Lanka, Suriname, Switzerland, Tajikistan, Tanzania, Togo, Tunisia, Turkey, Ukraine, United States, Vanuatu, Vietnam	Bangladesh, Cameroon, Chile, Côte d'Ivoire, EU28 Member States, Gambia, Georgia, Guinea, Lebanon, Liberia, Mongolia, Samoa, Thailand, Zimbabwe	Albania, Andorra, Barbados, Belarus, Botswana, Honduras, Israel, Maldives, Marshall Islands, Monaco, Montenegro, Oman, Rep. of Macedonia, Seychelles, South Korea, Swaziland, Trinidad and Tobago, Turkmenistan, United Arab Emirates
36	**59**	**41**	**19**

Table A.2

Information sources used for projecting LULUCF emissions in national business-as-usual and INDC scenarios, for the 95 countries whose INDCs explicitly state that the LULUCF sector is covered

LULUCF projections in both the business-as-usual and INDC scenario are based on information from the INDC	LULUCF projections in the business-as-usual scenario are based on information from the National Communication; in the INDC scenario, on information from the INDC	LULUCF projections in both the business-as-usual and INDC scenario are based on information from the National Communication	LULUCF projections in both the business-as-usual and INDC scenario are based on information from supporting documents
Azerbaijan, Central African Republic, Chad, Comoros, Congo, DR of Congo, Ethiopia, Gabon, Madagascar, Mali, Senegal, Uganda	Algeria, Australia, Benin, Bolivia, Burundi, Cabo Verde, Cambodia, China, Eritrea, Ghana, Guyana, Haiti, Japan, Lesotho, Malawi, Morocco, Namibia, Norway, Uruguay, Zambia	Argentina, Afghanistan, Antigua and Barbuda, Armenia, Belize, Bhutan, Bosnia-Herzegovina, Burkina Faso, Canada, Colombia, Costa Rica, Djibouti, Dominica, Dominican Republic, Ecuador, Equatorial Guinea, Grenada, Guatemala, Guinea Bissau, Iceland, Jordan, Kazakhstan, Kenya, Kiribati, Kyrgyzstan, Lao People's Democratic Republic, Lichtenstein, Mauritania, Mauritius, Mexico, Mozambique, Myanmar, New Zealand, Niger, Papua New Guinea, Paraguay, Peru, Philippines, Rep. of Moldova, Russia, Rwanda, San Marino, Sao Tome and Principe, Serbia, Sierra Leone, Singapore, Solomon Islands, Sri Lanka, Suriname, Switzerland, Tajikistan, Tanzania, Togo, Tunisia, Turkey, Ukraine, United States, Vanuatu, Vietnam	Brazil, India, Indonesia, South Africa
12	**20**	**59**	**4**

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