



PBL Netherlands Environmental  
Assessment Agency

# **ANALYSING THE EMISSION GAP between pledged emission reductions under the Cancún Agreements and the 2 °C climate target**

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**POLICY STUDIES**

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Michel den Elzen<sup>1</sup>

Mark Roelfsema<sup>1</sup>

Andries Hof<sup>1</sup>

Hannes Böttcher<sup>2</sup>

Giacomo Grassi<sup>3</sup>

<sup>1</sup> PBL Netherlands Environmental Assessment Agency, Bilthoven, the Netherlands

<sup>2</sup> Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

<sup>3</sup> European Commission – Joint Research Centre of the European Commission (JRC), Ispra, Italy

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### **Corresponding author**

Michel.denElzen@pbl.nl

### **Authors**

Michel den Elzen<sup>1</sup>, Mark Roelfsema<sup>1</sup>, Andries Hof<sup>1</sup>, Hannes Böttcher<sup>2</sup>, Giacomo Grassi<sup>3</sup>

<sup>1</sup> PBL Netherlands Environmental Assessment Agency, The Hague, The Netherlands

<sup>2</sup> Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

<sup>3</sup> European Commission – Joint Research Centre of the European Commission (JRC), Ispra, Italy

### **Contributions**

Michael Obersteiner<sup>2</sup>, Franziska Albrecht<sup>2</sup>, Angelica Mendoza Beltran<sup>1</sup>, Ilona Kirhensteine<sup>3</sup>, Tim Scarbrough<sup>3</sup>, Jasper van Vliet<sup>1</sup>, Detlef van Vuuren<sup>1</sup>

<sup>1</sup> PBL Netherlands Environmental Assessment Agency, The Hague, The Netherlands

<sup>2</sup> Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

<sup>3</sup> AMEC Environment & Infrastructure UK Limited

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Marian Abels

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# Contents

## **FINDINGS 7**

### **Analysing the emission gap between pledged emission reductions under the Cancún Agreements and the 2 °C climate target 8**

Introduction 8

Summary 8

## **FULL RESULTS 17**

### **1 Introduction 18**

1.1 Objective 18

1.2 Background 18

1.3 Method 19

1.4 Structure 20

### **2 Reduction pledges by Annex I countries 22**

2.1 Description and clarification of pledges 22

2.2 Overview of reductions 24

2.3 Main uncertainties 24

### **3 Mitigation action plans by non-Annex I countries 28**

3.1 Description of the mitigation action plans 29

3.2 Overview of reductions 32

### **4 Emissions by 2020, resulting from reduction pledges in Cancún Agreements, set against 2 °C pathways 38**

4.1 Four pledge scenarios 39

4.2 Expected emissions for 2020, based on pledges 39

4.3 Which emission levels for 2020 would be consistent with achieving the 2 °C and 1.5 °C climate targets? 41

4.4 How wide is the emission gap in relation to the 2 °C climate target? 43

### **5 Risks and uncertainties that could widen the emission gap 48**

5.1 Risks related to conditionality of pledges 49

5.2 Lenient or unclear accounting rules 49

5.3 Other risks 51

5.4 Uncertainties 52

5.5 Total effect of risks and uncertainties 53

### **6 Options for bridging the emission gap 54**

### **7 The role of land use, land-use change and forestry accounting rules in achieving reduction pledges 60**

7.1 Background 60

7.2 Evaluation of LULUCF accounting rules 61





FINDINGS

FINDINGS

# Analysing the emission gap between pledged emission reductions under the Cancún Agreements and the 2 °C climate target

## Introduction

Following the United Nations Climate Change Conference in Durban, in 2011, international climate policy has taken a further step towards agreement on legally binding commitments to reduce greenhouse gases. However, none of these commitments will be implemented before 2020. Therefore, the pledges to reduce greenhouse gas emissions as put forward by Parties in the Cancún Agreements (2010) still hold. These pledges have a voluntary nature and, therefore, a route of 'pledge and review' will be followed until 2020. This report reviews the country pledges and presents answers to several questions around this subject. What would be the emission level by 2020 if pledges indeed are achieved? How much do these pledges contribute to the long-term target of limiting global warming to a maximum of 2 °C? What are the risks of widening the emission gap between the proposed levels and those necessary for reaching the 2 °C target? Which measures could reduce this emission gap?

This report is the result of work done for the European Commission (DG Climate Action) and the Dutch Ministry of Infrastructure and the Environment.

## Summary

### Background and aim

- In the United Nations climate negotiations in Cancún (2010) and earlier in Copenhagen (2009), urgent action was called for to limit global warming to 2 °C. In order to reach this climate goal, countries were encouraged to submit emission reduction proposals for the year 2020 and accompanying mitigation actions. Since the climate negotiations in Copenhagen (2009), 42 Annex I Parties (developed countries) have submitted quantified economy-wide emission reduction targets for 2020, and 45 non-Annex I Parties (developing countries) have submitted nationally appropriate mitigation actions (NAMAs) for inclusion in the Appendices to the 2009 Copenhagen Accord (UNFCCC, 2009b). Of these NAMAs, 15 contained quantified economy-wide targets. These pledges and NAMAs have subsequently been 'anchored' in the 2010 Cancún Agreements (UNFCCC, 2010a, b, c, d). Together, the emissions from these Annex I countries represent about 40% of global emissions (level of 2005) and for the non-Annex I countries this is about 35%.
- Before the UN climate negotiations in Cancún, several studies projected the effect of these pledges on the emission level of 2020 and compared this level with the level needed for limiting global warming to certain temperature increases (e.g. Den Elzen et al., 2010a; European Climate Foundation, 2010; Rogelj et al., 2010; Stern and Taylor, 2010; Den Elzen et al., 2011b). The UNEP Emissions Gap Report (2010) and Höhne et al (2011) provide a summary of these studies. The UNEP Emissions Gap Report (and later also its update Bridging the Emissions Gap, UNEP, 2011) concluded that the pledges for 2020 were expected of leading to emission levels of above those being consistent with a likely chance of achieving a 2 °C global temperature limit (based on cost-optimal 2 °C emission pathways). This difference between expected emission levels and those needed for limiting global warming to a certain temperature is referred to as the 'emission gap'.
- The UN climate negotiations in Durban (2011) established a new body to negotiate a global agreement that would cover all countries by 2015. The new agreement is not scheduled to have any effect until 2020, and therefore is unlikely to affect the level of

pledges for 2020 and accompanying actions submitted in the Cancún Agreements. However, since the climate negotiations in Cancún, additional information provided by countries, especially regarding projected emission levels without climate policy (business-as-usual emissions), has led to changes in the expected emission levels that would result from the pledges and to further insight into the uncertainties regarding the emission gap. In this context, the main objective of this report can be formulated as follows:

*This report analyses the effect of the pledges submitted by Parties in the Cancún Agreements on the emission gap, taking into account all the new information available. It pays specific attention to uncertainties and risks and provides a detailed description of the emission implications of the pledges and actions by the 12 largest emitting countries and regions.*

- This report is an update of the PBL report Evaluation of the Copenhagen Accord (Den Elzen et al., 2010). The main updates consist of taking into account the business-as-usual emission projections as provided by countries themselves, and include CO<sub>2</sub> emissions from land use, land-use change and forestry (LULUCF), describe more uncertainties and factors that influence the emission gap, and include more countries in the pledge analysis.
- In the original report, the evaluation of the pledges was performed within the FAIR modelling framework (Den Elzen et al., 2011a; 2011b), using the following business-as-usual projections from several sources: projections published by the countries themselves (e.g. national communications, national climate action plans), PBL/IIASA projections (for Annex I countries: PBL business-as-usual projections), and projections based on data from the World Energy Outlook (WEO-2010) (IEA, 2010). PBL/IIASA projections contain all Kyoto greenhouse gases (except CO<sub>2</sub> emissions from land-use change) and have been developed for the upcoming OECD Environmental Outlook to 2050 (OECD, 2012). These projections had been made using the PBL energy model 'TIMER' (Van Vuuren et al., 2006; 2011) and the PBL land-use model 'IMAGE' (Bouwman et al., 2006). These business-as-usual emission projections were based on GDP projections calculated by the OECD ENV-Linkages model (Burniaux and Chateau, 2008), and projections from the ENV-Linkages model of the OECD (Burniaux and Chateau, 2008). These GDP projections do not include any possible effects of future climate policy. For the non-Annex I countries, projections for CO<sub>2</sub> emissions from land-use change (e.g. from deforestation) were based on the IIASA forestry model 'G4M' (Kindermann et al., 2006; 2008). For the WEO-2010 projections, data on energy-related CO<sub>2</sub> emissions were taken from the World Energy Outlook 2010 (IEA, 2010) and the greenhouse gas emissions from other sources were derived from the PBL/IIASA business-as-usual projections.

**If all Annex I pledges would be fully implemented, Annex I emissions could reach a level by 2020 that is 12% to 18% below the level of 1990; however, if only their unconditional pledges would be implemented, the decrease would only be 5% below the 1990 level**

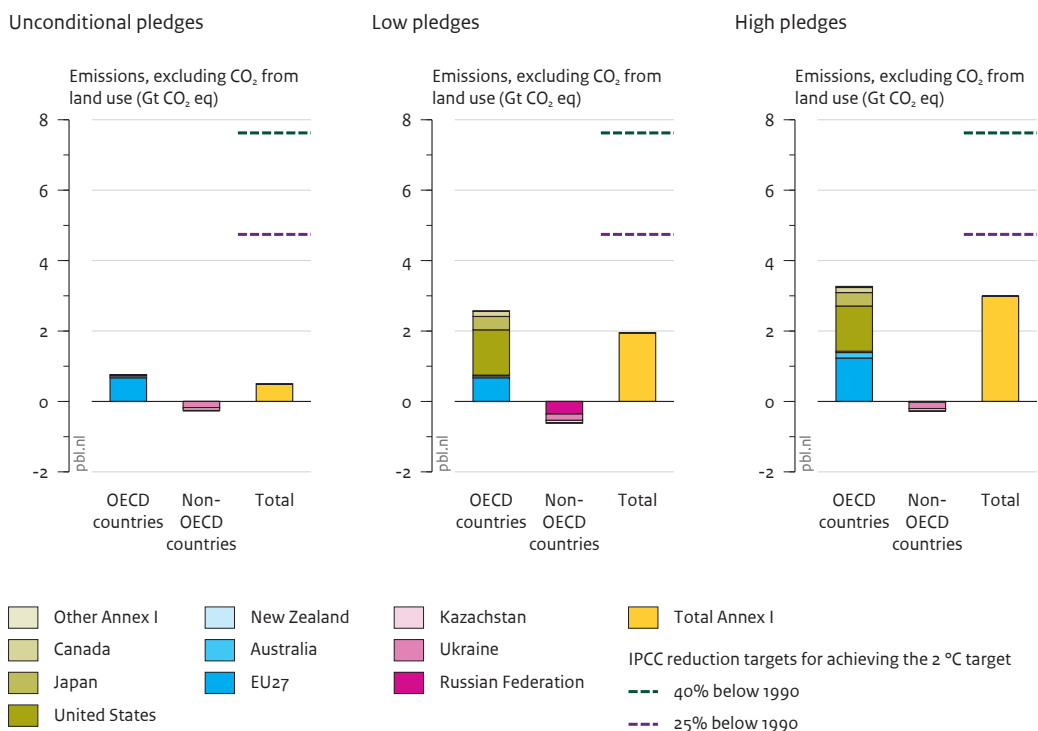
- Since the climate negotiations in Copenhagen, there have been no substantial changes in the proposed emission reductions by Annex I Parties. This means that, if the low and high pledges were to be fully implemented, this, by 2020, would lead to an aggregate Annex I emission level (excluding CO<sub>2</sub> emissions from land use, land-use change and forestry (LULUCF)) of 12% to 18% below 1990 levels. This is less than the range of 25% to 40% that was reported by the IPCC as being consistent with scenarios stabilising greenhouse gas concentrations at 450 ppm CO<sub>2</sub> eq. If Annex I countries with only a conditional pledge and those that announced not to be on board for a second commitment period under the Kyoto Protocol do not implement their low pledges, the Annex I emission level by 2020 would increase to 5% below 1990 levels. Figure S.1 presents a comparison of the reductions relative to PBL business-as-usual emission projections for 2020 resulting from i) pledges by Annex I countries, and ii) the IPCC AR4 25% to 40% reduction range.
- There are some important uncertainties that affect the targeted Annex I emission levels that would result from the pledges, besides the conditionality of the pledges. The accounting rules for LULUCF credits and surplus assigned amount units (AAUs) are one of those uncertainties. LULUCF accounting rules may result in additional credits from land-use change activities, such as forest management. Annex I countries could use these LULUCF credits to achieve their pledges and thereby lower the reduction target of greenhouse gas emissions that exclude CO<sub>2</sub> from LULUCF or land use. Surplus AAUs may result from the first commitment period (2008–2012) of the Kyoto Protocol. New surplus AAUs could also arise in the period up to 2020, because pledges by Russia and the Ukraine are expected by 2020 to lead to emission levels of above business-as-usual emission projections. In Figure S.1, surplus AAUs for the 2013–2020 period are assumed to be fully used and traded, but not included are Kyoto surplus AAUs and LULUCF credits from accounting rules.

**Upward revisions of business-as-usual emission projections have led to higher emission levels expected from pledges by non-Annex I countries**

- Since the Cancún climate negotiations, non-Annex I countries have not changed their reduction proposals (mitigation actions). However, new information from non-Annex I countries about published business-as-usual emissions to which their pledges are connected

Figure S.1

Greenhouse gas emission reductions from PBL business-as-usual projections for Annex I countries, by 2020



Source: PBL

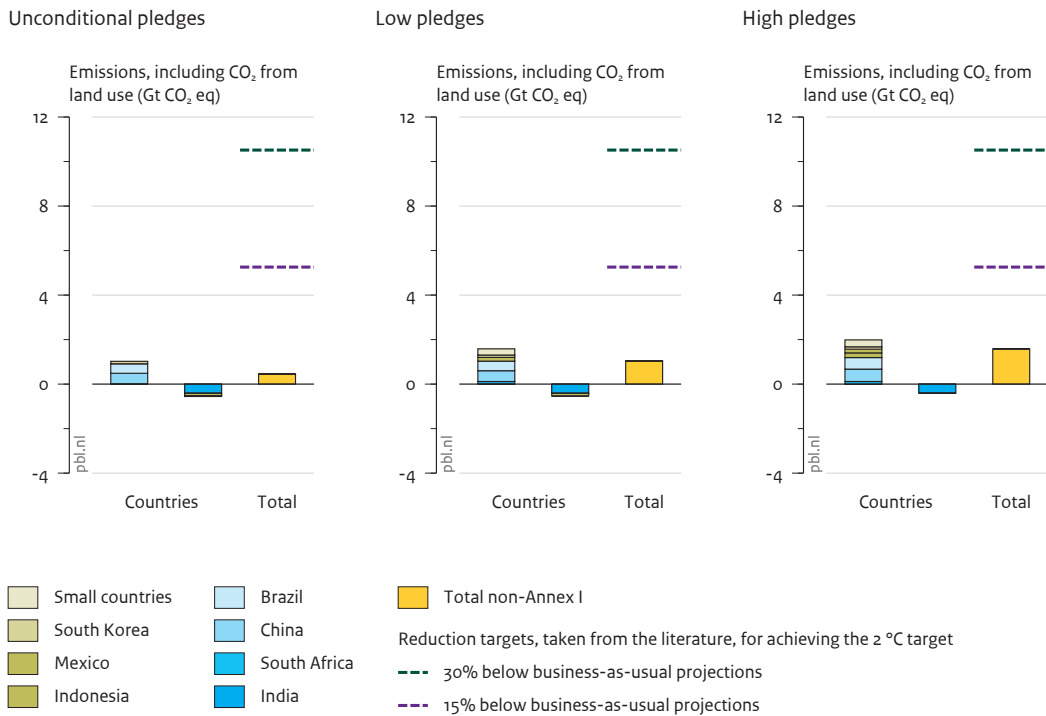
Emission reductions based on PBL business-as-usual projections resulting from the Annex I pledges compared with the IPCC reduction range for achieving the 2 °C climate target.

- especially from Brazil, China and India – has increased projected emission levels resulting from their pledges by 1.0 to 1.5 Gt CO<sub>2</sub> eq.
- The mitigation action plans by the seven largest emitting non-Annex I countries (China, India, Brazil, Indonesia, Mexico, South Africa and South Korea), which together will be responsible for more than two-thirds of non-Annex I business-as-usual emissions by 2020, are estimated to reduce emissions, by 2020, by approximately 3% to 6% below PBL/IIASA business-as-usual emission projections. As GDP growth is very uncertain for China and India, the emissions resulting from their pledged actions are uncertain, as well. This implies that the reduction range could still change, substantially. Nine other non-Annex I countries also have pledged reductions, leading to a total reduction below PBL/IIASA business-as-usual projections, of 21% and 25% for their low and high pledges, respectively.
- If all other non-Annex I countries (those that have not pledged quantifiable reductions) were to follow PBL/IIASA business-as-usual emission projections, then the emissions in the group of non-Annex I countries, by 2020, would be about 3% and 4% below PBL/IIASA

- business-as-usual emission projections (including CO<sub>2</sub> from LULUCF) for the low and high pledges, respectively. This is less than the 15% to 30% reported in the literature as consistent with scenarios that would stabilise emission levels at 450 ppm CO<sub>2</sub> eq (Figure S.2). If non-Annex I countries with only a conditional pledge would not implement their low pledges, the aggregated emission level of the entire group of non-Annex I countries, by 2020, would increase to 1% below the PBL/IIASA business-as-usual emission projections (Figure S.2).
- Our analysis shows that about 60% of the total reduction by non-Annex I countries would come from reductions in emissions from deforestation (REDD) and other land-use related emissions. This makes the non-Annex I contribution to emission reductions highly uncertain.
- China and India have set emission intensity targets, for which the emission target level heavily depends on GDP growth. For China, the non-fossil fuel target of 15% may be more limiting than its intensity target, leading to a reduction, by 2020, of 4% below PBL/IIASA business-as-usual emission projections. For India, the

Figure S.2

**Greenhouse gas emission reductions from PBL/IIASA business-as-usual projections, for non-Annex I countries, by 2020**



Source: PBL

Non-Annex I emission reductions compared against business-as-usual projections with the reduction range which, according to the literature, would be needed to achieve the 2 °C climate target.

emission target level is 13% above PBL/IIASA business-as-usual emission projections, but 23% below the business-as-usual projection provided by India itself.

**To have a likely chance of limiting global warming to 2 °C, the 2020 emission gap could be about 5 to 9 Gt CO<sub>2</sub> eq, which is 2.5 Gt CO<sub>2</sub> eq higher than in our earlier assessment**

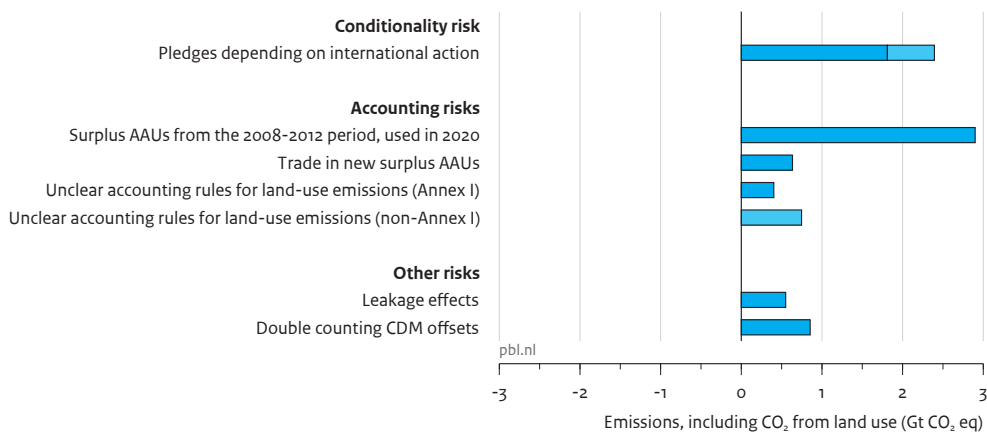
- Based on the same pledge scenarios as described in UNEP (2010, 2011) studies, this study projects global emissions to be as high as about 55.4 Gt CO<sub>2</sub> eq by 2020, if all countries were to implement their unconditional pledges under lenient accounting rules (i.e. the maximum use of LULUCF credits and surplus AAUs), and 54.5 Gt CO<sub>2</sub> eq under strict accounting rules (i.e. the impact of LULUCF credits and surplus AAUs are set to zero). The emission level in 2020 could be as low as about 50.9 Gt CO<sub>2</sub> eq if all countries were to implement their conditional pledges under strict accounting rules, and 54.3 Gt CO<sub>2</sub> eq under lenient accounting rules. Before the Cancún climate negotiations, it was estimated that if all countries were to implement their conditional pledges under strict accounting rules, the emission level would be about 48.5

Gt CO<sub>2</sub> eq by 2020. The current estimate is about 2.5 Gt CO<sub>2</sub> eq higher, which is mainly due to the higher business-as-usual emissions published by developing countries, Russia and the Ukraine themselves.

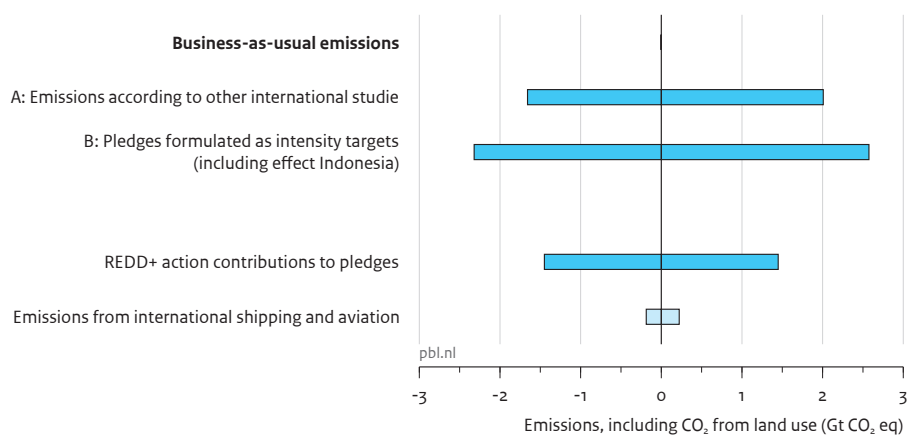
- Whether the 2 °C climate target could be achieved depends to some extent on the emission level of 2020, but longer term reductions are even more important. The literature assessment in the revised UNEP Bridging the Emissions Gap report (2011) shows that least-cost emission pathways consistent with a 'likely' chance of achieving the 2 °C target, generally, peak before 2020, and have emission levels in 2020 of around 44 Gt CO<sub>2</sub> eq (20th–80th percentile range: 41–46 Gt CO<sub>2</sub> eq). For a medium likelihood of achieving the 2 °C target, 2020 emissions levels must be around 46 Gt CO<sub>2</sub> eq (range: 45–49 Gt CO<sub>2</sub> eq). Therefore, the emission gap between the levels resulting from the pledges (51 to 55 Gt CO<sub>2</sub> eq) and those consistent with achieving the 2 °C target, ranges from 7 to 11 Gt CO<sub>2</sub> eq for a likely chance and from 5 to 9 Gt CO<sub>2</sub> eq for a medium chance of achieving this target. For the likely chance this would imply that 5% to 40% of the mitigation effort must be achieved. For a medium chance, this range is between 5% and 50%.

Figure S.3  
**Impacts of risks and uncertainties on global greenhouse gas emissions, by 2020, for low pledges with strict accounting rules**

Risks



Uncertainties



Contributions by

- Annex I
- Non-Annex I
- International shipping

Source: PBL

The effect of some risks and uncertainties that could decrease the ambition level that have been discussed in the negotiations and corresponding literature.

- As explained above, most least-cost emission pathways restrict 2020 emissions consistent with the 2 °C target to no more than 49 Gt CO<sub>2</sub> eq. However, recent studies of multi-gas emission pathways show that even emission levels of up to 50 to 51 Gt CO<sub>2</sub> eq could still be consistent with a medium chance of achieving the 2 °C target, if higher costs are allowed across the entire 21st century. Such scenarios, however, also depend more heavily on advanced future technologies with negative emissions. The OECD (2012) has a similar finding of substantial additional costs after 2020.

**Several uncertainties, mainly related to accounting rules and business-as-usual emission projections, together, could result in a global emission level of close to that of the PBL/IIASA business-as-usual projections for 2020**

- There are several risks and uncertainties that could lead to higher or lower emission levels resulting from the pledges. First of all, a major risk relates to pledges being conditional on international action and availability of international support. It is uncertain whether pledges, conditional or not, will be achieved. If only the conditional pledges would not be achieved, this would lead to an increase in emissions of 2.4 Gt CO<sub>2</sub> eq (about 70% of which comes from Annex I countries). Furthermore, carry-over and use of Kyoto surplus assigned amount units could increase emissions by up to 2.9 Gt CO<sub>2</sub> eq, for trading of new surplus assigned amount units the increase could be 0.3 to 0.6 Gt CO<sub>2</sub> eq, and for the use of LULUCF credits resulting from the accounting rules this could be up to 0.4 Gt CO<sub>2</sub> eq (all coming from Annex I countries) (see Figure S.3).
- With regard to non-Annex I countries, the most important uncertainty relates to pledges formulated as intensity targets. Due to uncertain business-as-usual GDP projections, this could increase emissions by about 2.6 Gt CO<sub>2</sub> eq (but could also lead to lower emission levels). Other important uncertainties concern contributions from REDD+ actions (which could increase or decrease emissions by 1.5 Gt CO<sub>2</sub> eq) and business-as-usual emission developments (which could increase the global emission level by 2.6 Gt CO<sub>2</sub> eq, but, again, could also lead to a lower emission level). Finally, land-use accounting rules for afforestation, reforestation and forest management could increase emissions by about 0.7 Gt CO<sub>2</sub> eq.
- Risks that are difficult to attribute to Annex I or non-Annex I countries include: i) double counting of offset emissions (which happens if the same amount in emission reduction is counted for achieving the pledges of two countries), which could increase emissions by 0.9 to 1.1 Gt CO<sub>2</sub> eq; ii) uncertainty about business-as-usual emissions from international shipping, which could increase emissions by 0.2 Gt CO<sub>2</sub> eq; and iii) leakage

effects that occur if emissions are shifted from countries that have emission targets onto countries without emission targets, which could increase emissions by 0.05 to 0.55 Gt CO<sub>2</sub> eq.

- When all the risks and uncertainties explored in this study are taken into account, including the possible overlaps, the total emission level by 2020 could end up close to the PBL/IIASA business-as-usual emission projection of 56 Gt CO<sub>2</sub> eq.

**A selected set of options could result in an additional emission reduction of 4.1 Gt CO<sub>2</sub> eq, which would narrow the emission gap towards achieving the 2 °C target**

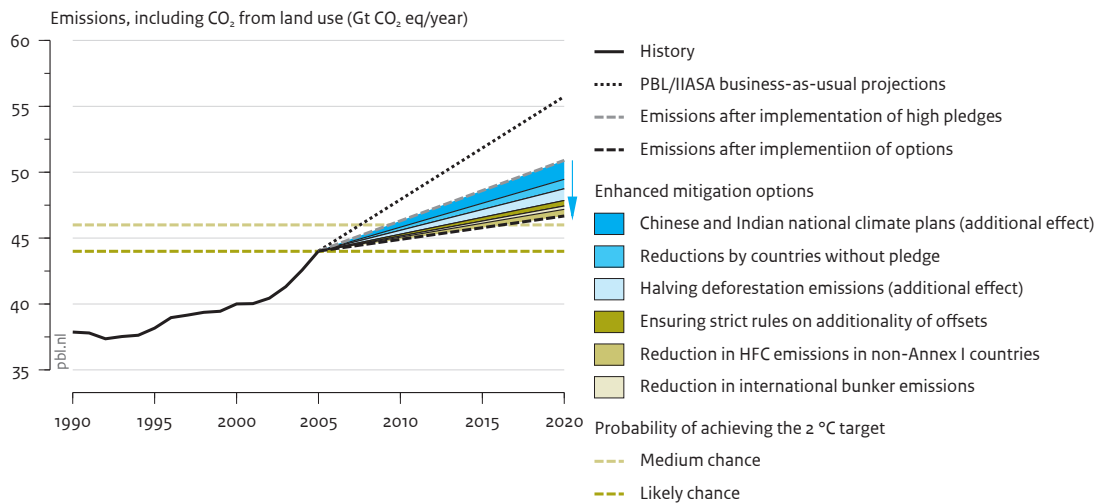
- The most ambitious interpretation of the pledges assumes that high pledges are adopted and strict accounting rules are applied (meaning that no surplus assigned amount units can be used and no credits for LULUCF accounting rules are given). In this scenario, the pledges would lead to an emission reduction of about 5 Gt CO<sub>2</sub> eq, compared to business-as-usual emission levels. A selected set of options could result in an additional reduction in emissions of 4.1 Gt CO<sub>2</sub> eq, which would narrow the 2020 emission gap towards achieving the 2 °C target (Figure S.4):
  - o Additional reductions of 0.7 Gt CO<sub>2</sub> eq in China and 0.6 Gt CO<sub>2</sub> eq in India, which are presented in their national plans, but are not part of the pledges;
  - o Reducing emissions from deforestation by up to 50% by 2020, below 2005 levels, which would reduce global emissions by about 0.9 Gt CO<sub>2</sub> eq;
  - o Reductions in countries that currently have not submitted any pledges, which could be expected to contribute about 0.7 Gt CO<sub>2</sub> eq;
  - o Ensuring strict additionality of offsets, by ensuring that CDM projects lead to real emission reductions, compared to business-as-usual emissions, which could contribute about 0.4 Gt CO<sub>2</sub> eq;
  - o Reducing hydrofluorocarbon (HFC) emissions, which could contribute 0.5 Gt CO<sub>2</sub> eq;
  - o Reducing emissions from international shipping, which could contribute 0.3 Gt CO<sub>2</sub> eq.

All these options could reduce the global emission level of 2020 to about 46.7 Gt CO<sub>2</sub> eq, just within the range consistent with the level required for having a medium chance of achieving the 2 °C target, according to the UNEP Bridging the Emissions Gap Report (2011).

- The above options do not include the possible impact of implemented measures that go beyond current pledges and/or strengthen pledges. For instance, the IPCC emission reduction range for 2020, necessary to keep the temperature increase below 2 °C, could be followed. For this, the total Annex I emission target for

Figure S.4

**Impact of enhanced mitigation options on global greenhouse gas emissions under strict accounting rules**



Source: PBL

*The effect of some options that could increase the ambition level, based on policy choices that have been discussed in the negotiations and corresponding literature.*

2020 has to increase to 25% below 1990 levels. This would narrow the gap by an additional 1.5 Gt CO<sub>2</sub> eq. An increase in the targeted level towards 30% and 40% below the 1990 level would result in additional reductions of 2.4 and 4.3 Gt CO<sub>2</sub> eq, respectively.

**Land Use, Land Use Change and Forestry (LULUCF) accounting rules as agreed in Durban could lead to additional LULUCF credits of up to 2% of 1990 Annex I emissions**

- LULUCF accounting rules could generate credits or debits. The emission levels resulting from the pledges by Annex I countries could change substantially if these credits were to be taken into account. In the Durban climate negotiations, Parties agreed on LULUCF accounting rules for the post-2012 commitment period. A main feature of these new rules is that accounting of forest management becomes mandatory. The credits and debits during the commitment period will be calculated by subtracting a reference level from the actually reported emissions or removals. For most countries (those of the EU, Australia, New Zealand, Canada, Switzerland, Ukraine, Croatia), this reference level is based on business-as-usual emission projections. For Norway, Russia and Belarus, it is based on the net forest management emission level of 1990. Furthermore, there is a cap on forest management credits equal to 3.5% of base-year emissions.
- The current LULUCF accounting rules may result in additional LULUCF credits of up to about 2% of 1990

Annex I emissions or 400 Mt CO<sub>2</sub> eq, as calculated with the Joint Research Centre’s LULUCF tool, version 8 December (JRC/EC, 2011). The LULUCF accounting rules have a relatively small impact on the EU reduction target that includes LULUCF credits, but can have a larger impact for some other countries. For instance, for New Zealand, the accounting rules could lower the reduction target that includes LULUCF credits, with more than 25% of its 1990 emission levels. For Australia, the combined effect of i) maximum land-use credits from LULUCF accounting rules, and ii) adding deforestation emissions of 2000 to the base-year emissions, leads to an emission target for 2020, including LULUCF credits, of 23% above 1990 levels for the unconditional pledge, and 4% below 1990 levels for the conditional pledge.

**Theoretically, having no restrictions on carry-over of surplus AAUs could decrease the ambition level for Annex I countries, as a whole, by 15% of 1990 emission levels**

- In the Kyoto Protocol, it was decided that countries with emission levels below their Kyoto target would be allowed to carry over the difference to subsequent commitment periods to reward overachievement. This difference is referred to as surplus AAUs. Most surplus assigned amount units originate from the economic downfall of former Eastern Bloc countries, but also some western European countries have generated surplus AAUs. Surplus AAUs can be sold or used domestically to meet future mitigation commitments



up to 2020. Both activities can result in higher 2020 emission levels.

- Options for addressing the carry-over and use of Kyoto surplus AAUs vary from prohibiting such carry-over, to restricting their use, to having no restrictions on carry-over (current Kyoto Protocol rules). For no restrictions on carry-over, the ambition level of Annex I countries as a whole could decrease by 14% (equivalent to 2.9 Gt CO<sub>2</sub> eq), and, for the EU 30% target, by up to 14% (equivalent to 0.8 Gt CO<sub>2</sub> eq) of 1990 emission levels. Decreases in ambition level will be much smaller if the use of surplus AAUs to achieve the future targets is restricted, such as under the other options.
- The actual effect of surplus AAUs on emission reductions depends on how much of them will actually be traded. The EU, for instance, has decided that surplus AAUs cannot be used by Member States to achieve their 20% unconditional target (for the 30% target, the rules are still unclear). Moreover, without the participation of Russia as largest potential seller and Japan and Canada as potential buyers in a second commitment period, it is unlikely that much surplus AAUs will be traded.

**A closer look at the individual pledges of the ten major emitting economies reveals that the uncertainty regarding China's pledge is very large and that national business-as-usual emission projections are generally much higher than PBL/IIASA projections**

- A closer look at the pledges by the ten major emitting countries led to a few interesting findings. Firstly, national business-as-usual emission projections provided by Annex I countries and non-Annex I countries are in most cases higher than the PBL projections. For non-Annex I countries that generally have pledged targets relative to business-as-usual levels, this implies that the emission reductions from PBL business-as-usual projections are lower than the pledged reductions. The second finding relates to the fact that China pledged an intensity target without providing reference projections of its GDP growth (which is uncertain). The emission level resulting from China's pledge is therefore very uncertain. This study shows that the 2020 emission level for China is expected to be 12.9 Gt CO<sub>2</sub> eq according to the PBL/IIASA business-as-usual projections, with a reduction of 4%, whereas according to projections by the World Energy Outlook (WEO-2010), this is 11.4 Gt CO<sub>2</sub> eq, with a reduction of 10%. Finally, Brazil has provided a new, higher estimate for its business-as-usual emissions, to which its 36% to 39% reduction pledge is to be applied.

This leads to higher greenhouse gas emissions resulting from its pledges; in particular, due to higher deforestation emissions, and lower reductions compared to PBL/IIASA business-as-usual projections. This study estimates that all reductions will result from REDD actions (about 560 Mt CO<sub>2</sub>).



FULL RESULTS

FULL RESULTS

# Introduction

## 1.1 Objective

In the Cancún Agreements, Annex I Parties (industrialised countries) and non-Annex I Parties (developing countries) made voluntary pledges to reduce greenhouse gas emissions by 2020. The Cancún Agreements also state a long-term target of limiting temperature increase to a maximum of 2 °C above pre-industrial levels. This report is an update of the PBL report Evaluation of the Copenhagen Accord (Den Elzen et al., 2010a), which similar to earlier studies showed that there is a possible gap in emissions between the emission level resulting from the pledges and the level necessary to achieve the 2 °C target. The updates involve new information on many topics that have become available over the last two years, including updated national business-as-usual emission projections as provided by the countries themselves, and more information on uncertainties and on factors influencing the size of the emission gap.

In this context, the main objective of this report can be formulated as follows:

This report analyses the effect of the pledges put forward by the Parties in the Cancún Agreements on the emission gap, taking into account all the new information available. It pays specific attention to uncertainties and risks and describes in more detail the emission implications of the pledges and actions of the 12 largest emitting countries or regions.

## 1.2 Background

Climate negotiations take place under the United Nations Framework Convention on Climate Change (UNFCCC). In December 2010, at the annual UNFCCC conference in Cancún, Mexico, it was recognised 'that deep cuts in global greenhouse gas emissions are required according to science, and as documented in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, with a view to reducing global greenhouse gas emissions so as to hold the increase in global average temperature below 2 °C above pre-industrial levels, and that Parties should take urgent action to achieve this long-term goal, consistent with science and on the basis of equity; also recognises the need to consider, in the context of the first review [...] strengthening the long-term global goal on the basis of the best available scientific knowledge, including in relation to a global average temperature rise of 1.5 °C.' (UNFCCC, 2010b).

One year earlier, the Copenhagen Accord of 2009<sup>1</sup> (UNFCCC, 2009b) also referred to a 2 °C target, and encouraged countries to submit their emission reduction proposals and actions for the year 2020. Following that conference, 42 Annex I Parties (developed countries) submitted quantified economy-wide emission targets for 2020. In addition, 44 non-Annex I Parties (developing countries) submitted so-called nationally appropriate mitigation actions (NAMAs) for inclusion in the Appendices to the 2009 Copenhagen Accord. The reduction proposals and actions have not changed

significantly since early 2010 and were ‘anchored’ in the Cancún Agreements (UNFCCC, 2010a, d, c) in December 2010. More specifically, the Cancún Agreement (UNFCCC, 2010b) ‘takes note of quantified economy-wide emission reduction targets to be implemented by Parties included in Annex I to the Convention as communicated by them and contained in document FCCC/SB/2011/INF.14’, and ‘takes note of nationally appropriate mitigation actions to be implemented by Parties not included in Annex I to the Convention as communicated by them and contained in document FCCC/AWGLCA/2011/INF.15’.

In December 2011, at the annual UN climate negotiations in Durban, South Africa, the international community established a new body to negotiate and develop a new protocol for a global agreement. This body, the Ad Hoc Working Group on the Durban Platform for Enhanced Action, should reach such an agreement in 2015, which will not take effect until 2020. Therefore, such an agreement is unlikely to affect the ambition levels of the reduction pledges proposed in the Cancún Agreements.

Before the UN climate negotiations in Cancún, several studies determined the effect of the pledges put forward by the Parties in the Copenhagen Accord (UNFCCC, 2009b) on the global emission level by 2020. These studies also analysed the size of the gap between the emission level resulting from those pledges and the level needed to limit climate change to a certain temperature (e.g. Den Elzen et al., 2010a; European Climate Foundation, 2010; Rogelj et al., 2010a; Stern and Taylor, 2010; Den Elzen et al., 2011c). These studies were assessed in the UNEP Emissions Gap Report for the Cancún climate negotiations (UNEP, 2010) and later published in Höhne et al (2011c). According to their shared main conclusion, pledges for 2020 lead to higher emission levels than those consistent with a likely chance of achieving the target of limiting global temperature to 2 °C (based on cost-optimal 2 °C emission pathways).

Climate negotiations are an ongoing process, and, since Cancún, there have been developments that may have influenced the size of the emission gap. Firstly, following the negotiations in Cancún, two workshops were held; one at the climate conference in Bangkok (April 2011) and one at the climate conference in Bonn (June 2011), as mandated in the Cancún Agreements. The workshops allowed countries to clarify assumptions and conditions regarding their pledges (UNFCCC, 2011f, g). The workshops provided much useful information, but there were no new announcements that would increase the ambition levels (UNFCCC, 2011d). Secondly, many non-Annex I countries provided information about their business-as-usual emissions through national communications to the UNFCCC<sup>2</sup>, national climate action

plans or other national documentation, or in statements by government officials. Because non-Annex I countries expressed their reduction pledges relative to their business-as-usual emission levels, information on these levels influences emission levels resulting from the pledges. Thirdly, projections of business-as-usual emissions and economic growth especially in China, but also in the non-Annex I countries without a reduction pledge, have been revised. Fourthly, in the Durban climate negotiations, Parties agreed on Land Use, Land Use Change and Forestry (LULUCF) accounting rules for the post-2012 commitment period. These rules may strongly influence the emission reduction levels, excluding LULUCF, resulting from the Annex I pledges. Finally, there are updates regarding the mitigation potential of reforestation and avoided deforestation, options for carry-over of surplus assigned amount units (AAUs) from the Kyoto Protocol’s first commitment period, as well as new insights into the 2020 emission levels that would be consistent with achieving the 2 °C limit to a global temperature increase.

### 1.3 Method

Pledges were evaluated within the FAIR modelling framework (Den Elzen et al., 2011b; 2011c) (see Appendix A). Because the size of the emission gap strongly depends on business-as-usual emission projections, we compared the pledged reductions against business-as-usual projections from several sources. These were projections by the countries themselves<sup>3</sup>, PBL/IIASA projections (for Annex I countries we refer to the PBL business-as-usual projections), and those based on data from the World Energy Outlook (WEO-2010) (IEA, 2010), when available. PBL/IIASA projections contain all Kyoto greenhouse gases (except CO<sub>2</sub> emissions from land-use change) and were developed for the coming OECD Environmental Outlook (OECD, 2012). These projections were calculated using the PBL energy model ‘TIMER’ (Van Vuuren et al., 2006; 2011) and the PBL land-use model ‘IMAGE’ (Bouwman et al., 2006), and using the GDP projections from the ENV-Linkages model of the OECD (Burniaux and Chateau, 2008). Data on CO<sub>2</sub> emissions from land-use change (e.g. deforestation), for the non-Annex I countries, were based on the IIASA forestry model ‘G4M’ (Kindermann et al., 2006; 2008). For the WEO projections, data on energy-related CO<sub>2</sub> emissions were taken from the World Energy Outlook 2010 (IEA, 2010) and the greenhouse gas emissions from the other sources were derived from the PBL/IIASA business-as-usual projections. Appendix B provides a comparison of business-as-usual scenarios from the different sources.

## 1.4 Structure

The structure of the report is organised around the following main policy questions:

- What is the contribution of Annex I reduction pledges to emission reductions by 2020? (Chapter 2)
- What is the contribution of mitigation actions by non-Annex I countries to emission reductions by 2020? (Chapter 3)
- What if any will be the emission gap in 2020 between the emission level to be expected from the pledges and mitigation plans, on the one hand, and that consistent with achieving the long-term 2 °C climate target, on the other? (Chapter 4)
- What are the options for narrowing this emission gap? (Chapter 5)
- What are the main risks of increasing the emission gap? (Chapter 6)
- What is the effect of forestry accounting rules on effective emission reductions by Annex I countries in 2020? (Chapter 7)
- Which options are on the negotiation table regarding the use of Kyoto surplus AAs for reaching future reduction targets, and how do these affect reduction levels? (Chapter 8)
- How do the emission reduction pledges by the twelve major emitting economies (including the EU) relate to projected emission levels? (Chapter 9)
- Main conclusions (Chapter 10)

## Notes

- <sup>1</sup> [http://unfccc.int/meetings/copenhagen\\_dec\\_2009/items/5262.php](http://unfccc.int/meetings/copenhagen_dec_2009/items/5262.php).
- <sup>2</sup> See for example: [http://unfccc.int/national\\_reports/non-annex\\_i\\_natcom/items/2979.php](http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php).
- <sup>3</sup> For Annex I countries, see: [http://unfccc.int/national\\_reports/annex\\_i\\_natcom/submitted\\_natcom/items/4903.php](http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/4903.php).



# Reduction pledges by Annex I countries

## Key findings

- Full implementation of the low pledges as put forward by Annex I Parties in the Cancún Agreements are estimated to lead to an Annex I emission level by 2020 which is 12% below the 1990 level. For the high pledges, this would be 18%. These numbers exclude emissions from land use, land-use change and forestry. This is less than the range of 25% to 40% that was reported by the IPCC to be consistent with scenarios stabilising at 450 ppm CO<sub>2</sub> eq.
- If the Annex I countries that presented only a conditional pledge and that announced not to be on board for a second commitment period under the Kyoto Protocol do not implement their low pledges, the Annex I emission level by 2020 increases to 5% below 1990 levels.
- The pledges by Russia, the Ukraine and Kazakhstan lead to emission levels of above their business-as-usual level; thus creating new surplus assigned amount units (AAUs). The amount of new surplus AAUs has been adjusted downward, due to higher PBL business-as-usual estimates for Russia and the Ukraine. If surplus AAUs remain unused or not traded, the Annex I emission levels in the low pledge scenario would decrease from 12% to 16% (range 13-17%) below 1990 levels, by 2020, depending on business-as-usual emission projections. Emission levels in the high pledge scenarios would not decrease according to the national business-as-usual projections, but would decrease to 19% below the 1990 level according to PBL business-as-usual projections.
- The Annex I emission level that would result from implementation of the high pledges could increase by up to 2%, from the 1990 emission level, under the land-use and forestry accounting rules as agreed by the Parties during the Durban climate negotiations.
- Since the Cancún climate negotiations, no Annex I country has changed its reduction proposal. Some Annex I countries, notably Australia, have made clarifications about the assumptions and conditions with respect to their proposed reductions, but this hardly has affected the overall Annex I reduction target.
- The EU clarified that surplus AAUs and credits from land-use accounting cannot be used for achieving the 20% unconditional target.

## 2.1 Description and clarification of pledges

Reduction pledges as put forward by major Annex I countries in the Cancún Agreements can be summarised as follows. The EU has made an unconditional reduction pledge of 20% from 1990 levels, and a conditional pledge of 30%, under the precondition that other Annex I countries commit to comparable emission reductions and that more advanced non-Annex I countries contribute adequately according to their responsibilities and respective capabilities. The United States pledged to reduce their greenhouse gas emissions by 17% from 2005



levels, by 2020, under an international climate agreement, but made this commitment contingent on passing legislation at home. Japan pledged a 25% reduction from 1990 levels, subject to the establishment of a fair and effective international framework in which all major economies participate and come to an agreement on ambitious reduction targets. Canada matched the US pledge to reduce emissions by 17% relative to 2005 levels. Norway and Russia pledged reduction targets of 30% to 40% and 15% to 25%, respectively, relative to 1990 levels. Australia, finally, pledged reduction targets of 5%, 15% and 25% from 2000 levels, by 2020, with the last two pledges being conditional on mitigation action by others.

Since the Cancún climate negotiations, none of the Annex I countries changed their reduction proposals. In the UNFCCC's Climate Change Conferences in Bangkok (April 2011) and Bonn (June 2011), some Annex I countries have clarified the assumptions and conditions regarding their proposed emission reductions (for an overview, see UNFCCC, 2011d; Höhne et al., 2011b, a; and Earth Negotiations Bulletin, IISD, 2011). The most important clarifications that could have an effect on the projected 2020 emission level came from Australia and the EU.

*Australia* provided new information during the Bangkok conference on the interpretation of its targets. First, Australia stated that its pledge includes net CO<sub>2</sub> emissions from deforestation to be added to its base-year (2000) emissions by applying Article 3.7<sup>1</sup> to future emission levels. The net CO<sub>2</sub> emissions from deforestation appear to be based on those reported under the Kyoto Protocol's Article 3.3. This would imply a deforestation emission level of about 70 Mt CO<sub>2</sub> eq in 2000, which is a similar level as was found by Höhne et al (2011b). Adding these emissions to Australia's energy and industrial greenhouse gas emissions of 496 Mt CO<sub>2</sub> eq of 2000, the total 2000 emission level on which the pledges are based amounts to 566 Mt CO<sub>2</sub> eq. Therefore, for Australia, we calculated absolute allowed emission levels for 2020 of 538, 481, and 425 Mt CO<sub>2</sub> eq for their respective reduction targets of 5%, 15% and 25%. The 5% target would translate into an effective greenhouse gas emission target (including all greenhouse gases under the Kyoto Protocol and emissions from deforestation, but excluding those from LULUCF) of 29% above 1990 levels, while for the 25% target this would be 2%. This compares to a target of +8% for the first commitment period.

The *European Union* made some clarifications and communicated some expectations on the following issues:

- Emissions from international aviation are included in the target, and it is foreseen that legislation will need

to include international maritime emissions if on an international level no progress is made towards the inclusion of these emissions;

- LULUCF emissions and emission removals through sinks resulting from LULUCF activities, and related accounting rules, at present, are not included in the 20% reduction target, but may be at a later stage, given that, from a legislative viewpoint, accounting rules should ensure permanence and environmental integrity;
- The EU anticipates achieving up to a maximum of 4% of the 20% target and 9% of the 30% target by using international offsets (JI and CDM credits).

The pledges of the major Annex I countries differ in general assumptions and conditions. Some Annex I countries made both an unconditional pledge and a more ambitious pledge in the Cancún Agreement. The more ambitious pledges are conditional, mainly on a high level of ambition from other countries or domestic legislation (see UNFCCC (2011d) and Table 2.1 for details of these conditions). Other countries made only one pledge, conditional or unconditional, or without being unclear on this issue. For the purpose of this report, we developed three scenarios, providing a range of plausible outcomes for the Annex I emission level by 2020:

1. an unconditional pledge scenario;
2. a low pledge scenario;
3. a high pledge scenario.

The *unconditional pledge scenario* is based on the least ambitious scenario according to the UNEP (2010, 2011) reports. In this scenario, all countries with both an unconditional and a conditional pledge are assumed to implement their least ambitious, unconditional pledges. For countries that only provided a conditional pledge, their business-as-usual emissions are assumed. This holds for Canada, Japan, the United States and Russia – all countries that have indicated not to be on board for a second commitment period of the Kyoto Protocol. Given that all these countries are implementing and/or planning to implement some domestic climate policies, this is a conservative assumption and represents the low end of the expected emission reductions.

The *low pledge and high pledge scenarios* are based on UNFCCC documents (e.g. UNFCCC, 2011d). The low pledge scenario refers to a scenario in which all countries with only one conditional emission reduction pledge for 2020 implement these pledges, and all countries with only an unconditional or both an unconditional and a conditional pledge implement their least ambitious, unconditional pledges. The high pledge scenario refers to a scenario in which all countries implement their most ambitious, conditional emission reduction pledge for 2020.

Therefore, for Annex I countries that have made a conditional pledge only, such as Canada, Japan and the United States, we assumed this pledge to be implemented, for both the low pledge and high pledge scenarios. The unconditional pledge scenario, thus, leads to the highest emission level for 2020, and the high pledge scenario to the lowest.

The 2020 emission level resulting from the pledges not only depends on the conditionality of the pledges; accounting rules for Land Use, Land Use Change and Forestry (LULUCF) credits (and debits) and surplus AAUs, leakage effects, and double counting of CDM projects also play an important role (Section 2.3 presents the results under lenient rules, where these allowances and credits can be used). In the three scenarios, we assumed strict accounting rules, meaning allowances from LULUCF accounting credits and surplus AAUs will not be used for achieving reduction pledges. However, we did allow for trade in new surplus AAUs in the low pledge and high pledge scenarios. Finally, we assumed no leakage effects and no double counting of CDM projects.

## 2.2 Overview of reductions

The emission reductions expected from the unconditional, low and high pledges by Annex I countries are given in Table 2.1. Although the targets were proposed relative to different base years, for the sake of comparability, they are all shown against 1990 and 2005 levels.

The unconditional pledges would result in an Annex I emission target for 2020 of 5%, the low pledges in 12%, and the high pledges in 18% below the 1990 level, for all greenhouse gas emissions, except for CO<sub>2</sub> emissions from LULUCF. According to the IPCC Fourth Assessment Report (AR4) (Gupta et al., 2007), a reduction of 25% to 40% below 1990 levels would be needed to achieve the long-term 2 °C climate target. Figure 2.1 shows the reductions relative to PBL business-as-usual emission projections for 2020 resulting from the pledges by Annex I countries compared against the IPCC AR4 25% to 40% reduction range (see Appendix B for a comparison with other business-as-usual emission projections). The figure also shows the new surplus AAUs from Russia and the Ukraine.

## 2.3 Main uncertainties

There are several major uncertainties – apart from the conditionality of the pledges discussed above – that may strongly influence the emission reductions resulting from the Annex I pledges. Some important ones relate to

LULUCF accounting rules and the use of surplus AAUs. Chapter 5 elaborates further on these uncertainties. Below, a brief explanation is presented of the assumptions that underlie the reduction efforts as given in Table 2.1 and Figure 2.1, including a focus on their impact on the aggregated reduction for Annex I countries as a group (Table 2.2).

### 2.3.1 LULUCF accounting rules

The LULUCF rules for the current Kyoto commitment period state that individual countries should keep an account of their greenhouse gas fluxes from afforestation, reforestation and deforestation, and offer the choice of also including forest management (with a cap on accruing emission allowances), cropland management, grassland management and revegetation.

After years of negotiations, a decision was made in Durban regarding LULUCF accounting rules for the second (post-2012) commitment period<sup>2</sup>. The main features of the new rules include:

- Accounting of forest management becomes mandatory. The credits and debits during the commitment period will be calculated by subtracting a ‘reference level’ from the actually reported emissions or removals. For most countries (i.e. EU countries, Australia, New Zealand, Canada, Switzerland, Ukraine, Croatia), this reference level is based on business-as-usual projections. For Norway, Russia and Belarus, it is based on 1990 net emissions from forest management. For Japan, it is set to zero. Furthermore, there is a cap on forest management credits that equals 3.5% of base-year emission levels (usually 1990).
- Rules on accounting of afforestation, reforestation and deforestation, cropland management, pasture management and re-vegetation, remain essentially the same as under the first Kyoto commitment period.

For all Annex I countries, LULUCF credits during the second commitment period resulting from these rules will be calculated using the JRC LULUCF tool, version December 2010<sup>3</sup>, of the European Commission, Joint Research Centre (JRC). Depending on the amount of forest management credits, credits resulting from LULUCF may result in additional total emission credits for all Annex I countries, ranging from 1.6% to 2.1% of 1990 emission levels (Table 2.2). LULUCF credits may not lead to additional greenhouse gas reductions, as LULUCF activities take place regardless of further policy intervention (UNEP, 2010)<sup>4</sup>. LULUCF credits could be used to replace other mitigation actions and therefore weaken the total reduction effort of Annex I countries. Chapter 7 discusses, in more detail, the implications of the LULUCF credits that result from the agreed accounting rules, including their impacts on individual Annex I countries.

Table 2.1

**Emission targets of Annex I countries in 2020 resulting from the pledges put forward by the Parties in the Cancún Agreements**

Topic	Emissions in Mt CO <sub>2</sub> eq* (excluding LULUCF)		Unconditional pledge		Low pledge		High pledge	
	1990	2005	% relative to 1990	% relative to 2005	% relative to 1990	% relative to 2005	% relative to 1990	% relative to 2005
Australia	418	528	29	2	29	2	2	-19
Belarus	139	84	-5	57	-5	57	-10	49
Canada	590	731	27	3	3	-17	3	-17
Croatia	31	30	-5	-1	-5	-1	-5	-1
EU27	5,589	5,149	-20	-13	-20	-13	-30	-24
Iceland	3	4	-30	-36	-30	-36	-30	-36
Japan	1,267	1,351	5	-1	-25	-30	-25	-30
New Zealand	59	75	-10	-29	-10	-29	-20	-37
Norway	50	54	-30	-35	-30	-35	-40	-45
Russia	3,351	2,118	-26	17	-15	34	-25	19
Switzerland	53	54	-20	-22	-20	-22	-30	-31
Ukraine	931	425	-20	75	-20	75	-20	75
United States	6,167	7,185	18	1	-3	-17	-3	-17
Kazakhstan	370	245	-26	11	-26	11	-26	11
<b>Annex I total**</b>	<b>19,019</b>	<b>18,034</b>	<b>-5</b>	<b>1</b>	<b>-12</b>	<b>-7</b>	<b>-18</b>	<b>-13</b>

Source: Annex I countries base-year emissions are based on UNFCCC national inventory submissions.

\* All greenhouse gas emissions in this report refer to all emissions relevant under the Kyoto Protocol (Annex A) with the exception of emissions from LULUCF, i.e. the global warming potential-weighted sum of six Kyoto greenhouse gas emissions.

\*\* Total Annex I emissions exclude emissions from Turkey.

*Pledges differ in scope and conditionality.* The following qualifications apply (UNFCCC, 2011d):

*Australia's* pledge accounts for CO<sub>2</sub> emissions from deforestation in its base-year (2000) emissions. Australia will unconditionally reduce its emissions by 5% below 2000 levels, by 2020, and by up to 15% or 25% under certain conditions. Australia will reduce emissions by 25% below 2000 levels, conditional on an ambitious global deal capable of stabilising greenhouse gas concentrations at 450 ppm CO<sub>2</sub> eq. The 15% target applies if there is a global agreement which falls short of securing atmospheric stabilisation at 450 ppm CO<sub>2</sub> eq under which all major developing economies commit to substantially restraining their emissions and advanced economies take on commitments comparable to those of Australia.

*Canada* will reduce its carbon emissions by 17% from 2005 levels, over the next 10 years, as part of the Copenhagen Accord on climate change. *The EU* has pledged to cut its greenhouse gas emissions by 20% below 1990 levels, by 2020, and to extend this cut to 30%, on the condition that other Annex I countries commit to comparable emission reductions and that non-Annex I countries contribute adequately.

*Japan* will reduce greenhouse gas emissions by 25% below 1990 levels, by 2020, on the condition that all major emitters commit to ambitious targets.

*New Zealand's* pledge is conditional on the Copenhagen Agreement (450 ppm, comparable efforts), including LULUCF and carbon market use.

*Norway* puts forward emission reduction targets of 30% to 40% below 1990 levels, by 2020, and signals that it may move to a reduction of 40% as part of a global and comprehensive agreement for the period beyond 2012.

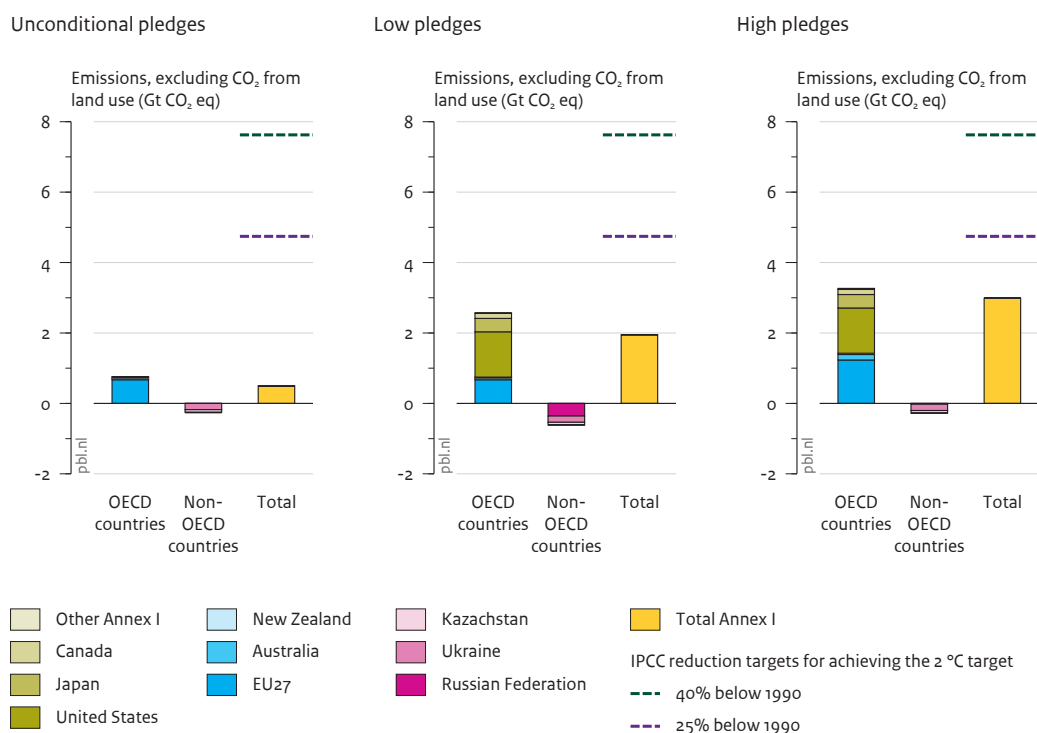
*Russia's* range of greenhouse gas emission reductions depends on the following conditions: (i) Appropriate accounting of the potential contribution of Russian forests to meeting the obligations of the anthropogenic emissions reduction; (ii) All major emitters comply with the legally binding obligation to reduce anthropogenic greenhouse gas emissions.

*The United States'* reduction target for 2020 is around 17% below 2005 levels, in conformity with anticipated US energy and climate legislation, recognising that the final target is yet to be submitted to the Secretariat in light of enacted legislation.

The targets in Table 2.1 exclude emissions from and uptake by the LULUCF sector (emissions from deforestation, thus, are also excluded). Therefore, the targets are expressed as effective targets for industrial processes, solvent and other product uses, and the energy, agriculture and waste sectors. Chapter 7 describes the targets that include land-use credits from land-use accounting rules as agreed at the Durban climate negotiations.

Figure 2.1

## Greenhouse gas emission reductions from PBL business-as-usual projections for Annex I countries, by 2020



Source: PBL

Pledged reductions by Annex I countries or regions below PBL business-as-usual emission projections compared against the IPCC reduction range needed for achieving the 2 °C climate target.

### 2.3.2 Surplus assigned amount units

Another major uncertainty concerns the use of surplus assigned amount units (AAUs), often referred to as 'hot air', notably from Russia, the Ukraine, Belarus, Kazakhstan and other countries in central and eastern Europe. Surplus AAUs may be carried over from the first commitment period of Kyoto or result from pledges for 2020.

New surplus AAUs are generated because the reduction pledges by Russia and the Ukraine are well above their business-as-usual emission projections. If these surplus AAUs would not be used or traded, the Annex I emission level resulting from the low pledge would decrease from 12% to 16% below 1990 levels, under the PBL business-as-usual scenario, with a range of 13% to 17% for alternative business-as-usual projections. For the high pledges, the emission level of 18% below 1990 levels would decrease to 19%, with a range of 18% to 20% (Table 2.2, third column).

'Kyoto surplus AAUs' relate to the surplus assigned amount units (AAUs) that are generated during the Kyoto period. Countries may carry-over or bank these surplus AAUs for use in the following commitment period. Surplus AAUs may be sold or used domestically to meet future mitigation commitments up to 2020. If this happens, then estimates of 2020 emissions would increase, because these surplus AAUs could be used to achieve the pledges, replacing domestic emission reductions. The UNFCCC negotiation text<sup>5</sup> basically describes four options for dealing with Kyoto surplus AAUs, for achieving the reduction pledges by 2020 (see Chapter 8):

- Option 1 is the status quo, implying no restrictions on the future use of Kyoto surplus assigned amount units. This will lead to about 3 Gt CO<sub>2</sub> eq in surplus AAUs by 2020.
- Option 2 allows full use of new surplus assigned amount units, but restricts their carry-over to a certain percentage. The percentages currently proposed are 1, 2, 5, and 10. This leads to surplus AAUs varying from 0.1 to 1 Gt CO<sub>2</sub> eq by 2020.

Table 2.2

**Impact of including allowance increases from land-use and forestry (LULUCF) rules and new surplus assigned amount units (AAUs) for Russia and the Ukraine, for the aggregated emission reduction by Annex I countries under the unconditional pledge, low pledge and high pledge scenarios**

Annex I countries <sup>i</sup> as a group, emission reduction from 1990 levels (%)	Default: excluding LULUCF credits & including new surplus AAUs*	Including LULUCF credits** & including new surplus AAUs	Excluding LULUCF credits & excluding new surplus AAUs**	Excluding LULUCF credits & including new surplus AAUs & including Kyoto surplus AAUs***
Unconditional pledge	5% [1%;6%]*	3% to 4%	6% [ 2%; 7%]**	2% to 3%
Low pledge	12%	11%	16% [13%;17%]**	9% to 11%
High pledge	18%	16%	19% [18%;20%]**	15% to 16%

<sup>i</sup> Total emissions from Annex I countries exclude emissions from Turkey.

\* The range reflects the impact of different business-as-usual emission projections, default: PBL business-as-usual emission projections, and range based on World Energy Outlook business-as-usual emissions and national business-as-usual emissions provided by the countries themselves.

\*\* Impact of LULUCF accounting rules. The range is based on countries' projections and a maximum estimate of emissions from forest management, as described in Chapter 7.

\*\*\* Impact of restricting the carry-over to 2% to 5% of the total Kyoto surplus assigned amount units.

- Option 3 restricts surplus AAUs to be used for future domestic compliance only. This means that surplus AAUs cannot be sold, and may only be used for reaching reduction targets. This will lead to between 0.4 and 0.8 Gt CO<sub>2</sub> eq in surplus AAUs by 2020.
- Option 4 prohibits the carry-over of surplus AAUs as well as the use of new surplus AAUs, leading to the phasing out of surplus AAUs by 2020.

In the first three columns in Table 2.2, it is assumed that surplus AAUs during the Kyoto period cannot be carried over or banked for use in the next commitment period. The last column of Table 2.2 shows the impact of option 2, with varying carry-over of between 2% to 5% of the total surplus AAUs from the Kyoto commitment period. Chapter 8 discusses in more detail the implications of the various options for the use of carried over Kyoto surplus AAUs.

## Notes

- <sup>1</sup> Article 3.7 allows emissions from deforestation to be included in the base year for those Parties with a net source of emissions from land-use change and the forestry sector and applied to the target in the first Kyoto commitment period.
- <sup>2</sup> [http://unfccc.int/files/meetings/durban\\_nov\\_2011/decisions/application/pdf/awgkp\\_lulucf.pdf](http://unfccc.int/files/meetings/durban_nov_2011/decisions/application/pdf/awgkp_lulucf.pdf).
- <sup>3</sup> [http://afoludata.jrc.ec.europa.eu/index.php/models/JRC\\_LULUCF\\_TOOL](http://afoludata.jrc.ec.europa.eu/index.php/models/JRC_LULUCF_TOOL).
- <sup>4</sup> Land use and forestry measures tend to remove CO<sub>2</sub> and thus decrease the atmospheric CO<sub>2</sub> built up. However, it cannot be guaranteed that the accounted land use and forestry adjustments reflect real, additional and permanent changes there is no way to ensure that carbon stored in a planted forest or in agricultural soils will not be subsequently released.
- <sup>5</sup> FCCC/KP/AWG/2010/CRP.4/Rev.4.

# Mitigation action plans by non-Annex I countries

## Key findings

- The mitigation action plans by the seven largest emitting non-Annex I countries (China, India, Brazil, Indonesia, Mexico, South Africa and South Korea, which, by 2020, will be responsible for more than two-thirds of non-Annex I emissions in business-as-usual projections), as part of the Cancún Agreements, are estimated to reduce emissions by approximately 3% and 6% below PBL/IIASA business-as-usual emission projections for 2020, according to their respective low and high pledges. As for China GDP growth is very uncertain, the emission level resulting from its pledged actions is uncertain, as well. This implies that the reduction range could still change, substantially.
- Nine other non-Annex I countries also have pledged reductions, leading to a total reduction of 21% and 25% below PBL/IIASA business-as-usual emission projections, according to their respective low and high pledges.
- If all other non-Annex I countries (those that pledged no quantifiable reductions) follow PBL/IIASA business-as-usual emission projections, then the emissions for non-Annex I countries as a group would be about 3% and 4% below PBL/IIASA business-as-usual emission projections for 2020 (including LULUCF CO<sub>2</sub>), according to their respective low and high pledges. This is less than the 15% to 30% that literature reports to be consistent with scenarios stabilising at 450 ppm CO<sub>2</sub> eq.
- If non-Annex I countries with only a conditional pledge do not implement this (low) pledge, the non-Annex I emission level by 2020 would increase to 1% below PBL/IIASA business-as-usual emission projections.
- Our analysis shows that about 60% of the total reduction by non-Annex I countries will result from reducing emissions from deforestation (REDD) and other land-use related emissions. This makes the non-Annex I contribution to emission reductions highly uncertain.
- China and India have set emission intensity targets for CO<sub>2</sub> and greenhouse gases, for which the target level strongly depends on GDP growth. For China, the additional non-fossil-fuel target of 15% may be more limiting than its intensity target, leading to a reduction of 4% below PBL/IIASA's business-as-usual emission projections. For India, the emission level resulting from their intensity target is 13% above the PBL/IIASA projections, but 23% below India's own business-as-usual projections.
- Since the Cancún climate negotiations non-Annex I countries have not changed their reduction proposals (mitigation actions). However, new published information about business-as-usual emissions from non-Annex I countries – especially Brazil, China and India – has led to an upward revision of the emission level by 1.0 to 1.5 Gt CO<sub>2</sub> eq, resulting from the pledges.

### 3.1 Description of the mitigation action plans

About 45 non-Annex I countries have submitted mitigation action plans under the UNFCCC in line with the 2010 Cancún Agreements. These submissions include the conditions under which these mitigation actions will be implemented. This chapter focuses on the 16 non-Annex I countries (including the seven major emitting countries) that have submitted quantified mitigation goals. These goals can be divided into four categories:

- (i) Reduction in greenhouse gas emissions per unit of GDP (emission intensity targets), in China and India;
- (ii) Goals specified as reduction percentages in relation to business-as-usual emissions (in Brazil, Indonesia, Mexico, South Africa, South Korea, Chile, Israel, Papua New Guinea, Singapore and Taiwan) or as absolute reductions below business-as-usual emission projections (in Colombia and Peru);
- (iii) Goals specified as a reduction target below a certain historical base year (Moldova);
- (iv) Goals related to carbon neutrality (in Costa Rica and the Maldives).

The remaining non-Annex I countries have not submitted any action plans related to economy-wide goals, but only in terms of mitigation policies, projects, and/or sectoral actions. Reductions resulting from these actions are difficult to quantify; therefore, we assumed no reductions below business-as-usual emission projections for these countries.

During the Bonn and Bangkok UN Climate Change Conference of 2011, several non-Annex I countries presented and clarified their reduction action plans and the underlying business-as-usual emission projections. They also indicated the support needed for implementation of their proposed actions. Much information is published in national, government-funded studies, which are described briefly in this chapter, and in more detail in Chapter 9. Table 3.1 provides the sources of the national business-as-usual emission levels for greenhouse gas for 2020.

The mitigation action plans are described in detail, below, per type of mitigation action (UNFCCC, 2011b).

*Group (i)* consists of China and India; both countries having pledged emission intensity targets (UNFCCC, 2011b). The conditionality of these pledges has not been described in detail. China has pledged to reduce CO<sub>2</sub> emissions per unit of GDP by 40% to 45%, relative to 2005 levels. In addition, it has pledged to increase the share of non-fossil fuels in primary energy consumption to 15%, and to

increase forest coverage by 40 million hectares and forest stock volume by 1.3 billion m<sup>3</sup>, relative to 2005 levels. These are autonomous, voluntary domestic actions, and will be implemented in accordance with the principles and provisions of the UNFCCC, particularly Article 4.7<sup>1</sup> (UNFCCC, 1992).

Although China has provided more information about its actions in the INF.1 document (UNFCCC, 2011b) and in its pre-session presentation at the April 2011 UN Climate Change Conference in Bangkok, the Chinese Government has not yet released a projection of China's business-as-usual emissions or emission intensity target. This study estimates the emission level resulting from China's pledge, based on PBL/IIASA projections of business-as-usual emissions, energy consumption and GDP, as described in Section 3.2.

*India* has pledged to reduce greenhouse gas emissions per unit of GDP by 20% to 25%, relative to 2005 levels by 2020. Emissions from the agricultural sector have not been taken into account in defining India's emission intensity (UNFCCC, 2011b). Actions to achieve this pledge will be implemented not only in accordance with the provisions of the relevant national legislations and policies, but also according to the principles and provisions of the UNFCCC, particularly Article 4.7. The Indian Government has provided estimates of emission reductions by 2020 based on a 20% to 25% reduction in emission intensity, from 2005 levels. These estimates, together with corresponding annual GDP growth estimates of 8% and 9%, have been based on the interim report 'Low Carbon Strategies for Inclusive Growth' (Planning Commission, Government of India, 2011). This interim report projects the business-as-usual emission levels for 2020 to vary between 4571 and 5248 Mt CO<sub>2</sub> eq.

*Group (ii)* consists of non-Annex I countries with reduction targets of below their projected business-as-usual emissions. The business-as-usual emission projections have been based on estimates provided by the countries themselves, as mainly clarified during the Bangkok and Bonn Climate Change Conferences (see Table 3.1).

- *Brazil* pledged actions to reduce emissions by 36% to 39%, relative to its business-as-usual emission projections. The actions will be implemented in accordance with the principles and provisions of the UNFCCC. Brazil has set specific goals for a number of actions related to deforestation, agriculture and energy. These include increasing energy efficiency, improving agricultural techniques, increasing hydropower capacity, increasing the use of biofuels and renewable energy, and, finally, reducing emissions from deforestation. Brazil has characterised its actions as voluntary domestic actions that will be implemented in accordance with the principles and provisions of the



Table 3.1

## Description of business-as-usual emission projections for 2020, as provided by non-Annex I countries

Country	National business-as-usual emissions (excl. LULUCF) (Mt CO <sub>2</sub> eq) *	Source of emission projections
Brazil*	3,236	DECREE No. 7.390/2010 (Presidency of the Republic of Brazil, 2010), as clarified at the Bonn UN Climate Change Conference (June 2011), see: <a href="http://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2010/Decreto/D7390.htm">www.planalto.gov.br/ccivil_03/_Ato2007-2010/2010/Decreto/D7390.htm</a>
Chile*	118	LEAP Model Implementation (PROGEA, 2010), January 2011, Ministry of Energy, as presented at the Bonn UN Climate Change Conference (June 2011), <a href="http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/chile_approach_progress_in_chile.pdf">http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/chile_approach_progress_in_chile.pdf</a>
India*	4,571 - 5,248	Low Carbon Strategies for Inclusive Growth: An Interim Report, based on growth rates of 8% and 9% of GDP (Planning Commission, Government of India, 2011).
Indonesia*	2,170 2,530	– Ministry of Finance Green Paper (2009) – Dewan Nasional Perubahan Iklim, National Council on Climate Change (DNPI, 2009)
Israel	109	Israel's Ministry of Environmental Protection (2009)
Mexico*	884	SEMARNAT (2009), as clarified at the Bangkok UN Climate Change Conference (April 2011), <a href="http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/mexico_ws.pdf">http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/mexico_ws.pdf</a>
Republic of Korea	813	Presentation at the Bangkok UN Climate Change Conference (April 2011), <a href="http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/korea_ws.pdf">http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/korea_ws.pdf</a> see also: <a href="http://www.greengrowth.go.kr/english/en_subpolicy/en_greenhouse/en_greenhouse.cms">www.greengrowth.go.kr/english/en_subpolicy/en_greenhouse/en_greenhouse.cms</a>
Papua New Guinea*	91 - 120	<a href="http://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/pngphaccord_app2.pdf">http://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/pngphaccord_app2.pdf</a>
South Africa	744	South Africa's long-term mitigation scenarios (Scenario Building Team, 2007), see also: Winkler et al (2011), as presented at the Bangkok UN Climate Change Conference (April 2011), <a href="http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/south_africa_ws.pdf">http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/south_africa_ws.pdf</a>
Singapore	75	Presentation at the Bangkok UN Climate Change Conference (April 2011), <a href="http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/singapore_ws.pdf">http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/singapore_ws.pdf</a> , see also: <a href="http://www.lowcarbonsg.com/2010/03/20/singapore-to-reduce-carbon-emissions-by-16-below-2020-business-as-usual-levels/">www.lowcarbonsg.com/2010/03/20/singapore-to-reduce-carbon-emissions-by-16-below-2020-business-as-usual-levels/</a>

\* = Including CO<sub>2</sub> emissions from LULUCF.

UNFCCC (1992). The use of CDM to achieve the targets has not been excluded (which implies a high risk of double counting of emission reductions related to CDM). In April 2011, Brazil provided an upward revision of its national business-as-usual emission projections, from 2704 to 3236 Mt CO<sub>2</sub> eq level, as part of its national law (Presidency of the Republic of Brazil, 2010), which forms the basis for its reduction target. The pledged reductions of 36% to 39% against business-as-usual emission projections has remained the same. The business-as-usual emission projections were revised to include additional emission sources and larger projected emissions from deforestation and other sources, as clarified during the Bonn Climate Change Conference in June 2010. Because of the revision, the

absolute emission target increased substantially. The forestry sector contributes most to the emission reductions, but since current emissions from deforestation are highly uncertain, the impact of measures to reduce deforestation rates on national emissions is also uncertain.

- *Indonesia* submitted an unconditional pledge to reduce emissions by 26%, from its business-as-usual emission projections. Indonesia also entered a high pledge of 41%, announced prior to the conference in Copenhagen and also presented at the Bangkok conference (April 2011). This pledge is conditional on international support. A large proportion of these reductions would come from reducing deforestation and managing peatland emissions. Indonesia has provided two



national business-as-usual emission projections, one of which was published by the Ministry of Finance (2009) and one by the National Council on Climate Change (DNPI, 2009), as shown in Table 3.1. Unlike in our earlier study (Den Elzen et al., 2010a), this time we used the business-as-usual emission projections from the publication by the Indonesian Ministry of Finance for our default calculations. This business-as-usual emission projection is lower than that by the DNPI, as emissions from peatland and deforestation are estimated to be lower. Uncertainties around deforestation and peatland emissions are large.

- *Mexico* submitted a pledge of 30% reduction below its projected business-as-usual emissions, conditional on adequate financial and technological support from Annex I countries, as part of a global agreement.
- *South Africa* submitted a pledge of 34% below its projected business-as-usual emissions, conditional on adequate financial, technological and capacity-building support from Annex I countries, as part of a global agreement.
- *South Korea* committed to reduce emissions by 30% below its projected business-as-usual emissions. This is a voluntary, unconditional reduction target.
- *Chile* pledged a 20% reduction against its projected business-as-usual emissions. Mitigation action will focus on energy efficiency, renewable energy, land-use change and forestry. These actions are conditional on international support.
- *Israel* pledged a 20% reduction against its projected business-as-usual emissions. Main actions to achieve this target include a 10% share of renewable energy in electricity production and a 20% reduction in electricity consumption.
- *Papua New Guinea* pledged to decrease its greenhouse gas emissions by at least 50% before 2030, and to become carbon neutral before 2050. Mitigation actions will take place in forestry, agriculture, oil and gas, transportation, power generation and mining. The action is preliminary and conditional, as described in UNFCCC (2011b).
- *Taiwan* committed to reduce emissions by 30% below its projected business-as-usual emissions. This is a conditional reduction target, which is not described in UNFCCC (2011b), but announced and published by the Taiwanese Government<sup>2</sup>.
- *Singapore* pledged a 16% reduction against its projected business-as-usual emissions, conditional on a legally binding global agreement. Of this 16%, Singapore has stated that between 7% and 11% of this reduction will be domestically funded and unilaterally implemented.
- *Colombia* submitted unconditional and conditional pledges. Its unconditional pledge concerns implementation of renewable energy equalling 77% of the installed capacity by 2020. This pledge could not be quantified. Other actions are conditional on financial support or related to the carbon market. Actions that depend on financing include reducing deforestation, and increasing biofuel production up to a 20% share by 2020. The measures that could be financed through the carbon market include CDM projects. There is an already existing CDM portfolio with a reduction potential of 17.4 Mt CO<sub>2</sub> eq (low pledge) and a possibility to increase this portfolio by taking more mitigation measures in the energy, forestry, industrial and transport sector, with a total reduction potential of 54.8 Mt CO<sub>2</sub> eq (included in high pledge). Reforestation measures could also be financed through the carbon market, but have not been specified in the pledge.
- *Peru* proposed mitigation measures for 2020, at the Bangkok conference<sup>3</sup>, emphasising that deforestation is its main emission source followed by energy consumption. The proposed actions are to deliver a reduction of 67 Mt CO<sub>2</sub> eq, resulting from net emission reductions in the LULUCF sector down to zero (a reduction of 53 Mt CO<sub>2</sub> eq), an increased share of renewable energy up to 40% (7 Mt CO<sub>2</sub> eq) and reduced emissions from urban solid waste (7 Mt CO<sub>2</sub> eq). Peru also stated that its mitigation actions are voluntary in nature, and for implementing these actions it requires support from the international community through the range of financial and cooperative mechanisms available.

*Groups (iii) and (iv)* consist of non-Annex I countries with reduction targets from their base-year emissions or those that aim to achieve carbon neutrality (UNFCCC, 2011b):

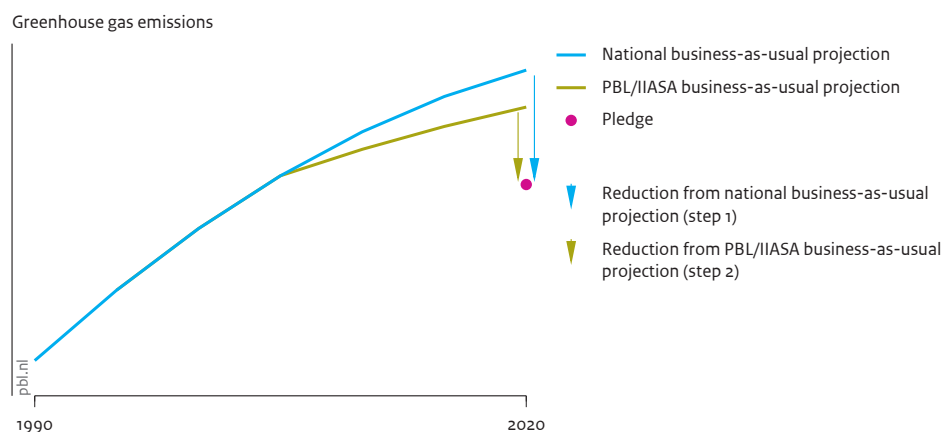
- *Costa Rica* pledged carbon neutrality by 2021. Its goal is to stop deforestation, and increase the use of LULUCF sinks. The entire scope of Costa Rica's actions is of a voluntary nature, contingent on support from the international community and subject to international financing.
- The *Maldives* pledged carbon neutrality by 2021. Mitigation actions are voluntary and unconditional.
- *Moldova* pledged a 20% reduction against 1990 emissions, which has to be achieved through global economic mechanisms. Actions are voluntary and unconditional.

Finally, there is a diverse group of non-Annex I countries that have pledged no quantifiable reductions. This group can be divided into three types of countries:

- Countries that have submitted a pledge, but this could not be quantified into emission reductions (e.g. Argentina, Botswana, Central African Republic, Chad,

The following non-Annex I countries pledged actions that would lead to absolute reductions below their business-as-usual emission projections (UNFCCC, 2011b):

Figure 3.1  
Illustration of the calculation of the non-Annex I reduction levels, for 2020



Source: PBL

Methodology in two steps: 1. Calculating the emission level of the pledge and the reduction effort required to achieve this level, starting from the national business-as-usual emission projections. 2. Calculating the reduction effort required to achieve this pledged level with the PBL/IIASA business-as-usual projection level as a starting point.

- Congo, Ethiopia, Gabon, Ghana, Mongolia, Morocco, the former Yugoslav Republic of Macedonia (see UNFCCC (2011b)).
- Countries that have associated themselves with the Copenhagen Accord, but have not submitted Nationally Appropriate Mitigation Actions (NAMAs) (e.g. Bosnia & Herzegovina, Burkina Faso, Guatemala, Kenya, Montenegro, Namibia, Serbia, Tanzania and Zambia)
- Countries that have not associated themselves with the Copenhagen Accord (e.g. Bolivia, Cuba, Ecuador, Kuwait and Venezuela).

## 3.2 Overview of reductions

This study has analysed how much reduction can be expected from all of the above pledges compared to the PBL/IIASA business-as-usual emissions projections. Emissions include CO<sub>2</sub> emissions from deforestation and afforestation when part of the pledge, which were estimated using the IIASA G4M model (Kindermann et al., 2006; 2008) (see Appendix A). The methodology used for those countries that provided both business-as-usual emission estimates (Table 3.1) and reduction pledges (Figure 3.1). The 2020 emission target resulting from the pledged reduction was calculated from the national business-as-usual emission projections provided by the countries themselves. This level was then used for calculating the reduction below the PBL/IIASA business-as-usual emission projections. As the nationally provided

projections were often higher than the PBL/IIASA projections, the calculated reductions for which the PBL/IIASA projections were used would generally also be lower than those for which the national estimates were used (Table 3.2).

For countries such as China, Colombia, Peru and Taiwan that provided neither national business-as-usual emission projections nor emission levels resulting from their pledges, we calculated their reductions using the PBL/IIASA business-as-usual emission projections.

The mitigation actions of China are:

- to reduce the CO<sub>2</sub> emissions intensity target by 40% to 45% by 2020, from 2005 levels. The CO<sub>2</sub> emission intensity of China is projected to improve by around 42% between 2005 and 2020. As the emission intensity target is an improvement of 40% to 45%, this leads to a further reduction from the PBL/IIASA business-as-usual emission projections of -0.4 to 0.6 Gt CO<sub>2</sub> eq;
- to increase the share of non-fossil fuels in primary energy consumption to around 15% by 2020. The non-fossil energy target is assumed to overlap with the intensity target. Their combined effect was calculated as the maximum reduction resulting from the two individual targets. According to TIMER model calculations, the non-fossil energy target would lead to a reduction of 0.5 Gt CO<sub>2</sub> eq, which is slightly lower than the projected 0.6 Gt CO<sub>2</sub> eq reduction related to

the 45% intensity target. Therefore, it is estimated that the non-fossil energy target will not lead to additional reductions;

- (iii) to increase forest coverage by 40 million ha and forest stock volume by 1.3 billion m<sup>3</sup> by 2020, from 2005 levels. For forest coverage and volume target projections, the IIASA business-as-usual emission projections were used. This would not lead to a further decrease in emissions. For further details on the calculations, see Section 9.2.

Our calculations show a 4% reduction in the PBL/IIASA business-as-usual emission level (see Table 3.2). For the non-Annex I countries that pledged no quantifiable reductions (representing about 30% of non-Annex I business-as-usual 2020 emissions), we assumed emissions to follow the PBL/IIASA business-as-usual emission projections. This is a conservative estimate, since a number of these countries have indicated to have certain plans for mitigation.

As was done for the Annex I countries (Section 2.1), the pledges by non-Annex I countries were analysed using three scenarios: the unconditional pledge, low pledge and high pledge scenario. The unconditional pledge scenario is based on UNEP (2010, 2011) reports. Under this scenario, emissions equal business-as-usual projections for countries that have only provided a conditional pledge (e.g. Mexico, South Africa). Under the low pledge and high pledge scenarios, these countries are assumed to implement their conditional pledge. Under the high pledge scenario, the most ambitious pledges are assumed to be implemented. These definitions of scenarios lead to the same emissions in all three scenarios for countries with only an unconditional pledge. Similar as in the UNEP (2010, 2011) report, we assumed the pledges by Brazil and China to be unconditional. However, this is a source of uncertainty. Therefore, the low pledge and high pledge scenarios represent the reduction range of the pledges made by China and Brazil. For Indonesia, its 26% reduction pledge is assumed to be unconditional and its 41% pledge to be conditional, following the UNEP report.

Table 3.2 presents the reduction targets for the non-Annex I countries, against both nationally provided and PBL/IIASA business-as-usual emission projections. The seven major emerging economies will be responsible for more than two-thirds of total non-Annex I business-as-usual emissions by 2020. Their mitigation action plans are estimated to reduce emissions by approximately 2% to 6% below PBL/IIASA business-as-usual projections (Figure 3.2), depending in the pledge scenario. Because China did not provide a national business-as-usual estimate, a reduction in aggregated national business-as-

usual emissions could not be estimated. As Table 3.2 shows, differences in reductions vary widely between the seven major emerging economies; for the high pledges, from a 21% reduction from projected PBL/IIASA business-as-usual emission levels for Mexico, to a 13% increase for India. Table 3.2 also shows that, for individual emerging economies (excluding China), reductions below national business-as-usual emission levels are higher than those below PBL/IIASA business-as-usual projections. It also shows that, for India, the emission level resulting from its pledge is a reduction below the national business-as-usual emission level, whereas it is an increase relative to PBL/IIASA business-as-usual levels (surplus emission allowances). This also holds for Indonesia's low pledge. The total reduction range for all major emerging economies, excluding China, is 24% to 32% below the nationally provided business-as-usual estimates. This equals 0% to 8% reduction below the PBL/IIASA business-as-usual projections. As GDP growth is very uncertain for both China and India, the expected results from pledged actions are uncertain, as well. This implies that the actual total reduction range for the seven major emerging economies could still change, substantially.

Nine smaller non-Annex I countries, including Singapore and Chile, also submitted quantifiable reduction pledges. Together, these pledges would lead to an increase of 3% for their unconditional pledges, total reductions of 21% for low pledges and 25% for high pledges, compared to PBL/IIASA business-as-usual emission projections (see Table 3.2).

If emissions in all other non-Annex I countries (representing about 30% of total non-Annex I business-as-usual emissions by 2020) would follow the projected PBL/IIASA business-as-usual emissions, then the total emissions for non-Annex I countries would be about 1% to 4% below those PBL/IIASA projections (including land-use related CO<sub>2</sub>), depending on the pledge scenario. This compares to an estimated 15% to 30% reduction below business-as-usual emissions needed to reach the long-term greenhouse gas concentration target of 450 ppm CO<sub>2</sub> eq, which would limit global warming to 2 degrees Celsius, with a medium likelihood (Den Elzen and Höhne, 2008). The difference between reductions expected from non-Annex I pledges and a 15% to 30% reduction below business-as-usual levels is shown in Figure 3.2. This figure also shows that there is a group of countries that have surplus emission allowances, compared to the projected PBL/IIASA business-as-usual emissions, such as India and Indonesia. As, to date, there are no strict rules for the additionality of offsets, non-Annex I countries can sell any surplus allowances that arise if the emission level resulting from their pledge is above the business-as-usual emission level projected by the PBL/IIASA (certified

Table 3.2

The emission levels for non-Annex I countries, by 2020, resulting from their reduction pledges as submitted by the Parties in the Cancún Agreements

Country	Emissions (excl. LULUCF) (Mt CO <sub>2</sub> eq) *				Unconditional pledge		Low pledge		High pledge	
	1990	2005	2020 National business as usual	2020 PBL/ IIASA business as usual	Relative to		Relative to		Relative to	
					National business as usual	PBL/ IIASA business as usual	National business as usual	PBL/ IIASA business as usual	National business as usual	PBL/ IIASA business as usual
China	3,594	7,233		13,450		-4%		-4%		-4%
India	1,106	1,859	4,571	3,121	-23%	13%	-23%	13%	23%	13%
Brazil*	1,854	2,279	3,236	2,497	-36%	-17%	-36%	-17%	39%	-21%
Indonesia*	913	1,195	2,170	1,487	-26%	8%	-26%	8%	41%	-14%
Mexico*	581	774	884	784	0%	0%	-30%	-21%	30%	-21%
South Africa	334	422	744	608	0%	0%	-34%	-19%	34%	-19%
South Korea	308	569	813	678	-30%	-16%	-30%	-16%	30%	-16%
<b>Seven major emerging economies</b>	<b>8,690</b>	<b>14,331</b>		<b>22,625</b>		<b>-2%</b>		<b>-3%</b>		<b>-6%</b>
Chile*	59	91	118	101	0%	0%	-20%	-6%	-20%	-6%
Colombia*	180	233		287		0%		-19%		-31%
Costa Rica*	8	9	18	13	0%	0%	-92%	-89%	-92%	-89%
Israel	45	81	109	115	-20%	-25%	-20%	-25%	-20%	-25%
Moldova	39	13		22		31%		31%		31%
Papua New Guinea*	147	117	105	29	0%	168%	-25%	168%	-25%	168%
Peru*,**	139	174	163	209	0%	0%	-41%	-54%	-41%	-54%
Singapore	31	49	75	60	-7%	17%	-7%	17%	-16%	6%
Taiwan	134	284		362		0%		-30%		-30%
<b>Smaller non-Annex I countries</b>	<b>782</b>	<b>1,050</b>		<b>1,198</b>		<b>3%</b>		<b>-21%</b>		<b>-25%</b>
Other AOSIS	131	156		187				0%		0%
Remaining non-Annex I	4,438	6,431		9,110				0%		0%
<b>Other non-Annex I</b>	<b>4,569</b>	<b>6,587</b>		<b>9,303</b>		<b>0%</b>		<b>0%</b>		<b>0%</b>
Remaining land use CO <sub>2</sub> emissions	3,995	2,627		1,925						
<b>Non-Annex I total</b>	<b>18,036</b>	<b>24,595</b>		<b>35,051</b>		<b>-1%</b>		<b>-3%</b>		<b>-4%</b>

\* = Including CO<sub>2</sub> emissions from LULUCF.

\*\* = Peru only provided national estimates for land use. These have been supplemented with PBL energy/industry data.

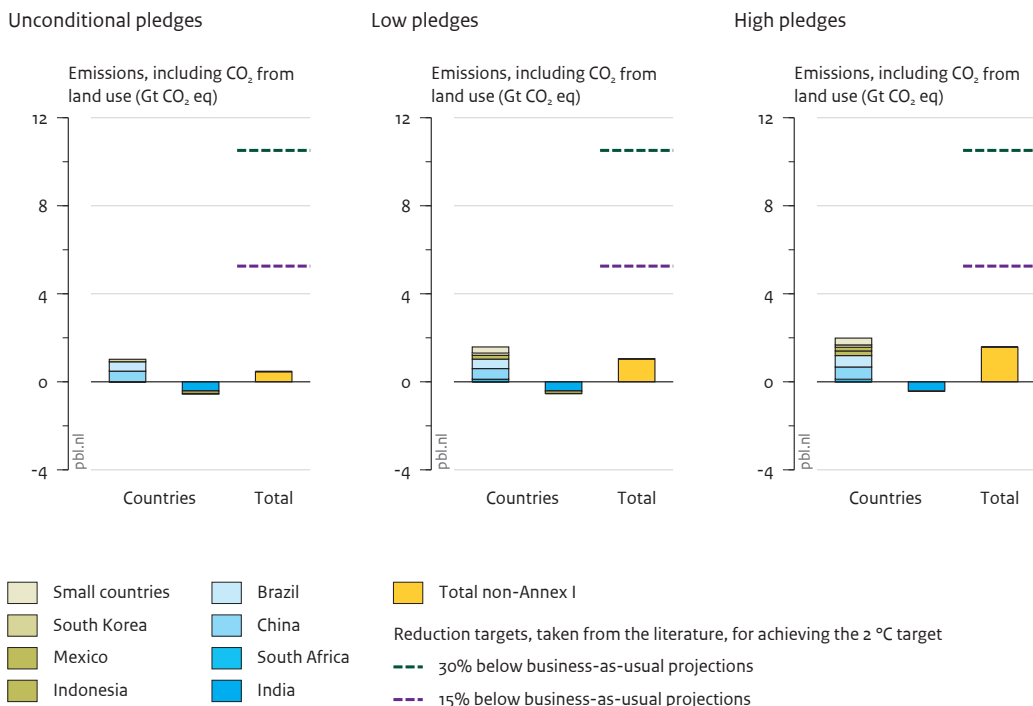
reductions). Therefore, according to our analysis emission levels that result from the pledges could be above the projected business-as-usual emissions. Chapter 6 discusses some options to increase the mitigation effort by non-Annex I countries.

The uncertainty in projected emission levels is much higher than the range of 1% to 4% suggests. This is especially due to uncertainties in business-as-usual emissions, since most mitigation action plans are expressed relative to these emission levels (Sections 3.1 and 9.2). Figure 3.3 presents reduction estimates for six major emerging economies against both PBL/IIASA

business-as-usual emission projections and estimated business-as-usual emission levels provided by the countries themselves. The figure also presents reductions compared to the business-as-usual emission levels based on the World Energy Outlook 2010 (WEO-2010) (IEA, 2010) for Brazil, China and India. For China, reductions based on the WEO-2010 business-as-usual projections are higher because, according to WEO-2010, GDP is projected to be lower. For India, according to the WEO-2010 projection, there would be even more surplus allowances. For Brazil, we see similar reductions according to both the WEO-2010 and PBL/IIASA business-as-usual projections. For the other countries, energy-related CO<sub>2</sub> emissions were

Figure 3.2

Greenhouse gas emission reductions from PBL/IIASA business-as-usual projections, for non-Annex I countries, by 2020



Source: PBL

Comparison of i) pledged reductions by non-Annex I countries below their business-as-usual emission level, and ii) reduction range needed to achieve the 2 °C target according to literature.

not available from the World Energy Outlook 2010, and therefore no reductions from the WEO-2010 business-as-usual emission projections are given here.

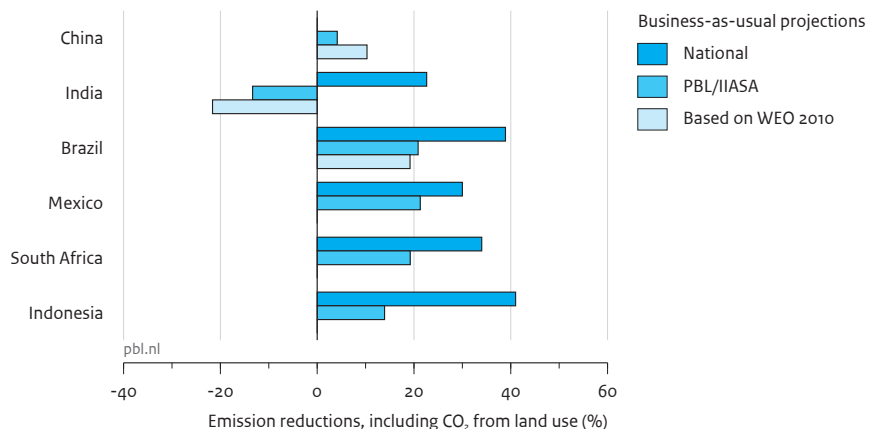
Another important uncertainty relates to the contribution from the UN programme REDD (Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries). Our analysis shows that about 60% of the total reductions for non-Annex I countries, as a group, for the low pledge and high pledge scenarios will come from reducing emissions from deforestation and other land-use related emissions (including from peatlands) (Figure 3.4). Under the unconditional pledge scenario this is even more than 60%. This reduction estimate was based on the pledged reductions by eight countries, representing half of the deforestation business-as-usual emissions by 2020. Together with the large uncertainty around CO<sub>2</sub> emissions from LULUCF, this makes the total emission reduction resulting from the non-Annex I pledges highly uncertain.

Most of the deforestation mitigation measures will be taken in Brazil and Indonesia. These countries contain

large forest areas with a large greenhouse gas emission reduction potential; CO<sub>2</sub> emissions from deforestation will be about 40% (Brazil) and 45% (Indonesia) of total PBL/IIASA business-as-usual greenhouse gas emission projections for 2020. Some smaller countries also have CO<sub>2</sub> emissions from deforestation or other land-use activities, for which some countries have formulated a reduction target (e.g. Peru and Papua New Guinea). However, the majority of these smaller countries does not have a specific reduction objective. Additionally, afforestation, reforestation and forest management may act as emission sinks and could therefore be used for mitigation. The projected total business-as-usual CO<sub>2</sub> emissions from LULUCF for 2020 is 3.8 Gt CO<sub>2</sub> eq, which equals about 10% of projected total business-as-usual emissions for non-Annex I countries. Emission targets related to land use are expected to result in a 17% to 26% reduction against projected CO<sub>2</sub> business-as-usual emissions from LULUCF.

Chapter 5 addresses in more detail the reduction in CO<sub>2</sub> emissions from land use, and afforestation, reforestation and forest management, for all non-Annex I countries

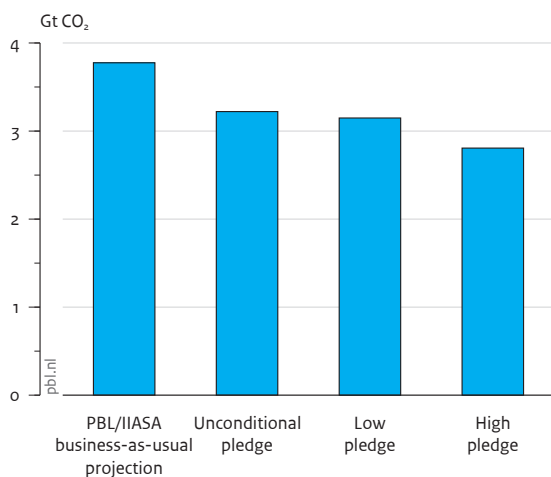
Figure 3.3  
**Greenhouse gas emission reductions from projected business-as-usual levels, for the high pledges by major non-Annex I countries, by 2020**



Source: PBL; IEA (2010)

The impact of various business-as-usual emission projections on total reductions, for six major emerging economies, according to the high pledge scenario.

Figure 3.4  
**Land-use CO<sub>2</sub> emissions for non-Annex I countries, by 2020**



Source: PBL

CO<sub>2</sub> business-as-usual emissions from LULUCF by 2020 are estimated at 3.8 Gt CO<sub>2</sub> eq. Mitigation actions submitted through the REDD programme and reducing other CO<sub>2</sub> emissions from land use are estimated to reduce between 17% and 26% of CO<sub>2</sub> business-as-usual emissions from LULUCF, and make 60% of non-Annex I contributions to emission reductions by 2020 highly uncertain.

together, and Section 9.2 specifies those for Brazil, China, India and Indonesia.

## Notes

- <sup>1</sup> Article 4.7 states: 'The extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology and will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties.'
- <sup>2</sup> [Http://unfccc.epa.gov.tw/unfccc/english/\\_uploads/20100901/B5-NAMAs\\_en.pdf](http://unfccc.epa.gov.tw/unfccc/english/_uploads/20100901/B5-NAMAs_en.pdf).
- <sup>3</sup> [Http://unfccc.int/files/meetings/ad\\_hoc\\_working\\_groups/lca/application/pdf/peru\\_ws.pdf](http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/peru_ws.pdf).

# Emissions by 2020, resulting from reduction pledges in Cancún Agreements, set against 2 °C pathways

## Key findings

- Based on the same pledge scenarios as those described in the UNEP Emissions Gap Reports (2010, 2011), this study projects global emissions to be as high as about 55.4 Gt CO<sub>2</sub> eq by 2020, if all countries implement their unconditional pledges with lenient accounting rules, and at 54.5 Gt CO<sub>2</sub> eq under implementation with strict accounting. In the scenario of implementation of all conditional pledges, the emission level by 2020 could be as low as about 50.9 Gt CO<sub>2</sub> eq under strict accounting rules, and about 54.3 Gt CO<sub>2</sub> eq if lenient accounting rules are applied.
- Whether the 2 °C climate target can be met depends to some extent on the emission level of 2020, although longer term reductions are more important, in this respect. Literature assessment of the revised UNEP (2011) report shows that least-cost emission pathways consistent with a 'likely' chance of achieving the 2 °C target, generally, peak before 2020, and, by that year, have emission levels of around 44 Gt CO<sub>2</sub> eq (20<sup>th</sup> to 80<sup>th</sup> percentile, range: 41 to 46 Gt CO<sub>2</sub> eq). For a medium likelihood of achieving the 2 °C target, 2020 emissions levels must be around 46 Gt CO<sub>2</sub> eq (range: 45 to 49 Gt CO<sub>2</sub> eq).
- The emission gap between the emission levels resulting from the pledges (51 to 55.4 Gt CO<sub>2</sub> eq) and the median levels consistent with a likely chance of achieving the 2 °C target ranges from 7 to 11 Gt CO<sub>2</sub> eq, and for a medium chance of reaching this target the range is between 5 and 9 Gt CO<sub>2</sub> eq.
- Most least-cost emission pathways limit 2020 emissions consistent with the 2 °C target to 49 Gt CO<sub>2</sub> eq, at the most. However, recent studies of multi-gas emission pathways show that even emissions of up to 50 to 51 Gt CO<sub>2</sub> eq could still be consistent with a medium chance of achieving the 2 °C target, if higher costs are allowed across the whole 21st century. Such scenarios, however, also depend on advanced future technologies with negative emissions.
- Before the Cancún climate negotiations, it was estimated that if all countries would implement their conditional pledges with strict accounting rules, this would lead to an emission level of about 48.5 Gt CO<sub>2</sub> eq. The current estimate is about 2.5 Gt CO<sub>2</sub> eq higher, which is mainly due to the higher published business-as-usual emissions from developing countries and from Russia and the Ukraine.

This chapter presents the expected emission gap for 2020 between emission levels consistent with a 2 °C limit on global temperature increases, and those resulting from the pledges put forward by the Parties in the Cancún Agreements. For this report, we calculated the emission gap related to achieving the 2 °C target, based on the same four pledge scenarios as those in the UNEP (2010, 2011) reports.



## 4.1 Four pledge scenarios

The four pledge scenarios are combinations of the following two interdependent factors: conditional versus unconditional pledges and 'lenient' versus 'strict' accounting rules:

- Scenario 1. Unconditional pledges, lenient rules
- Scenario 2. Unconditional pledges, strict rules
- Scenario 3. Conditional pledges, lenient rules
- Scenario 4. Conditional pledges, strict rules

Both the unconditional and conditional pledge scenarios are described in Chapters 2 and 3, where the conditional pledge scenario is described as the high pledge scenario. Furthermore, the low pledge scenario as described in Chapters 2 and 3 is not included in this chapter.

The accounting rules describe how LULUCF emission credits and surplus AAUs can be used to achieve emission reduction pledges. The international accounting rules for achieving emission reduction targets by 2020 have yet to be defined. Rules for Annex I countries exist under the Kyoto Protocol up to 2012, and proposals for the second Kyoto commitment period have been negotiated for many years. In the Durban climate negotiations in 2011, a decision was made regarding LULUCF accounting rules for the second (post-2012) commitment period. Rules for non-Annex I countries are not available, as these countries made no commitment to reduce emissions under the Kyoto Protocol.

The emission levels for the 'lenient rules' scenarios presented in this chapter, similar to those in the UNEP Emissions Gap Report and its update, include the maximum effect of allowances from LULUCF accounting rules (see Section 2.3.1) and the use of surplus assigned amount units (AAUs) (see Section 2.3.2). These issues have the potential to displace mitigation action in other sectors and, hence, to lead to higher actual global emissions by 2020 than those projected from the pledged reductions. The 'strict rules' scenarios assume that strict accounting rules prohibit the use of both LULUCF credits and surplus AAUs (Kyoto and new) in achieving targets, and thus reflect the lower bound of the emission level. For lenient accounting rules, both Kyoto and new surplus AAUs can be used and traded, and allowances from different LULUCF accounting rules can be used to achieve targets. Therefore, the 'lenient rules' scenarios reflect an upper bound of the 2020 emission level. We assumed that credits cannot lead to emission targets above business-as-usual projections. Since this would apply to the 'lenient rules' scenarios, around 2.4 Gt CO<sub>2</sub> eq for the unconditional pledges and 0.3 Gt CO<sub>2</sub> eq for the conditional pledges could be banked for the following period.

## 4.2 Expected emissions for 2020, based on pledges

The PBL/IIASA projected business-as-usual emission level without implementation of any of the pledges is around 56 Gt CO<sub>2</sub> eq by 2020, compared with 44 Gt CO<sub>2</sub> eq in 2005. This includes emission estimates on international aviation and shipping transport, which amount to 1.6 Gt CO<sub>2</sub> eq by 2020 in the PBL/IIASA business-as-usual projections (see Text box 1).

As explained above, the emission level expected from the pledges depends on assumptions about surplus AAUs – both new and from Kyoto – and on LULUCF accounting rules. The effect of these assumptions on emissions is explained below.

The total level of surplus AAUs by 2012 was estimated at 11.4 Gt CO<sub>2</sub> eq (range 9 to 13 Gt CO<sub>2</sub> eq) (Point Carbon, 2009; Den Elzen et al., 2010b). We translated this into a supply of surplus AAUs of 2.9 Gt CO<sub>2</sub> eq in the year 2020, by assuming the 11.4 Gt CO<sub>2</sub> eq are carried over and used or traded increasingly over time between 2012 and 2020<sup>1</sup>, up to the maximum by 2020. Such a distribution over time looks like a wedge of an increasing linear distribution, as described by Rogelj et al (2010a; 2010c). This means that in the 'lenient rules' scenarios, 2.9 Gt CO<sub>2</sub> eq will be used by 2020, compared to 1.3 Gt CO<sub>2</sub> eq according to our earlier assessment (Den Elzen et al., 2010a), which was based on an even distribution over the period. If Russia does not join the second commitment period of the Kyoto Protocol, then the supply of surplus AAUs would be reduced from 2.9 to 1.5 Gt CO<sub>2</sub> eq.

The maximum amount of new surplus AAUs from Annex I countries will be around 0.3 Gt CO<sub>2</sub> eq by 2020. In our assessment, non-Annex I countries could also generate surplus allowances, if the emission level resulting from the pledges would exceed the PBL/IIASA business-as-usual emission projection. These surplus allowances or AAUs are used or traded by surplus holding countries in both the lenient and strict scenarios, because relative to the national business-as-usual projections they might not result in surplus allowances. Moreover, these surplus allowances could also be traded through international offsets with Annex I countries.

The maximum amount of LULUCF credits that could be used in the 'lenient rules' scenarios was based on the maximum amount of credits under the land-use accounting rules as agreed in the Durban climate negotiations. The calculations were done by using the Joint Research Centre (JRC) LULUCF tool, version 8 December 2011 (as described in detail in Chapter 7), and resulted in 0 to 0.4 Gt CO<sub>2</sub> eq, for the unconditional and conditional

Table 4.1  
Emission targets of Annex I and non-Annex I countries for 2020

Greenhouse gas emissions <sup>a</sup> (Gt CO <sub>2</sub> eq)	1990	2005	Business-as-usual 2020	Unconditional pledge	Conditional pledge
<b>Annex I total excl. Turkey</b>	<b>19,019</b>	<b>18,034</b>	<b>18,646</b>	<b>17,868<sup>d</sup></b>	<b>15,368<sup>d</sup></b>
Australia	418	528	584	539	425
Belarus	139	84	115	115	115
Canada	590	731	751	751	607
Croatia	31	30	35	30	30
EU 27	5,589	5,149	5,144	4,471	3,912
Iceland	3	4	3	2	2
Japan	1,267	1,351	1,331	1,331	950
New Zealand	59	75	82	53	47
Norway	50	54	50	35	30
Russia	3,351	2,118	2,489	2,489	2,489
Switzerland	53	54	51	42	37
Ukraine	931	425	567	567	567
United States	6,167	7,185	7,249	7,249	5,964
Kazakhstan	370	245	193	193	193
<b>Other Annex I</b>	<b>187</b>	<b>330</b>	<b>503</b>	<b>503</b>	<b>503</b>
Turkey	187	330	503	503	503
<b>Non-Annex I total (incl. land-use CO<sub>2</sub>)</b>	<b>18,036</b>	<b>24,595</b>	<b>35,051</b>	<b>34,599</b>	<b>33,494</b>
China	3,594	7,233	13,450	12,964	12,894
India	1,106	1,859	3,121	3,537	3,537
Brazil <sup>b</sup>	1,854	2,279	2,497	2,068	1,977
Mexico <sup>b</sup>	581	774	784	784	617
South Africa	334	422	608	608	491
South Korea	308	569	678	569	569
Indonesia <sup>b</sup>	913	1,195	1,487	1,604	1,280
Chile <sup>b</sup>	59	91	101	101	94
Colombia <sup>b</sup>	180	233	287	287	198
Costa Rica <sup>b</sup>	8	9	13	13	1
Israel	45	81	115	87	87
Moldova	39	13	22	29	29
Papua New Guinea <sup>b</sup>	147	117	29	79	79
Peru <sup>b</sup>	139	174	209	209	96
Singapore	31	49	60	70	63
Taiwan	134	284	362	362	253
Other non-Annex I	4,569	6,587	9,303	9,303	9,303
Remaining land-use CO <sub>2</sub> emissions	3,995	2,627	1,925	1,925	1,925
<b>International marine &amp; aviation</b>	<b>624</b>	<b>1,059</b>	<b>1,546</b>	<b>1,546</b>	<b>1,546</b>
<b>World, strict rules</b>	<b>37,856</b>	<b>44,063</b>	<b>55,746</b>	<b>54,517</b>	<b>50,912</b>
<b>Credits from carry-over of Kyoto surplus AAUs, new surplus AAUs and LULUCF<sup>c</sup></b>				<b>858</b>	<b>3,357</b>
<b>World, lenient rules</b>	<b>37,856</b>	<b>44,063</b>	<b>55,746</b>	<b>55,374</b>	<b>54,269</b>

Source: Annex I countries base-year emissions are based on UNFCCC national inventory submissions. Non-Annex I business-as-usual emissions are based on our model projections

<sup>a</sup> Excludes CO<sub>2</sub> emissions from land use, unless otherwise noted.

<sup>b</sup> Includes CO<sub>2</sub> emissions from land use (peat lands) and reduction in emissions from deforestation and forest degradation (REDD).

<sup>c</sup> The number of credits is maximised by the emission level of the business-as-usual projections for Annex I countries.

<sup>d</sup> This number excludes Kyoto and new surplus AAUs (note that in Chapter 2 the unconditional pledge does allow new surplus AAUs).

scenarios, respectively. These estimates are lower than the maximum land-use credits of 0.6 Gt CO<sub>2</sub> eq used in the UNEP report Bridging the Emissions Gap (UNEP, 2011), because the newly agreed land-use accounting rules assume a cap on forest management credits.

With the above figures for surplus AAUs and LULUCF accounting rules, the expected emission levels for the four pledge scenarios are as follows:

*Scenario 1 – ‘Unconditional pledges, lenient rules’:* This scenario applies to countries that implement their unconditional pledges (or, if they do not have one, follow the business-as-usual emission scenario) subject to ‘lenient’ accounting rules. Annex I countries would maximise the use and trade of surplus AAUs and ‘lenient LULUCF credits’ to achieve the overall aggregated Annex I target<sup>3</sup>. In this scenario, the median estimate of the emission level for 2020 is 55.4 Gt CO<sub>2</sub> eq (see Figure 4.1).

*Scenario 2 – ‘Unconditional pledges, strict rules’:* This scenario applies to countries that implement their unconditional pledges (or, if they do not have one, follow the business-as-usual scenario) subject to ‘strict’ accounting rules. Surplus AAUs and LULUCF credits are assumed not to lead to higher emissions. In this scenario, the median estimate of the emission level for 2020 is 54.5 Gt CO<sub>2</sub> eq.

*Scenario 3 – ‘Conditional pledges, lenient rules’:* This scenario applies to countries that move to implement their higher, conditional pledges (as conditions are either met or relaxed), but subject to ‘lenient’ accounting rules. This scenario was included because some of the more ambitious pledges by Annex I countries (e.g. in the European Union, Russia, the Ukraine) are conditional on partial use of LULUCF credits or carry-over of surplus AAUs. In this scenario, the median estimate of the emission level for 2020 is 54.3 Gt CO<sub>2</sub> eq.

*Scenario 4 – ‘Conditional pledges, strict rules’:* This scenario applies to countries that move to implement their higher, conditional pledges subject to ‘strict’ accounting rules. In this scenario, the median estimate of the emission level for 2020 is 50.9 Gt CO<sub>2</sub> eq<sup>3</sup>.

Before the Cancún climate negotiations, the estimated 2020 emission level from all conditional pledges and with strict accounting rules was about 48.5 Gt CO<sub>2</sub> eq. The current estimate is about 2.5 Gt CO<sub>2</sub> eq higher, which is mainly due to the higher business-as-usual emission projections published by the developing countries themselves (Chapter 3). Another reason is the higher business-as-usual emission projections for Russia and the Ukraine. Under the ‘strict’ accounting rules, no new surplus AAUs are allowed. This implies that Russia and

the Ukraine follow their business-as-usual emission levels, which are higher than the earlier estimates.

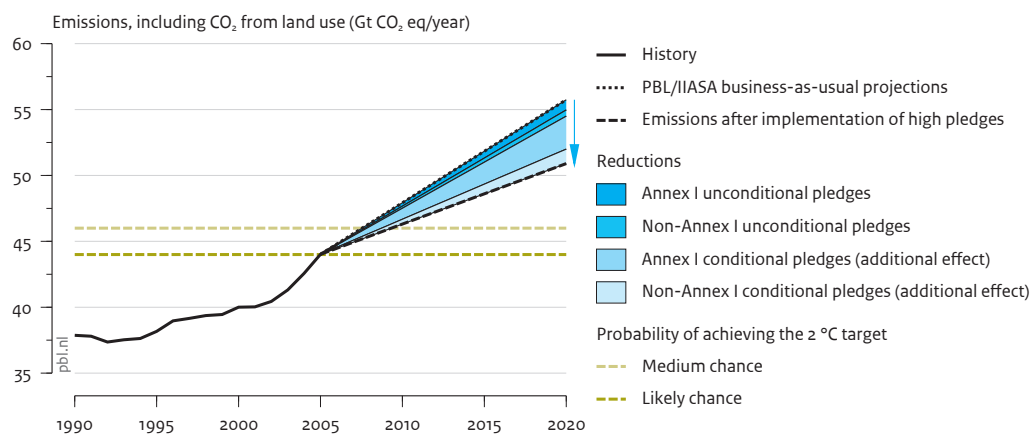
### 4.3 Which emission levels for 2020 would be consistent with achieving the 2 °C and 1.5 °C climate targets?

The Cancún Agreement has acknowledged that deep cuts in greenhouse gas emissions are required to hold the increase in global average temperature below 2 °C, from pre-industrial levels. It also has recognised the need to consider strengthening the long-term global goal on the basis of the best available scientific knowledge, including in relation to a global average temperature rise of 1.5 °C. Already one year earlier, the Copenhagen Accord of 2009 (UNFCCC, 2009b) referred to climate targets of 1.5 °C and 2 °C. This section addresses the question of which emission levels for 2020 would be consistent with limiting global warming to 2 °C and 1.5 °C.

It should be kept in mind that the level of human-induced global warming is primarily determined by cumulative emissions over time, which are mainly determined by when emissions peak, at what level this peak occurs, and how fast they decline thereafter (UNEP, 2010). Longer term emission reductions and the level of cumulative emissions in the coming decades, therefore, are much more important for achieving the 2 °C target than the 2020 emission level (e.g. Allen et al., 2009; Meinshausen et al., 2009). For maintaining at least a 50% chance of achieving the 2 °C target, total cumulative anthropogenic CO<sub>2</sub> emissions should be limited to about 1 to 1.4 trillion tonnes of carbon (Allen et al., 2009; Matthews et al., 2009). Given total CO<sub>2</sub> emissions up to 2000, this translates into cumulative emissions of about 0.4 trillion tonnes of carbon for the 2000–2050 period (Meinshausen et al., 2009). This implies that higher 2020 emission levels must be followed by faster reductions in subsequent years in order to achieve the same cumulative emissions.

Having said this, the UNEP report Bridging the Emissions Gap (UNEP, 2011) concluded, based on the results of many mitigation scenarios, that a global greenhouse gas emission level of 44 Gt CO<sub>2</sub> (range of 41 to 46 Gt CO<sub>2</sub> eq, see Table 4.3) by 2020 would be consistent with a ‘likely’ (greater than 66%) chance of limiting the global temperature increase to below 2 °C during the 21st century. When accepting a ‘medium’ chance (50–66%) of achievement, the total global greenhouse gas emission level by 2020 would have to be 46 Gt CO<sub>2</sub> eq (range of 45 to 49 Gt CO<sub>2</sub> eq). Since the UNEP Emissions Gap Report

Figure 4.1  
Impact of pledged reductions in global greenhouse gas emissions, under strict accounting rules



Source: PBL

Historical emissions for all Kyoto greenhouse gases for the period between 1990 to 2005, for Annex I countries based on national emission inventories, which were submitted to the UNFCCC (2009a). For non-Annex I countries, these were not available. Therefore, we used other sources: for all Kyoto greenhouse gas emissions, except for CO<sub>2</sub> from land use and international aviation and shipping emissions, we used data from the CAIT database version 4.0 (<http://cait.wri.org/>). The land-use related CO<sub>2</sub> emissions were taken from the IIASA models (Appendix A), and the international aviation and shipping emissions from Owen and Lee (2005) and the IMO greenhouse gas Study 2009 study (Buhaug et al., 2009). The green dotted lines indicate the median estimates for a 2020 emission level that would be consistent with a likely and medium chance of achieving the 2 °C target.

### Text box 1 Calculation of international aviation and shipping emissions

Emissions from the international aviation and shipping sectors are difficult to attribute to specific countries. Therefore, these emissions are not part of the pledges that were put forward by countries in the Cancún Agreements. According to the PBL/IIASA business-as-usual emission projections, international aviation and shipping emissions will amount to about 1.55 Gt CO<sub>2</sub> by 2020, about 0.55 Gt CO<sub>2</sub> of which from international aviation (Owen and Lee, 2005), and 1.0 Gt CO<sub>2</sub> from international shipping (based on the average of the low and high business-as-usual projections of the IMO greenhouse gas 2009 study (Buhaug et al., 2009) (see Table 4.2). This constitutes almost 3% of the PBL/IIASA projections of global business-as-usual emissions for 2020. Emissions from international aviation are expected to double between 2005 and 2020, whereas shipping shows a 25% increase.

The UNEP report Bridging the Emissions Gap (UNEP, 2011) estimated business-as-usual emissions for 2020 to be between 0.6 and 1.2 Gt CO<sub>2</sub> from aviation and between 1.1 and 1.3 Gt CO<sub>2</sub> from shipping. In 2006, 62% of emissions from aviation were from international air traffic. In 2007, 83% of emissions from shipping were from international traffic. A rough estimate of business-as-usual emissions for 2020 for international aviation and shipping emissions would be 1.3 to 1.8 Gt CO<sub>2</sub>, based on 2006 and 2007 data (i.e. about 0.4 to 0.7 Gt CO<sub>2</sub>, annually, from international aviation and 0.9 to 1.1 Gt CO<sub>2</sub> from international shipping) (Lee, 2011). Our business-as-usual projection of 1.55 Gt CO<sub>2</sub> by 2020 for international aviation and shipping emissions would be in the middle of the UNEP range.

Table 4.2  
Emissions from international aviation and shipping for 1990, 2005 and 2020

Gt CO <sub>2</sub>	1990	2005	2020
International aviation	0.15	0.25	0.55
International shipping	0.45	0.8	1.0
Total international emissions	0.6	1.05	1.55

Source: Owen and Lee (2005) and IMO greenhouse gas Study 2009 study (Buhaug et al., 2009)

Table 4.3

**Overview of key characteristics of pathways with a ‘likely’ (greater than 66%) or ‘medium’ (50–66%) chance of limiting global temperature increase to below 2 °C during the 21st century**

Number of pathways	Peaking decade*	Total greenhouse gas emissions in 2020	Total greenhouse gas emissions in 2050	Average industrial CO <sub>2</sub> reduction rates between 2020 and 2050
[–]	[2000+year]	[Gt CO <sub>2</sub> eq]	[Gt CO <sub>2</sub> eq]	[% of 2000 emissions/year]
‘Likely’ chance (>66%) of limiting global temperature increase to below 2 °C during 21st century				
23	2010–2020	26(41 <b>44</b> )46)49	12(18 <b>21</b> )23)32	0.6(2.3 <b>2.6</b> )3.1)3.6
‘Medium’ chance (50 to 66%) of limiting global temperature increase to below 2 °C during 21st century				
17	2010–2020	42(45 <b>46</b> )49)50	20(24 <b>26</b> )29)32	2.0(2.2 <b>2.5</b> )2.9)3.6

Source: UNEP (2011) and Rogelj et al (2011b)

Bold number is median of range

\* Because IAM pathways provide emission data only for 5- or 10-year increments, the encompassing period in which the peak in global emissions occurs is given. The peak year period given here reflects the 20th–80th percentile range. Note that pathways with a ‘likely’ chance show peaks earlier in the decade, while those with a ‘medium’ chance are spread across the whole decade.

Table 4.4

**Emission gap for the four pledge scenarios, with a likely and medium chance of achieving the 2 °C target**

Gt CO <sub>2</sub> eq		Business as usual	Scenario 1	Scenario 2	Scenario 3	Scenario 4
			Unconditional pledges, lenient rules	Unconditional pledges, strict rules	Conditional pledges, lenient rules	Conditional pledges, strict rules
Likely	median	12	11	11	10	7
	range	10-15	9-14	9-14	8-13	5-10
Medium	median	10	9	9	8	5
	range	7-11	6-10	6-10	5-9	2-6

(UNEP, 2010), no new emission pathways have been found for limiting global warming to below 1.5 °C by the end of this century. Limiting global warming to 1.5 °C or 2 °C requires similar 2020 emission levels, but for 1.5 °C, substantially higher annual reduction rates would be needed in the following decades.

As new literature becomes available – in particular, on the ability to implement policies, such as the pledges submitted in the Cancún Agreements – the range for the emission pathways considered feasible may change over time. For example, most emission pathways in the literature, gathered for UNEP’s revised Emissions Gap Report, aim at attaining cost-optimal paths over the entire 21st century. However, other trajectories are also possible; for example, with higher emission levels in 2020 but a steeper subsequent decline, which would involve higher costs throughout the century (e.g. Den Elzen et al., 2010c; Van Vliet et al., 2011; Van Vuuren and Riahi, 2011; OECD, 2012). These emission pathway studies were not included in the revised UNEP report, but this would broaden the 2020 emissions range for a medium

likelihood of achieving the 2 °C target, by up to 51 Gt CO<sub>2</sub> eq, as calculated by Van Vliet et al (2011). These studies conclude that, starting from the current pledges for 2020, reaching the 2 °C objective will be very difficult, require increased future effort by all countries, be more costly, and depend more heavily on future technological developments, compared to a scenario with lower 2020 emission levels.

Because of the importance and widely used methodology of the UNEP report, we will use emission levels for 2020 consistent with achieving the 2 °C target according to this report, to determine the emission gap, together with our evaluation of the pledges.

#### 4.4 How wide is the emission gap in relation to the 2 °C climate target?

As a reference point, the emission gap for the business-as-usual scenario is 12 Gt CO<sub>2</sub> eq for a likely chance of achieving the 2 °C target. If the pledges were to be

### Text box 2 The PBL estimates of the four pledge scenarios in this study, as included in the 2011 UNEP report

Figure 4.2 summarises the emission gaps according to the UNEP (2011) report *Bridging the Emissions Gap*, which would result from the four different pledge scenarios. The gaps are shown for a 'likely' (greater than 66%) and a 'medium' (50–66%) chance of staying below 2 °C, based on the data from ten different modelling studies, including this PBL study. More specifically, for the UNEP (2011) report, the emission estimates for the four scenarios and the business-as-usual projection that were used in the ten modelling studies were harmonised around consistent 2005 levels of 45 Gt CO<sub>2</sub> eq. The harmonisation included an absolute adjustment for each study's data set for 2005, which was kept constant for all subsequent years. For the PBL estimates of the four pledge scenarios in this study, this resulted in an upward adjustment of 1.0 Gt CO<sub>2</sub> eq. For further work on harmonisation, see Rogelj et al. (2011a). The harmonised PBL estimates are about 1.5 to 2 Gt CO<sub>2</sub> eq above the median estimates of the UNEP (2011) study, for all scenarios. The harmonised PBL estimates for the 2020 emission level that would result from the conditional pledge scenario under 'stringent rules' is 51.9 Gt CO<sub>2</sub> eq. This is about 1 Gt CO<sub>2</sub> eq higher than the (non-harmonised) estimates for the four scenarios published in this study. The harmonised PBL estimate for the conditional pledge scenario under 'stringent rules' is similar to the updated estimates in the studies by the OECD (Dellink et al., 2011) and the Grantham Research Institute, London School of Economics (Stern and Taylor, 2010), as included in the 2011 UNEP report. These two studies and ours belong to five of ten modelling studies that have updated their results for the UNEP (2011) report. The other two studies with updated estimates are the Climate Action Tracker by Ecofys, Climate Analytics and Potsdam Institute for Climate Impact Research (Climate Action Tracker, 2009; Rogelj et al., 2010a; Rogelj et al., 2010c) with an estimate of 53 Gt CO<sub>2</sub> eq, and Climate Interactive (C-ROADS) (<http://climateinteractive.org/simulations/C-ROADS>), with 49 Gt CO<sub>2</sub> eq, for the conditional pledge scenario under 'stringent rules'.

implemented, this emission gap would decrease to between 7 and 11 Gt CO<sub>2</sub> eq (see Table 4.4), depending on whether or not the conditional pledges are implemented and on accounting rules. This range decreases to between 5 and 9 Gt CO<sub>2</sub> eq for a medium likelihood of achieving the 2 °C target. These emission gaps are shown in Figure 4.1 and 4.2, where the dotted lines show the median emission level necessary for achieving the 2 °C target, with a likely and medium chance (44 and 46 Gt CO<sub>2</sub> eq, respectively). In addition to uncertainties about conditionality and accounting rules, the 2020 level that would be consistent with achieving the 2 °C target is also uncertain; ranges around the median levels are shown in Table 4.4. From the analysis above can be concluded that the mean estimate of the emission gap is between 5 and 11 Gt CO<sub>2</sub> eq, depending on the pledge scenario. The total uncertainty range, including uncertainty about the pledges as well as about the level needed for achieving the 2 °C target, would be 2 to 14 Gt CO<sub>2</sub> eq (see Table 4.4).

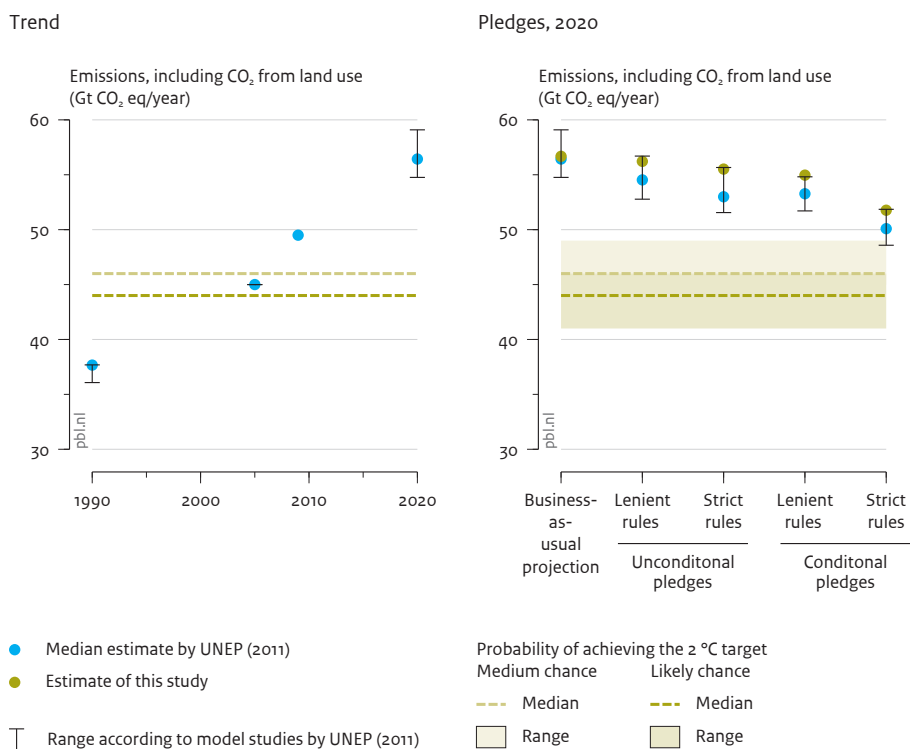
The resulting median estimate for the gap for Scenario 1 is equivalent to achieving less than 5% of the overall mitigation effort needed for achieving the 2 °C target for 2020 (with both a medium and likely chance). For Scenario 2, this becomes 10% with a likely chance of achieving the 2 °C target, and about 15% for a medium chance of doing so. Scenario 3 would achieve about 15% of the overall mitigation effort needed for achieving the

2 °C target for 2020 (with both a medium and likely chance). Finally, Scenario 4 achieves 40% of the overall mitigation effort with a likely chance of achieving the 2 °C target and 50% for doing so with a medium chance.

Chapter 6 provides some options for reducing this gap. There are also other uncertainties than those mentioned here, which could increase the gap again. These are described in Chapter 5.

**Text box 2 The PBL estimates of the four pledge scenarios in this study, as included in the 2011 UNEP report (continued)**

**Figure 4.2**  
**Global greenhouse gas emissions**



Source: Based on UNEP (2011) report

Global 2020 emissions that would result from historical emission levels and business-as-usual emission projections (left) and the four pledge scenarios, according to our harmonised estimations and results from various model studies, compared to the 2020 emission levels that would be consistent with a medium and likely chance of achieving the 2 °C target.

**Table 4.5**  
**The emission gaps for which there would be a medium and likely chance of achieving the 2 °C target**

		Business as usual	Scenario 1	Scenario 2	Scenario 3	Scenario 4
<b>What is the expected gap for having a likely chance of staying below 2 °C?</b> (In brackets harmonised PBL estimates)	Median gap (Gt CO <sub>2</sub> eq)	12 (13)	11 (12)	9 (12)	9 (11)	6 (8)
	Gap range (Gt CO <sub>2</sub> eq)	9-18	7-16	6-14	6-14	3-11
<b>What is the expected gap for having a medium chance of staying below 2 °C?</b> (In brackets harmonised PBL estimates)	Median gap (Gt CO <sub>2</sub> eq)	10 (11)	9 (10)	7 (10)	7 (9)	4 (6)
	Gap range (Gt CO <sub>2</sub> eq)	6-14	4-12	3-10	3-10	0-7



### Text box 3 The impact of updating the PBL/IIASA business-as-usual emission projections with emission data up to 2010

In our analysis, emission projections start from 2005. If the 2010 emission level would be used as a starting point, the emission gap could increase by about 3 Gt CO<sub>2</sub> eq. This is a preliminary estimate based on an update of the EDGAR historical emission data set, which shows a large emission growth in the 2005–2010 period, for China and India.

The business-as-usual emission projections that were used in the evaluation of the pledges as described in this report, are based on the 1990–2005 period. Emission levels between 2005 and 2020 are model projections. There were three reasons for using the historical period up to 2005. The first was that the UNEP (2010, 2011) reports harmonised projections based on consistent 2005 levels (see Text box 2). The second being the fact that, for our study, the underlying business-as-usual emission projections were calculated by energy and land-use models that were also calibrated against the historical emissions up to 2005. Final reason was that the UNFCCC and the CAIT database (see Figure 4.1), which are the sources for historical data, had no emission data available on 2010.

By using historical data up to only 2005, the analysis could not fully take into account recent events, such as the economic crisis and high growth both of the economy and in emissions, in China and India. To analyse the possible effect of using historical emissions up to 2010, we used historical data from EDGAR, which is available up to 2009, together with a preliminary estimate of 2010 emissions as described in Olivier et al (2011). After a decline in emissions in 2009, global CO<sub>2</sub> emissions especially increased substantially in 2010, largely because of the growth in China and India. This, together with high emission growth before 2009, caused non-Annex I emissions in 2010 to be higher, compared to the projections used for our study. Although the effect of short-term changes in emission levels on long-term emissions is uncertain (van Vuuren and Riahi, 2011), this could lead to an upward revision of non-Annex I emissions of about 3.5 Gt CO<sub>2</sub> eq, leading to an emission level of 39.1 Gt CO<sub>2</sub> eq by 2020. Annex I emission projections would slightly decrease for 2020, partly caused by the economic crisis, and would amount to 18.4 Gt CO<sub>2</sub> eq. Projections for emissions from shipping and land-use were not updated. All in all, the global business-as-usual emission projection for 2020 could increase from 55.5 Gt CO<sub>2</sub> eq to 59.5 Gt CO<sub>2</sub> eq, when taking into account 2010 emissions data.

The effect of such a higher business-as-usual emission projection on the expected increase in emissions resulting from the pledges would be 2.6 to 3 Gt CO<sub>2</sub> eq. The expected emission level of Annex I countries would not be affected, since these depend on emission levels of before 2010, whereas the expected emission level of some non-Annex I countries does depend on business-as-usual projections. Under the low and high pledge scenarios, there is no effect for non-Annex I countries that have provided a national business-as-usual projection, as the pledges are based on their own business-as-usual projection (see Section 3.2). Therefore, only changes in expected emission levels for non-Annex I countries that have not provided national business-as-usual projections – notably China – affect the low and high pledge scenarios. The unconditional pledge scenario for some countries follows the PBL/IIASA business-as-usual scenario. Therefore, the impact of a higher business-as-usual projection is larger. Table 4.6 presents a comparison in global emission levels between the four pledge scenarios, based on the business-as-usual projections used in this study, with an estimate that is 4 Gt CO<sub>2</sub> eq higher than the estimates based on the updated business-as-usual level. It shows that using the updated business-as-usual projections would increase the emission gap by 2.6 to 3 Gt CO<sub>2</sub> eq, for the four scenarios.



**Text box 3 The impact of updating the PBL/IIASA business-as-usual emission projections with emission data up to 2010 (continued)**

Table 4.6

**Global emission levels following implementation of pledges, based on updated business-as-usual projections for the historical period between 2005 and 2010**

Global greenhouse gas emissions (Gt CO <sub>2</sub> eq)	Updated business as usual	PBL/IIASA business as usual	Difference
Business-as-usual emissions	59.5	55.5	4.0
Unconditional pledges, lenient rules	58.4	55.4	3.0
Unconditional pledges, strict rules	57.3	54.5	2.8
Conditional pledges, lenient rules	56.9	54.3	2.6
Conditional pledges, strict rules	53.8	50.9	2.9

In this scenario, the median estimate of the emission gap for a medium to likely chance of reaching the 2 °C target is 14 to 16 Gt CO<sub>2</sub> eq, for the updated business-as-usual projections. For a likely chance, this is 10 to 14 Gt CO<sub>2</sub> eq, after implementation of the pledges, and for a medium chance, this is between 8 and 12 Gt CO<sub>2</sub> eq.

## Notes

- <sup>1</sup> Here, it is assumed that the reduction effort (i.e. difference between the business-as-usual emissions and the emission targets) by countries increase over time, leading to an increase in demand for credits and in carbon price on the carbon market.
- <sup>2</sup> Note that the emission level of Annex I countries as a group resulting from the pledges and accounting rules cannot exceed their projected business-as-usual emissions for 2020, which would be possible for these countries in case of 'lenient' accounting rules.
- <sup>3</sup> According to the WEO-2010 (IEA, 2010), the implementation of the most stringent versions of the current pledges announced by a number of countries would bring global energy-related CO<sub>2</sub> emissions by 2020 to 32.6 GtCO<sub>2</sub>. To compare this number with our estimate is difficult, as the reduction targets of the pledges hold for all greenhouse gas emissions and not relate to CO<sub>2</sub> only.

# Risks and uncertainties that could widen the emission gap

## Key findings

The main risks of pledges being watered down are:

1. Uncertain achievement of pledges conditional on international action and availability of international support. Obviously, it is uncertain whether pledges, conditional or not, will be achieved. If only the conditional pledges are not achieved, this would lead to a 2.4 Gt CO<sub>2</sub> eq increase in emissions (about 70% of which comes from Annex I countries);
2. Lenient or unclear accounting rules:
  - Carry-over and use of Kyoto surplus assigned amount units could lead to an increase in emissions of up to 2.9 Gt CO<sub>2</sub> eq, trading of new surplus assigned amount units of 0.3 to 0.6 Gt CO<sub>2</sub> eq, and lenient land-use accounting rules of up to 0.4 Gt CO<sub>2</sub> eq (all coming from Annex I countries).
  - Unclear land-use accounting rules for non-Annex I countries could increase emissions by about 0.7 Gt CO<sub>2</sub> eq. Countries can include Afforestation and Reforestation and Forest Management activities as reduction measures. Since these measures are expected to be taken even without policy intervention, this would decrease the effective reduction target.
  - Double counting of offset emissions (the same emission reduction measures are used for achieving pledges of two countries) could increase emissions by 0.9 to 1.1 Gt CO<sub>2</sub> eq.
3. A number of factors contributing to the uncertainty of the total emission level:
  - Leakage effects (the increase in greenhouse gas emissions caused outside the borders of countries that take domestic mitigation action) could increase emissions by 0.05 to 0.55 Gt CO<sub>2</sub> eq.
  - Uncertainty around business-as-usual emission developments (-1 to 2.6 Gt CO<sub>2</sub> eq);
  - Uncertainties associated with pledges formulated as emissions intensity targets (-2.0 to 2.6 Gt CO<sub>2</sub> eq);
  - Uncertain possible contributions from REDD+ actions (1.5 Gt CO<sub>2</sub> eq);
  - Uncertainty about business-as-usual emissions from international shipping (0.2 Gt CO<sub>2</sub> eq);
  - When all the risks explored in this study are taken into account, the total emission level by 2020 could end up close to that of the PBL/IIASA business-as-usual emission projections.

As shown in the previous chapter, the global emission level resulting from the high pledges under strict accounting rules would be about 51 Gt CO<sub>2</sub> eq. There are various reasons why the pledges could lead to a higher global emission level. We categorised these reasons into risks and uncertainties. A risk is the chance of an event occurring that would increase global emissions and thus increase the emission gap. An uncertainty is something that could either increase or decrease global emissions and is shown as a range of possible values. The first risk relates to the conditionality of the pledges (Section 5.1).

Other risks of watering down pledges can be distinguished into two types: i) lenient and unclear accounting rules for the use and trading of surplus assigned amount units (AAUs) and LULUCF credits (Section 5.2), and ii) other risks, related to offsets and leakage effects (Section 5.3). Most uncertainties relate to business-as-usual projections. It should be noted that the effect of some of the risks and uncertainties overlap, and that therefore it is very difficult to calculate an estimate of the aggregated effect of all individual risks on global emissions.

## 5.1 Risks related to conditionality of pledges

### Risk 1: Uncertainty around the achievement of pledges that are conditional on international action and availability of international support

Various countries only submitted a conditional pledge or announced that they will not be on board for the second commitment period of the Kyoto Protocol. Such conditional pledges for Annex I countries either depend on ambitious actions by other countries or on domestic legislation, and for non-Annex I countries on the adequate provision of international climate financing or technology transfer. Under the low pledge scenario, it is assumed that countries with only one pledge will implement this pledge, even if it is conditional. A major risk, here, is that these conditional pledges will not be implemented, for the following reasons: i) the low pledges of Canada, Russia and Japan are conditional on global ambitious climate policy (a condition that may not be met under the low pledge scenario), ii) the US climate bill could fail to pass the Senate (which would prevent implementation of the US conditional pledge), and iii) financial support is not provided (which would prevent implementation of pledges by Indonesia, Mexico, South Africa and some smaller non-Annex I countries). As shown in Chapter 4 (Table 4.1) and Figure 5.1, this would lead to a decrease in the total reduction of 1.8 Gt CO<sub>2</sub> eq for Annex I countries and 0.6 Gt CO<sub>2</sub> eq for non-Annex I countries, under the low pledge scenario. Under the high pledge scenario, the decrease would be 2.5 Gt CO<sub>2</sub> eq for Annex I countries and 1.1 Gt CO<sub>2</sub> eq for non-Annex I countries. Both scenarios would lead to a global emission level of 54.5 Gt CO<sub>2</sub> eq (which corresponds with the emission level of Scenario 1: unconditional pledges, strict rules, Table 4.1).

## 5.2 Lenient or unclear accounting rules

### Risk 2: Surplus Kyoto AAUs used for domestic compliance or trading in 2020

Surplus AAUs may arise when countries over-achieve their targets for the first commitment period of the Kyoto Protocol – either due to more ambitious policy or for non-climate policy reasons. These countries could carry-over or ‘bank’, these surplus AAUs for use in the second commitment period. Surplus AAUs from the first commitment period, if sold or used domestically to displace mitigation activity up to 2020, reduce the stringency of 2020 emission reductions and hence increase estimates of 2020 emission levels.

Total surplus AAUs by 2012, at the end of the first commitment period, are estimated to total 11.4 Gt CO<sub>2</sub> eq, with a range of 9 to 13 Gt CO<sub>2</sub> eq (Point Carbon, 2009; Bosetti et al., 2010; Den Elzen et al., 2010b; World Bank, 2010). If fully ‘carried over’ and traded, this could water down reduction targets in the low and high pledge scenarios by up to 2.9 Gt CO<sub>2</sub> eq, by 2020, when assuming the 11.4 Gt CO<sub>2</sub> eq are used and sold increasingly over time between 2012 and 2020 (see Chapter 3). This is higher than the earlier estimate of 1.3 Gt CO<sub>2</sub> eq (Den Elzen et al., 2010a), which was based on an even distribution over the period. According to Russia’s unconditional pledge, in which it does not sign up for a second commitment period, the supply of surplus AAUs would be reduced from 2.9 to 1.5 Gt CO<sub>2</sub> eq.

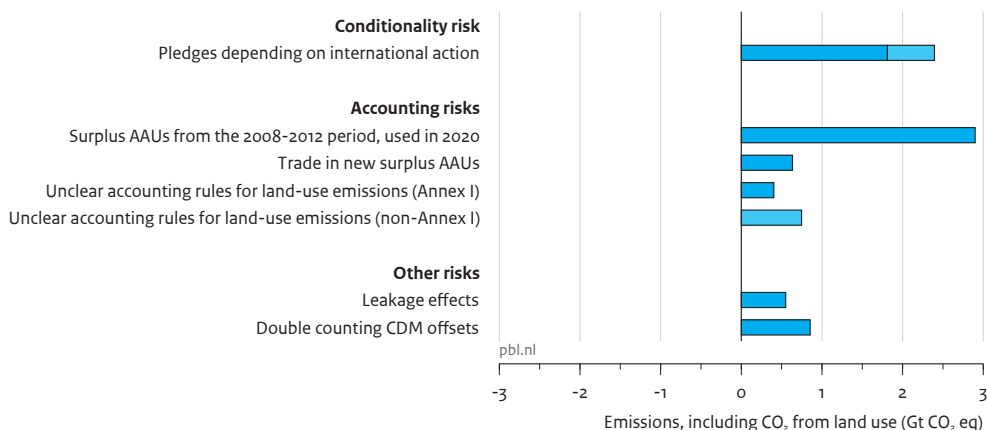
The total impact of surplus AAUs strongly depends on whether the carry-over of surplus AAUs will be limited, and on whether countries will actually buy such surplus AAUs. Currently, the largest potential buyer (the United States) does not have a federal law that allows the purchase of surplus AAUs. Canada has aligned its position with that of the United States. Japan has bought such surplus AAUs in the past, and so far has not made a clear statement on this subject. The EU announced that surplus AAUs cannot be used for compliance with its unconditional 20% pledge. Hence, the net impact could be much lower than 2.9 Gt CO<sub>2</sub> eq by 2020. Chapter 8 describes the impact of the options of how to deal with surplus AAUs, as currently under negotiation, in more detail.

### Risk 3: New surplus AAUs used for trading in 2020

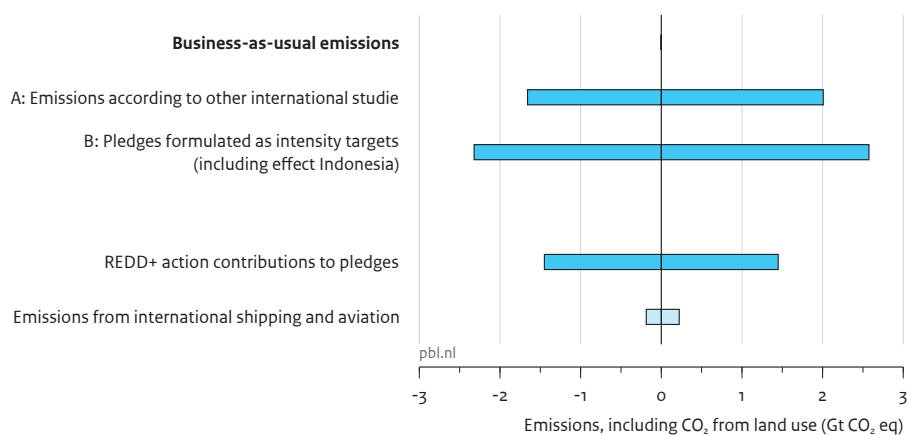
The pledges by Russia, the Ukraine, Belarus and Kazakhstan would lead to an emission target for 2020 that lies above their total business-as-usual emission projections, by 0.3 and 0.6 Gt CO<sub>2</sub> eq, for the high and low pledges, respectively. This means that new surplus AAUs

Figure 5.1  
**Impacts of risks and uncertainties on global greenhouse gas emissions, by 2020, for low pledges with strict accounting rules**

Risks



Uncertainties



Contributions by

- Annex I
- Non-Annex I
- International shipping

Source: PBL

Starting point is a scenario under which the low pledges are implemented with strict accounting rules. Note that risks and uncertainties overlap and cannot be added together. The total effect of all uncertainties and risks indicates that the global emission level by 2020 could end up close to that of the PBL/IIASA business-as-usual emission projections.

are generated (Section 2.3.2). If these surplus AAUs would be sold, the projected emission level for 2020 would increase by 0.3 and 0.6 Gt CO<sub>2</sub> eq, for the high and low pledges, respectively<sup>1</sup>. If Russia would follow its unconditional pledge, as this is not part of a final climate deal, it will not generate new surplus AAUs. In this scenario, the total level of surplus AAUs generated by

Annex I countries would be 0.3 Gt CO<sub>2</sub> eq, for both the low and high pledges. Figure 5.1 presents a comparison between the maximum impact of trade in new surplus AAUs on the global 2020 emission level and the other risks.

#### **Risk 4: Accounting rules for land-use emissions in Annex I countries**

In Durban, countries agreed on LULUCF accounting rules that determine the extent to which LULUCF credits in Annex I countries may be used to achieve their targets for the period following 2012. As explained in Chapters 2 and 7, the LULUCF credits coming from the accounting rules could decrease the projected Annex I emission reductions (which do not include LULUCF) by up to 0.4 Gt CO<sub>2</sub> eq, for the low and high pledge scenarios. For unconditional pledges, there would be no impact from LULUCF accounting rules on emission reductions. Since not all Annex I countries submitted their data to the UNFCCC, individual Annex I countries could adopt their own land-use accounting rules and projections. This could increase the above maximum estimates.

#### **Risk 5: Accounting rules for land-use emissions in non-Annex I countries**

For non-Annex I countries, the situation surrounding land-use accounting rules is more uncertain and unclear than for Annex I countries. Afforestation and reforestation (AR) and forest management (FM) activities are assumed not to be used to achieve the pledged reductions, except if they are explicitly mentioned in mitigation actions. Estimates of net land-use emissions to a large degree depend on the processes that are included in these estimates. Activities such as afforestation and reforestation, but also regeneration of existing forest lands and forest management, may lead to CO<sub>2</sub> removals. This could substantially change the land-use emission balance and, depending on the magnitude of greenhouse gas fluxes, may even make it from a source into a sink of CO<sub>2</sub>. AR/FM activities that lead to LULUCF sinks could be used as mitigation measures, even if no additional climate policy is necessary to promote these activities.

Afforestation and reforestation (AR) activities include the active expansion of forest area, such as increasing forest cover through seeding or planting. Typically, CO<sub>2</sub> removal from these activities occurs only after a certain delay, when tree cover is successfully established and trees reach their productive phase. Before the accelerated growth of the new trees, land conversion could cause substantial emissions; for example, due to grassland ploughing. If these are accounted for, the risk of reduced emission reduction due to inclusion of AR activities is rather low. However, the risk of emission offsets from AR activities increases over time, as removals also increase. To assess the risk related to including AR activities, the CO<sub>2</sub> removal due to human-induced processes should be separated from CO<sub>2</sub> removal due to natural re-growth after disturbances and due to other natural processes (Böttcher et al., 2008). In order to do so, a certain percentage of business-as-usual CO<sub>2</sub> removal due to AR

activities was applied, referring to the accounting rules of FM under Article 3.4 of the Kyoto Protocol (Höhne et al., 2007). If 15% of the baseline CO<sub>2</sub> removal would be due to human-induced AR activities, including related mitigation measures, this would lead to an increase in the global emission level of 0.1 Gt CO<sub>2</sub> eq, based on business-as-usual projections for CO<sub>2</sub> removal from AR activities for all non-Annex I countries, as calculated using IIASA's forestry model G4M (Kindermann et al., 2006; 2008) (Appendix A).

Forest management (FM) measures may lead to CO<sub>2</sub> emissions or removals. The direction of the flux depends on the initial state of the forest and the type and intensity of measures. In addition to an expanding forest area, existing managed and unmanaged forests in some countries accumulate carbon due to the fact that harvest rates are below the current increment rates. This trend is currently most pronounced in Annex I countries, such as those in Europe (Bellassen et al., 2011; Böttcher et al., 2011), but some non-Annex I countries also report a recovery of their forest resources after intensive management (e.g. China and India). The risk of lower net LULUCF emissions when including FM activities strongly differs between countries. There appears to be no general pattern and the effect depends on many parameters that can only be assessed at country level. Similarly to the risk assessment of the inclusion of AR activities, only some of the emission removals from FM may be attributed to human-induced activities. The same percentage as for AR (15%) is used for FM activities. Based on model calculations by the IIASA G4M model that use projections of carbon removals from FM activities by non-Annex I countries, the total increase in the global emission level from FM activities could be 0.6 Gt CO<sub>2</sub> eq.

Concluding, the total risk of unclear accounting rules in non-Annex I countries is of the order of 0.7 Gt CO<sub>2</sub> eq. The risk concerns the fact that countries could include AR/FM activities as reduction measures, even if the increased carbon removals result from natural expansion or higher sinks of existing forests that would also have occurred without policy intervention.

### **5.3 Other risks**

#### **Risk 6: Leakage effects**

For our model calculations it was implicitly assumed that the emissions of countries without a pledge will follow a business-as-usual pathway. However, mitigation actions in one country could lead to increases in emissions elsewhere. These are referred to as leakage effects. The UNEP report, Bridging the Emissions Gap (UNEP, 2011), estimated the size of the leakage effect to be 0.05 to 0.55

Gt CO<sub>2</sub> eq, based on a literature assessment by Dellink et al (2011) and Peterson et al (2011).

### **Risk 7: Double counting due to the use of offsets from CDM projects**

The final risk that was taken into account is the potential double counting of offsets. For our default calculations of the four pledge scenarios in Chapter 4, we assumed that reductions from CDM projects would be fully to the benefit of the donor country. However, there is a risk of double counting of these offset emissions, with reductions being counted for the Annex I country towards compliance with its reduction target, while they are also counted towards the non-Annex I country achieving its pledge.

If we simply assume that i) 33% of total Annex I reduction targets is achieved through offsets, and ii) all of these reductions are counted twice, then global emissions would increase by 0.9 Gt CO<sub>2</sub> eq for the low pledges and 1.1 Gt CO<sub>2</sub> eq for the high pledges. For unconditional pledges, the increase would only be 0.3 Gt CO<sub>2</sub> eq. This compares to an estimate by Erickson et al (2011) of a 1.6 Gt CO<sub>2</sub> eq increase in emissions, with assumptions on demand and supply balances, and to a 1 Gt CO<sub>2</sub> eq increase according to the European Climate Foundation (2010).

## **5.4 Uncertainties**

### **Uncertainty 1: Business-as-usual emissions**

A major uncertainty in estimating emission reduction targets for non-Annex I countries concerns the nationally published business-as-usual emission projections against which the proposals were defined. Possible upward revisions of these business-as-usual emission estimates, as was done by Brazil, or newly published national business-as-usual emission estimates, as was recently done by India (Planning Commission, Government of India, 2011), could increase the total emission level that would result from the pledges. For this study, we used two methodologies for calculating the potential impact of higher business-as-usual emission estimates; one based on international modelling studies and one based on the individual, major emitting non-Annex I countries (Figure 5.1).

The starting point for the methodology that was based on the international modelling studies was the 20th and 80th percentile range for the 2020 emission estimates for non-Annex I countries, for the unconditional pledge scenario (under strict rules), as taken from the UNEP (2011) report. This range in emissions extends from 31 to 34.7 Gt CO<sub>2</sub> eq. Our estimate for this scenario is about 32.7 Gt CO<sub>2</sub> eq (excluding remaining land-use emissions, see Table

4.1). If the emission level for this scenario would be 34.7 Gt CO<sub>2</sub> eq, as in the UNEP (2011) report, the global 2020 emission level would increase by almost 2 Gt CO<sub>2</sub> eq, compared to the estimate of this study. However, if the emission level were to be 31 Gt CO<sub>2</sub> eq (lower UNEP estimate), the global emission level would decrease by 1.7 Gt CO<sub>2</sub> eq, compared to the estimate of this study.

The methodology that was based on individual, major emitting non-Annex I countries was focused on China, India and Indonesia (for a comprehensive analysis, see Chapter 9). Both China and India have an emissions intensity target for which the resulting emission level depends on economic growth. For China this consists of CO<sub>2</sub> emissions only, for India the target includes all greenhouse gas emissions except those from agriculture. As economic growth projections have been adjusted upwards over the last few years, emissions could increase, as well. An upward revision of annual GDP growth for China from 9% to 10% would result in an increase in China's emission level of 1.8 Gt CO<sub>2</sub> eq, by 2020. However, a 7.5% economic growth rate would reduce China's emission level by 1.6 Gt CO<sub>2</sub> eq, by 2020. For India, we used an annual GDP growth rate of 8%, which is the lower projection of the Planning Commission of the Government of India (2011). If, instead, the higher projection of a 9% annual growth rate is used, the 2020 emission level would increase by 0.5 Gt CO<sub>2</sub> eq. A lower GDP growth rate of 7% would result in a decrease of 0.4 Gt CO<sub>2</sub> eq. Finally, Indonesia published two national studies with business-as-usual emission estimates. For our evaluation, we used the lower estimate. The higher estimate would increase the emission level by 0.3 Gt CO<sub>2</sub> eq.

The maximum increase in the 2020 emission level, according to the methodology based on individual major emitting non-Annex I countries, is 2.6 Gt CO<sub>2</sub> eq, which is higher than according to the methodology based on international modelling studies.

### **Uncertainty 2: Contributions from REDD+ actions to achieve pledges**

While estimates of changes in historical forest area are rather precise due to remote sensing technologies (Böttcher et al., 2009), estimates of resulting emissions are less certain, as they are based on certain assumptions, such as original forest biomass carbon stock, percentage of biomass burned, and extracted wood products, all of which cannot be validated easily. Including post-deforestation emissions from soils, especially carbon-rich soil types, such as peatland, introduce more unknown parameters. These uncertainties are reflected in estimates from scientific literature on annual global net deforestation emissions for the period between 1990 and 1999, which ranged from 3.3 Gt CO<sub>2</sub> eq (DeFries et al.,

2002) to 4.7 CO<sub>2</sub> eq (Houghton, 2010). Recently, Pan et al (2011) estimated the annual net deforestation emissions for the period between 1990 and 2007 at 4.8 Gt CO<sub>2</sub> eq [range: 2.2 to 7.3 Gt CO<sub>2</sub> eq].

Because about 60% of the total non-Annex I reductions comes from REDD actions combined with reductions in other land-use related emissions (including from peatlands), the uncertainty in these emissions is important to consider. The total reduction from REDD actions in our low pledge and high pledge scenarios amount units to 0.6 and 1.0 Gt CO<sub>2</sub> eq, respectively. Most of these reductions would take place in Brazil and Indonesia. Given the uncertainties around the emissions from deforestation, these estimates could be at least 50% lower or higher. This is a conservative estimate of uncertainty, as these reduction numbers also include reducing anthropogenic emissions from peatlands in Indonesia, which are especially uncertain. In general, uncertainties related to emissions from deforestation in individual countries may be lower for countries that have access to detailed remote sensing, forest inventory data and modelling tools, and higher for those relying on default values and basic assessment tools.

### Uncertainty 3: Emissions from international shipping and aviation

The uncertainty range for emissions from international aviation and shipping, based on the UNEP report Bridging the Emissions Gap (UNEP, 2011), is between 1.3 and 1.8 Gt CO<sub>2</sub> (Chapter 4). As our central estimate is about 1.55 Gt CO<sub>2</sub>, the uncertainty in these emissions is ± 0.25 Gt CO<sub>2</sub>.

## 5.5 Total effect of risks and uncertainties

The above risks and uncertainties are interdependent and their effect on emission reductions depends on the order in which these reductions are implemented. Hence, the numbers presented above cannot simply be added together. Taking into account possible overlaps between the risks listed above, the overall effect of those risks could be that emissions are hardly reduced from business-as-usual levels.

### Note

- <sup>1</sup> If Russia and the Ukraine would not use or trade their new surplus AAUs, they also would not use their additional allowances in land-use credits (about 0.1 Gt CO<sub>2</sub> eq).

# Options for bridging the emission gap

## Key findings

- The most ambitious interpretation of the pledges would be that the high pledges are adopted and strict accounting rules are applied (without the use of surplus AAUs or credits for LULUCF accounting rules). In this interpretation, pledges would lead to an emission reduction of about 5 Gt CO<sub>2</sub> eq, compared to business-as-usual emissions.
- A selected set of options could result in an additional reduction of 4.1 Gt CO<sub>2</sub> eq, which would narrow the 2020 emission gap towards achieving the 2 °C climate target.
- Assuming that surplus AAUs are not used and strict land-use accounting rules are implemented, these options include:
  - o Additional reductions of 0.7 Gt CO<sub>2</sub> eq from China and 0.6 Gt CO<sub>2</sub> eq from India, which are presented in their national plans, but are not part of the pledges;
  - o Reducing emissions from deforestation by up to 50% below 2005 levels, by 2020, which would reduce global emissions by about 0.9 Gt CO<sub>2</sub> eq;
  - o Emission reductions from countries currently without pledges, which could be expected to contribute about 0.7 Gt CO<sub>2</sub> eq;
  - o Ensuring strict additionality of offsets, which could contribute about 0.4 Gt CO<sub>2</sub> eq;
  - o Reducing hydrofluorocarbon (HFC) emissions, which could contribute 0.5 Gt CO<sub>2</sub> eq;
  - o Reducing emissions from international shipping, which could contribute 0.3 Gt CO<sub>2</sub> eq.
- The above options do not include the possible impact of implementing measures that strengthen and/or go beyond current pledges. For instance, the emission reduction range that according to the IPCC would be necessary to keep the global temperature increase below 2 °C by 2020, could be followed. For this, the total Annex I emission target for 2020 would have to increase to 25% below 1990 levels. This would decrease the gap by an additional 1.5 Gt CO<sub>2</sub> eq. An increase of the target towards 30% and 40% below the 1990 level would result in additional reductions of 2.4 and 4.3 Gt CO<sub>2</sub> eq, respectively.

This chapter discusses and assesses a number of options to close or narrow the current emission gap. For the low pledge under the strict accounting scenario, the most obvious options to narrow the emission gap are i) to increase the ambition level to that of the high pledges, ii) to not use surplus AAUs, and iii) to apply strict accounting rules. Therefore, as our starting point, we took the emission gap for the high pledge under the strict accounting scenario, with a median emission gap estimate of 5 Gt CO<sub>2</sub> eq [range: 4 to 6 Gt CO<sub>2</sub> eq], for a medium chance of achieving the 2 °C climate target.

In the climate negotiations, discussions were held on the issue of identifying options to bridge the emission gap, and to define a clear process to do so; in particular, following the publication of the UNEP Emissions Gap Report (UNEP, 2010). For example, in the submission by Poland and



European Commission – on behalf of the European Union and its Member States – for the Panama UNFCCC Climate Conference (October, 2011) (UNFCCC, 2011e), the following list of possible options for increasing the ambition level was proposed:

- a) Step up and over-perform on the current mitigation proposals in each country;
- b) Encourage countries that have not yet formulated any pledges to do so;
- c) Increase mutual trust to achieve a collaborative step-up of the ambition level in all countries;
- d) Further develop the global carbon market;
- e) Provide appropriate support for NAMAs;
- f) Address emissions from international aviation and maritime transport;
- g) Address emissions of hydrofluorocarbons.

In this chapter, different options are identified for increasing the level of ambition, based on policy choices that have been discussed in the negotiations and corresponding literature (e.g. Höhne et al., 2009b; Chen et al., 2010; Den Elzen et al., 2011b). We focused on options that could be quantified. They should be seen not as recommendations, but simply as examples.

### Option 1: Taking into account national climate policies of China and India

Some non-Annex I countries, notably China and India, have domestic climate policies that are not part of their submitted mitigation actions. These policies may contain measures that go beyond their international pledges, and may lead to further reductions.

China is the world's largest emitter of greenhouse gases; it was responsible for almost one-fifth of global emissions in 2005, and is projected to cause more than 25% of global emissions by 2020. The climate action foreseen in its latest five-year economic plan (2011–2015) that was published in March 2011, contains the following:

- A decrease of 17% in carbon dioxide emissions per unit of GDP, between 2011 and 2015;
- An increase in the share of non-fossil fuels in primary energy consumption, from 8.3% in 2010 to 11.4% by 2015;
- A decrease of 16% in energy consumption per unit of GDP, between 2011 and 2015;
- The implementation of several measures targeted at reducing non-CO<sub>2</sub> greenhouse gas emissions.

The first two targets are in line with China's pledge for 2020 and, hence, will not lead to additional reductions. An (energy-intensity) target, similar to the third on the list above, was also included in the previous five-year plan (2006–2010), but stated a decrease of 20% in energy consumption per unit of GDP for the period between 2005 and 2010. This was projected to result in a reduction of

0.9 Gt CO<sub>2</sub> eq by 2010 (Den Elzen et al., 2010a). As the new energy intensity target is lower and the PBL/IIASA business-as-usual emission projections shows a larger increase in energy intensity than that in the first period, the new target is projected to lead to a reduction of 0.6 Gt CO<sub>2</sub> eq by 2015, and this level is assumed to remain constant until 2020. The energy intensity target from the national plan and the non-fossil target from the pledge are mutually dependent. Implementing the energy-intensity target reduces primary energy use. If less primary energy is used, then increasing the share of renewables has a smaller effect on CO<sub>2</sub> reductions than in the situation where no energy-intensity target is implemented. We have calculated that the non-fossil-fuel target would lead to an additional 0.4 Gt CO<sub>2</sub> eq reduction for the energy-intensity target, by 2020. The reduction of the energy-intensity target and the non-fossil-fuel target combined would be 0.9 Gt CO<sub>2</sub> eq, which overlaps with the emission intensity target of China's pledge (Subsection 9.2.2) of 0.6 Gt CO<sub>2</sub> eq. The additional reduction from the energy-intensity target and the non-fossil-fuel target combined would be 0.4 Gt CO<sub>2</sub> eq.

The measures to reduce non-CO<sub>2</sub> emissions could contribute up to 0.3 Gt CO<sub>2</sub> eq. These measures include development of the coal-bed methane industry, use of waste for energy, maintaining N<sub>2</sub>O emissions from industrial processes at 2005 levels by 2010, and promotion of low-emission rice cultivation and reduction in CH<sub>4</sub> emissions from animals (Den Elzen et al., 2011b).

The Chinese national plan, therefore, could be expected to contribute a further reduction of 0.7 Gt CO<sub>2</sub> eq to China's pledge, which is expected to reduce emissions by 0.6 Gt CO<sub>2</sub> eq (Subsection 9.2.2). The total reduction, from both pledge and national plan, would be 1.3 Gt CO<sub>2</sub> eq, which is lower than the estimate of 1.7 Gt CO<sub>2</sub> eq of our earlier study (Den Elzen et al., 2011b), which included 0.9 Gt CO<sub>2</sub> eq from China's national plan. This difference can be explained by the assumptions in this study, such as higher business-as-usual emissions and GDP growth projections, less ambitious targets in the latest national climate plans, and no additional emission removals through forests sinks, related to the forest coverage target (Subsection 9.2.2).

India's domestic climate policies include:

- A target of 50% for additional efficient supercritical coal plants, leading to an emission reduction of 40 Mt CO<sub>2</sub> eq (TIMER model calculations);
- Installation of a 20 GW PV and solar-thermal generation capacity by 2020, leading to an emission reduction of 40 Mt CO<sub>2</sub> eq (TIMER model calculations);
- Increased use of renewable energy with 30 GW, leading to an emission reduction of 60 Mt CO<sub>2</sub> eq (TIMER model calculations);

- Increased use of nuclear power by 40 GW, leading to an emission reduction of 175 Mt CO<sub>2</sub> eq (TIMER model calculations);
- Additional energy efficiency measures, leading to an emission reduction of 124 Mt CO<sub>2</sub> eq (Moltmann et al., 2009);
- Afforestation of degraded land and increasing the area of forest plantations, leading to an emission reduction of between 55 and 191 Mt CO<sub>2</sub> eq (Höhne et al., 2009a).

These measures together are expected to lead to a decrease in emissions of 0.6 Gt CO<sub>2</sub> eq, which is 20% of the business-as-usual emissions projected for 2020. The evaluation of the national plan has not been updated since our earlier assessment (Den Elzen et al., 2011b).

The total effect of including measures from the national climate plans of China and India would be 1.4 Gt CO<sub>2</sub> eq.

### Option 2: Halving emissions from deforestation by 2020

Separate policy interventions are currently being discussed under the UNFCCC to prevent deforestation as early as possible. The EU has called for a halving of current deforestation levels, by 2020. Emissions related to land use can be assumed to be declining fast as a result of policy interventions against deforestation. Here, we explored the potential effect, by 2020, of implementing REDD measures of up to a price of between 25 and 50 USD/tCO<sub>2</sub>. This would reduce emissions by between about 0.2 and 0.9 Gt CO<sub>2</sub> eq by 2020, in addition to reductions from REDD measures in the pledges by Brazil, Indonesia and Mexico, based on calculations with IIASA's forestry model G4M. This is equal to reducing CO<sub>2</sub> emissions from deforestation to about 55% below 2005 levels.

### Option 3: Emission reductions by countries currently without reduction pledges

The emission gap could be reduced if the non-Annex I countries that currently have not submitted quantified reduction pledges would also adopt reduction targets. This group, which is expected to be responsible for about 20% of global business-as-usual emissions by 2020, can be split up into those that are associated with the Copenhagen Accord but have not submitted quantifiable pledges and those that are not associated with the Copenhagen Accord. If the first group would reduce their business-as-usual emissions by 10% and the second group by 5%, the total emission reduction would be 0.7 Gt CO<sub>2</sub> eq.

### Option 4: Ensuring strict additionality of offsets

For certain countries, such as India and Indonesia, the PBL/IIASA business-as-usual emission level was calculated to be lower than the level resulting from their

pledges. This implies that these countries would, in fact, have surplus allowances (assuming that the business-as-usual PBL/IIASA projection of future emission growth is correct). Reform of current international offset mechanisms may tighten the additionality of certified reductions, and may avoid the sale of such estimated surplus allowances as international offsets. This would increase the total reduction level for non-Annex I countries by about 0.4 Gt CO<sub>2</sub> eq. The UNEP report *Bridging the Emissions Gap* (UNEP, 2011) presented similar estimated offsets, which could be non-additional, and concluded that the reform of the current international offset mechanisms, ensuring strict additionality of offsets, would reduce 0.4 Gt CO<sub>2</sub> eq by 2020.

### Option 5: Addressing emissions from hydrofluorocarbons

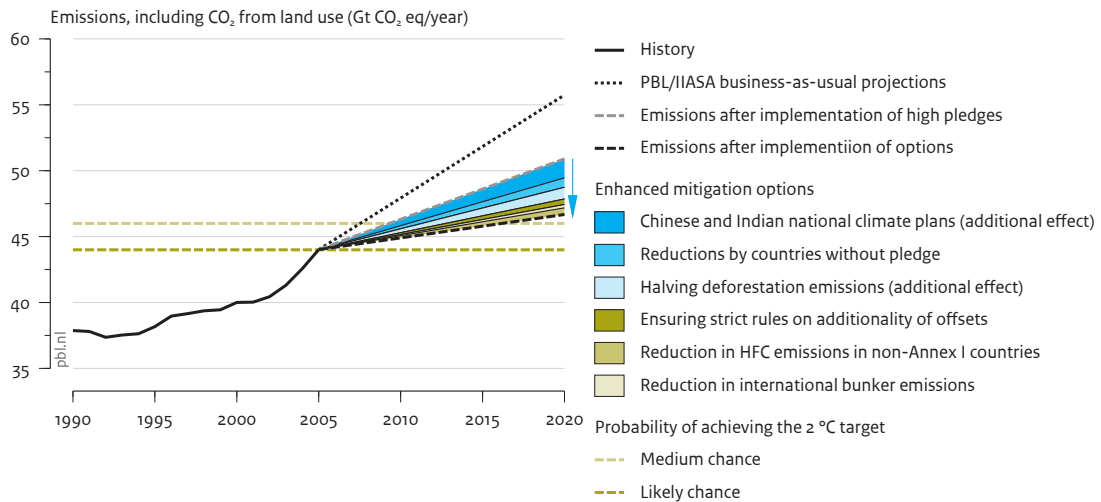
In its options to bridge the emission gap, the EU has included reducing emissions of hydrofluorocarbons (HFCs). These emissions are expected to increase from 0.3 in 2005 to between 0.9 and 1.5 Gt CO<sub>2</sub> eq by 2020, as they are a substitute for the ozone-depleting substances that are phased out under the Montreal Protocol. However, environmentally sound alternatives are already available for most sectors, as indicated by UNEP (2011). The Montreal Protocol, potentially, could incorporate a phase-down schedule for production and consumption of HFCs based on the model followed for ozone-depleting substances. Thereby, HFCs may contribute significantly to bridging the gap by 2020.

Velders et al (2009) describe an emission scenario in which the HFC emission level in 2020 is almost the same as in 2005. In this scenario, the business-as-usual mix of HFC emissions has been replaced by a mix of HFC emissions with a much lower effect on climate. For the PBL/IIASA business-as-usual scenario, this alternative scenario would represent a decrease in global HFC emissions from 1.3 Gt CO<sub>2</sub> eq to 0.3 Gt CO<sub>2</sub> eq by 2020. About 45% of HFC emissions in 2020 are expected to have originated in developing countries. The reductions can be assumed to be additional to the current pledges by developing countries. Therefore, we assumed that a total reduction of 0.5 Gt CO<sub>2</sub> eq could be achieved in addition to the amount in the pledges.

As HFCs are mainly short-lived greenhouse gases, reducing HFC emissions by 2020 does not directly increase the probability of achieving the 2 °C climate target, in the long term. However, we assumed that HFC emissions will continue to be reduced after 2020.

Figure 6.1

### Impact of enhanced mitigation options on global greenhouse gas emissions under strict accounting rules



Source: PBL

The effect of some options that could increase the ambition level, based on policy choices that have been discussed in the negotiations and corresponding literature.

#### Option 6: Reducing emissions from international shipping

Reducing bunker-fuel emissions from international shipping was a subject of discussion in the Bali Action Plan. Various emission reduction options were put forward by the Parties<sup>2</sup>. The Parties at the 37<sup>th</sup> Session of the International Civil Aviation Organisation (ICAO) Assembly on international aviation and climate change reached an agreement to globally improve annual fuel efficiency by 2% and stabilise global CO<sub>2</sub> emissions from international aviation at the 2020 level<sup>3</sup>. However, this implies no actual reductions by 2020. The ICAO currently is reviewing a medium- to long-term global goal and may also consider the 2 °C climate target. The International Maritime Organisation (IMO) did not agree to a 2020 emission target, but made agreements on standards in energy efficiency for new ships and management of ship energy efficiency for all ships.

As there are no pledged reductions for international shipping and aviation (with the exception of pledge by the European Union), we assessed the abatement potential that could be used to fill the emission gap for these sectors at a price of 50 USD/tCO<sub>2</sub>, as illustrated in Figure 6.1.

#### Shipping

To determine the amount of emissions that could be reduced in the international shipping sector at a price of 50 USD/tCO<sub>2</sub>, the IMO greenhouse gas study (Buhaug et al., 2009) was used. This study includes a marginal abatement cost (MAC) curve for total global shipping,

which gives an estimation of the abatement potential at different prices. This MAC curve was subsequently adjusted for international shipping by scaling the MACs of total shipping to that of international shipping. From this could be concluded that the abatement potential at 50 USD/tCO<sub>2</sub> would be 205 Mt CO<sub>2</sub>, which is 16% of the projected business-as-usual emissions for 2020.

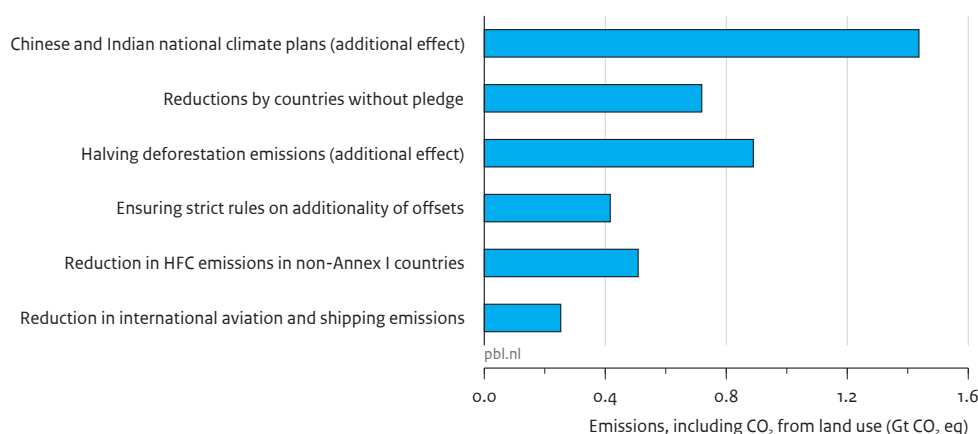
#### Aviation

The abatement potential for 2020 for international aviation was based on the 2009 Omega report (Owen and Lee, 2006). This report includes a MAC curve for 2025 for the European fleet and a MAC curve for 2020 for the UK domestic fleet. These regions were chosen because of the lack in such studies on a global scale. We tried to account for discrepancies in the regional scale by excluding certain abatement measures that we considered were not applicable to the global scale. For the abatement measures in the Omega report that we did use, we assumed that they would be applicable to the international fleet at the same costs, as described below.

We assumed that the costs in 2020 would be the same as in 2025, except for measures related to open rotors and blended wings, which will only apply after 2020. The MACs for the United Kingdom show an abatement potential of 24% at zero or negative cost, and increase only slightly to 26% at a cost of 50 USD/tCO<sub>2</sub>. The MAC curve for the EU shows very similar abatement potential.

Figure 6.2

### Impact of enhanced mitigation options on global greenhouse gas emissions, under strict accounting rules, by 2020



Source: PBL

Individual options that could increase the ambition level based on policy choices as discussed in the negotiations and corresponding literature. Note: starting point is a scenario in which the high pledges are implemented under strict accounting rules.

The following adjustments to these numbers were made:

- The 'fuel reserves' measure was omitted, because it involves decreasing safety margins;
- For the following measures, we reduced the abatement potential by 50%, as these are likely to be more important at EU level than international level:
  - o Optimising take-off and landing efficiency (as this is mainly an EU issue due to crowding off EU airspace);
  - o Air traffic management improvements (mainly EU measures, e.g. Single European Sky project);
  - o Increase the use of turboprop engines (for short-haul flights);
  - o Reduce fuel tankering (less potential for long-haul shipping).

This equates to removing around one third of the total reduction potential, leading to a potential total emission reduction of 17% by 2020<sup>4</sup>.

If global emissions from aviation and international shipping were to be reduced according to these targets, global emissions by 2020 would be decreased by 0.3 Gt CO<sub>2</sub> eq. In the UNEP report Bridging the Emissions Gap total emissions from aviation and shipping are estimated to have the potential of reducing emissions by 2020 by about 0.3 to 0.5 Gt CO<sub>2</sub> eq, between 0.2 and 0.4 of which in international emissions.

### Combined effect of all options

The total effect of all options mentioned above could amount to a reduction of about 4.2 Gt CO<sub>2</sub> eq (see Figure 6.2). This would result in an emission level of 46.7 Gt CO<sub>2</sub> eq, which lies within the range that is consistent with having a medium chance of achieving the 2 °C climate target, according to UNEP (2011).

Of the 46.7 Gt CO<sub>2</sub> eq, 15.9 Gt CO<sub>2</sub> eq would be emitted in Annex I countries (including Turkey) and 29.5 Gt CO<sub>2</sub> eq in non-Annex I countries (the remainder consisting of emissions from aviation and marine transport). This translates into a reduction effort of about 17.5% below 1990 levels for Annex I countries as a group, and 16% below PBL/IIASA business-as-usual emission projections for the group of non-Annex I countries.

According to the IPCC (Gupta et al., 2007), an emission target for 2020 that would be compatible with achieving the 2 °C target would be 25% to 40% below the 1990 levels for Annex I countries as a group, and, according to Den Elzen and Höhne (2008, 2010), between 15% and 30% below business-as-usual levels for the group of non-Annex I countries. If the (more ambitious) conditional pledges (under 'strict rules') and all options as discussed in this Chapter would be fully implemented, Annex I countries as a group would emit at least 17.5% below their 1990 levels by 2020, and non-Annex I countries would be at the low end of the range, between 15% and 30%. In order for Annex I countries to achieve their 25% reduction target, they would

need to decrease emissions by at least a further 1.5 Gt CO<sub>2</sub> eq up to 2020. This would result in a global emission level of about 45.7 Gt CO<sub>2</sub> eq, which is at the low end of the global emission level of 2020 that would be needed for having a medium chance of achieving the 2 °C climate target. An Annex I emission reduction of 30% or 40% below 1990 levels would result in a global emission level of 45 or 43 Gt CO<sub>2</sub> eq, respectively, which would be well within the range for the global emission level that would be needed to have a likely chance of achieving the 2 °C target by 2020.

## Notes

- <sup>1</sup> The 20 GW in solar power capacity by 2020 is comparable to the expected installed solar capacity in Europe.
- <sup>2</sup> For example, the EU has proposed reduction targets of 10% for the aviation sector and 20% for the maritime sector, below 2005 levels, for 2020 (European Council, 2009).
- <sup>3</sup> [Http://unfccc.int/resource/docs/2011/sbsta/eng/misc09.pdf](http://unfccc.int/resource/docs/2011/sbsta/eng/misc09.pdf).
- <sup>4</sup> Two important caveats: (i) the OMEGA report does not take interactions between measures into account, nor does it give any data/information which could be used to estimate impact, so this percentage is likely to be an overestimate; (ii) the OMEGA report also does not take into account any barriers to uptake, which means the cost-effective abatement potential is also likely to be overestimated.

# The role of land use, land-use change and forestry accounting rules in achieving reduction pledges

## Key findings

- With LULUCF accounting rules, countries may receive credits from forest activities (forest management, afforestation/reforestation, deforestation) that could increase CO<sub>2</sub> removal. These credits may subsequently be used to achieve pledged emission targets, and thereby raise the allowed levels of greenhouse gas emissions (excluding LULUCF, but including LULUCF credits) resulting from the pledges by Annex I countries.
- In the Durban climate negotiations, Parties agreed on LULUCF accounting rules for the post-2012 commitment period. For Annex I countries, these rules could result in LULUCF credits to the amount of up to 2% of 1990 emission levels (about 400 Mt CO<sub>2</sub> eq).
- The projected number of LULUCF credits for the EU is relatively small, but for other countries these credits may substantially add to the necessary emission reductions outside the LULUCF sector. For instance, LULUCF credits resulting from the accounting rules could lower the reduction target for greenhouse gas emissions for New Zealand by more than 25% of its 1990 emission level, from -20% (excluding LULUCF credits) to +6% (including LULUCF credits), relative to 1990 levels for its high pledge.
- For Australia, the combined effect of the maximum credits from LULUCF accounting rules, and adding the deforestation emissions of 2000 to the base-year emissions, would lead to an emission target (including LULUCF credits) for 2020, of 23% above 1990 levels for the unconditional pledge, and 4% below 1990 levels for

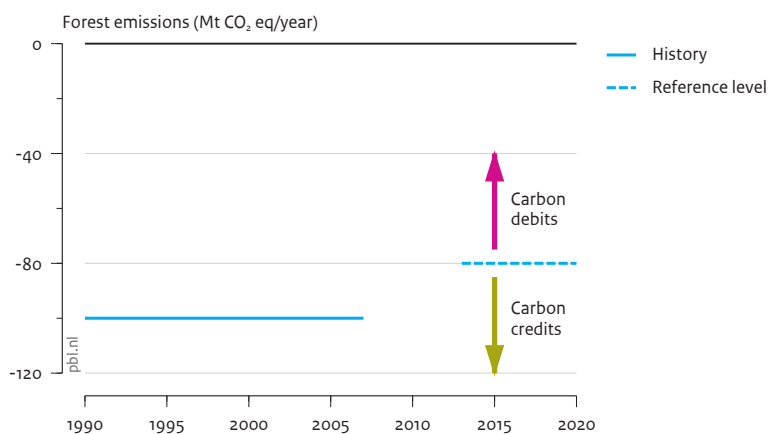
the conditional pledge. Without this combined effect, the emission target would range from +13% to -11%, relative to 1990 levels.

## 7.1 Background

Activities related to land use, land-use change and forestry (LULUCF) tend to remove CO<sub>2</sub> and thus decrease the build up of atmospheric CO<sub>2</sub>. Therefore, Annex I countries could receive credits from LULUCF measures, which subsequently may be used for reaching their individual reduction targets. This implies that these credits could strongly influence their projected emission reductions outside the LULUCF sector. The amount of credits given depends on the LULUCF accounting rules. The rules for the current Kyoto commitment period state that individual countries should keep an account of anthropogenic emissions from sources and removals by sinks from afforestation/reforestation and deforestation (ARD), and may choose also to include forest management ((FM) with a cap on accruing emission allowances), cropland management, grazing land management, revegetation, wetland drainage and rewetting. Some countries have indicated whether their targets include or exclude debits and credits from LULUCF accounting, but others are vague on this point.

After years of negotiations, an agreement was reached at the climate negotiations in Durban on LULUCF accounting

Figure 7.1  
Example of how the forest management reference level is used



Source: Grassi et al (2010)

Example of results from the forest management net-net accounting rule, using a reference level for the 2013–2020 period, assuming a decrease in forest sink from 100 to 80 Mt CO<sub>2</sub> eq. Credits or debits arise only if future sinks differ from the reference level. Negative values of emissions indicate removals (i.e. a 'sink').

rules for the second commitment period'. The main features of the new rules include:

- Accounting of forest management becomes mandatory. Credits and debits during the commitment period will be calculated by subtracting a 'reference level' from the reported, actual emissions or emission removals (see Figure 7.1). For most countries, this reference level is based on business-as-usual emission projections. There is a cap on forest management credits equal to 3.5% of base-year<sup>2</sup> emissions;
- Accounting of ARD, cropland management, grazing land management, and revegetation will remain essentially the same;
- Accounting of harvested wood products becomes mandatory;
- Excluding emissions due to natural disturbances (e.g. wildfires, storms) is allowed;
- Emission fluxes from wetland drainage and rewetting may be included.

## 7.2 Evaluation of LULUCF accounting rules

The total in LULUCF credits per country, resulting from LULUCF accounting rules for the second commitment period, depends on a country's forest age structure. With forest management accounting using historical net emissions as reference level, a country with an increasing sink due to young and thus fast growing forests would

receive credits independent of additional actions, while a country with a declining sink due to old forests would end up with debits – even if its forest management would be sustainable. By introducing the concept of a projected reference level in forest management accounting, the additionality issue could be solved, because, in theory, any credit would reflect additional changes. In practice, the assumptions used in projections add a level of largely unavoidable uncertainty, which may be significant for some countries (Grassi et al., 2010).

Table 7.1 gives the total estimated LULUCF credits by 2020 for all Annex I countries according to the LULUCF accounting rules as agreed at the Durban climate negotiations, based on calculations using the JRC LULUCF tool (Joint Research Centre (JRC) European Commission, 2011) (see Text box 4). For Annex I countries for which projected data were used as reference level, we included two options for determining the level of forest management credits:

- (i) No additional forest management policies, which would lead to zero forest management credits;
- (ii) Additional forest management policies, which would lead to a level of credits based on JRC's estimate of the maximum potential. In this case, these credits would be equivalent to 3% of base-year emissions, except for the EU and the Ukraine, for which 1% of base-year emissions was used, based on expert judgement.



Table 7.1

**Estimated LULUCF credits for all Annex I countries\*, by 2020, due to LULUCF accounting rules for the second commitment period**

	Estimated LULUCF credits	
	Mt CO <sub>2</sub> eq	Share of 1990 emissions in Annex I countries
(i) Country projections for forest management (FM)	298	1.6%
(ii) JRC Maximum estimate of FM credits	403	2.1%

Source: Joint Research Centre (JRC), European Commission, JRC LULUCF tool, version 8 December (2011)

\* Excluding Turkey and Kazakhstan.

**Text box 4 Calculating LULUCF credits for Annex I countries**

LULUCF credits for all Annex I countries during the second commitment period that arise from afforestation/reforestation and deforestation (ARD) and forest management (FM) may be calculated with the JRC LULUCF tool, version 8 December (2011)<sup>3</sup>, of the Joint Research Centre (JRC), European Commission. The tool contains 1) the latest historical greenhouse gas data (1990–2009) submitted by the Parties in the context of greenhouse gas inventories under the Convention and Kyoto Protocol<sup>4</sup>; 2) the latest data on forest management reference levels submitted to the UNFCCC in the context of the Ad hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP)<sup>5</sup>; 3) JRC elaboration of country data (e.g. interpolation/extrapolations, other elaborations using transparent assumptions). Cropland management, grazing land management and revegetation are not included in this analysis, due to lack of reliable data. However, it is likely that their contribution will be smaller than that of ARD and FM.

Credits for afforestation/reforestation and deforestation (ARD). ARD estimates were taken from official country projections, or, in some cases, from linear extrapolation of afforestation/reforestation rates or historical averages of deforestation rates.

Credits or debits from forest management (FM). The JRC LULUCF tool (2011) calculates forest management credits using country projections and their reference levels. For Australia, Canada, Croatia, EU countries, Iceland, New Zealand, Switzerland and the Ukraine, reference levels for forest management are based on projected emissions from sources and removals by sinks, without any effects from additional policies on forest management. Therefore, they will not accrue LULUCF credits. It seems likely, however, that countries will implement additional forest management policies. We based the maximum estimates for forest management credits from such policies on JRC's estimates. These estimates amount to 3% of base-year (1990) emissions for Australia, Canada, New Zealand and Belarus, and 1% of base-year emissions for the EU and the Ukraine; these percentages equal those in our previous study (Den Elzen et al., 2011a).

For Norway, Russia and Belarus, the forest management reference level was based on 1990 net emissions from forest management. For Japan, this was set to zero. For the United States, we assumed 2005 emissions as their reference level. For all countries, there is a cap on forest management credits of 3.5% of base-year emissions.

For the other countries, reference levels differed from projections (Text box 4). Furthermore, forest management credits are limited by the cap of 3.5% of base-year emissions.

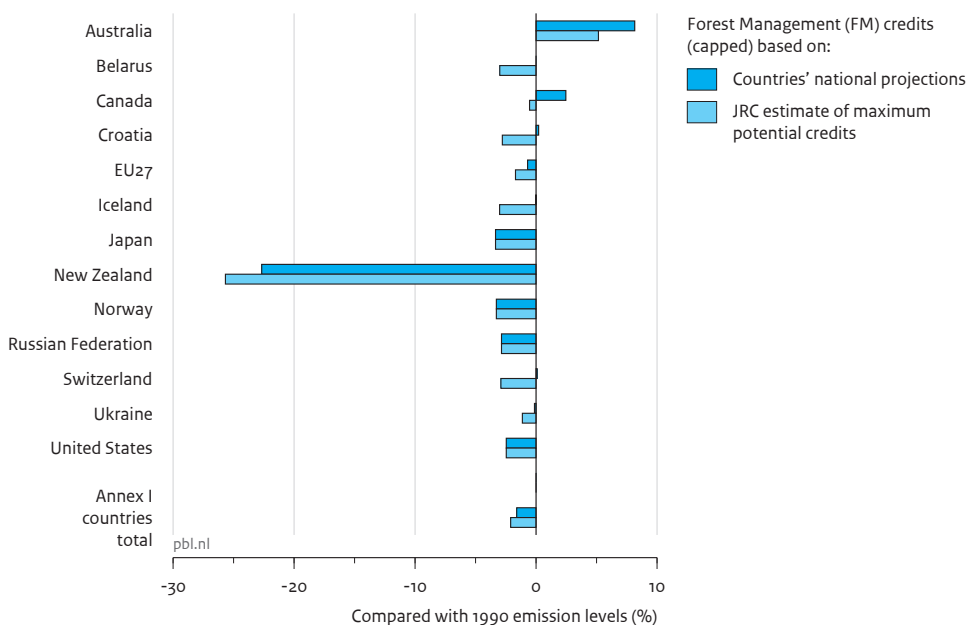
Depending on the option, LULUCF accounting rules could result in credits of 1.6% to 2.1% of the total 1990 Annex I emission level, which would decrease the reduction target excluding LULUCF by the same percentage.

Figure 7.2 presents estimates of LULUCF debits and credits for individual Annex I countries and for them as a group. The effects on emission targets excluding LULUCF for the EU (0.7% to 2.1% of its 1990 emissions) is smaller than on average for Annex I countries (1.6 to 2.1% of 1990 emissions). For the EU's unconditional 20% target, LULUCF credits are not included, but may at a later stage, given that in legislation it is foreseen that accounting rules should ensure permanence and environmental integrity.



Figure 7.2

## Impact of carbon credits resulting from options for forestry accounting rules, by 2020



Source: Joint Research Centre (JRC), European Commission, JRC LULUCF tool, version 8 December (2011)

Estimated LULUCF credits for all Annex I countries, by 2020, due to LULUCF accounting rules for the second commitment period, expressed as % of 1990 emissions

For some Annex I countries, LULUCF accounting rules can have a great impact on their reduction target, excluding LULUCF (Tables 7.2 and 7.3). For instance, for New Zealand, the additional LULUCF credits from the accounting rules could lower its reduction target by more than 25% of the 1990 emission level, which is mainly due to the credits from afforestation and reforestation. In other words, the emission level for the high pledge, for instance, increases from -20% (excluding LULUCF credits) to +6% (including LULUCF credits), relative to 1990 levels. The adoption of a cap on forest management credits of 3.5% of base-year emissions would substantially lower the amount of LULUCF credits for Norway and Russia<sup>6</sup>, for which historical reference levels were used, to around 3.3% and 2.9% of 1990 emission levels. The accounting rules for afforestation/reforestation and deforestation (ARD) results in debits for Canada, mainly due to deforestation projections, which would increase its reduction target (including LULUCF credits) by 2.5% of 1990 emission levels. However, this could be counteracted by forest management accounting rules, as shown in the option of maximum forest management credits.

For Australia, carbon debits resulting from LULUCF accounting rules increase reduction targets (including LULUCF credits), by around 5% to 8% of 1990 emission levels (Figure 7.2). In addition, Australia's target is strongly influenced by its statement that deforestation emissions of the year 2000 (about 70 Mt CO<sub>2</sub>) are also included in its base-year (2000) emission level (which is an option under Article 3.7 of the Kyoto Protocol). Therefore, Australia's reduction targets of 5% (unconditional) and 25% (conditional) below 2000 levels translates to respective Kyoto greenhouse gas emission targets of 29% and 2% above 1990 levels, including LULUCF credits (Table 7.3) (Chapter 2). If maximum FM credits would be added, the respective targets (including LULUCF credits) would be 23% above and 4% below 1990 emission levels.

Emission reductions expected from unconditional, low and high pledges, for all Annex I countries, with and without maximum estimates of LULUCF credits, are given in Table 7.3. The impact of the maximum LULUCF credits on aggregated Annex I emission targets for the low and high pledges is 1.5 %<sup>7</sup> and 2.1%, respectively. For the unilateral pledges, no significant impact is expected, as Canada, the EU, Japan, Russia and the United States all have no LULUCF credits.

Table 7.2

**Estimated LULUCF credits according to LULUCF accounting rules for the 2<sup>nd</sup> Kyoto commitment period, for the major Annex 1 Parties, arising from afforestation/reforestation and deforestation (ARD) and from forest management (FM)**

Country	Base-year emissions (usually 1990)	ARD	FM (country projections capped)	FM (maximum estimate capped)	FM (country projections capped) and ARD	FM (maximum estimate capped) and ARD
<b>In Mt CO<sub>2</sub> eq</b>						
Australia	418	-34	0	13	-34	-22
Belarus	139	0	0	4	0	4
Canada	590	-15	0	18	-15	3
Croatia	31	0	0	1	0	1
EU27	5,589	40	0	57	40	98
Iceland	3	0	0	0	0	0
Japan	1,267	-2	44	44	42	42
New Zealand	59	14	0	2	14	16
Norway	50	0	2	2	2	2
Russia	3,351	-22	116	116	95	95
Switzerland	53	0	0	2	0	2
Ukraine	931	1	0	9	1	10
United States	6,167	82	70	70	152	152
<b>Total Annex I*</b>	<b>18,650</b>	<b>65</b>	<b>232</b>	<b>338</b>	<b>298</b>	<b>403</b>

Source: Joint Research Centre (JRC), European Commission, JRC LULUCF tool, version 8 December (2011)

\* Excluding Turkey and Kazakhstan.

Note: '+' represents credits and '-' debits.

Table 7.3

**The impact of the maximum LULUCF credits according to LULUCF accounting rules, for the 2<sup>nd</sup> commitment period, on the emission reduction targets (below 1990 levels) for Annex I countries for 2020, resulting from the pledges submitted by the Parties in the Cancún Agreements**

Relative to 1990 emission levels	Unconditional pledge		Low pledge		High pledge	
	Excluding LULUCF credits <sup>v</sup> , in %	Including maximum LULUCF credits <sup>vv</sup> , in %	Excluding LULUCF credits, in %	Including maximum LULUCF credits, in %	Excluding LULUCF credits, in %	Including maximum LULUCF credits, in %
Australia*	29	23	29	23	2	-4
Belarus	-5	-2	-5	-2	-10	-7
Canada	27	27	3	3	3	3
Croatia	-5	-2	-5	-2	-5	-2
EU27**	-20	-20	-20	-20	-30	-28
Iceland	-30	-27	-30	-27	-30	-27
Japan	5	5	-25	-22	-25	-22
New Zealand	-10	16	-10	16	-20	6
Norway	-30	-27	-30	-27	-40	-37
Russia	-26	-26	-15	-12	-25	-22
Switzerland	-20	-17	-20	-17	-30	-27
Ukraine	-20	-20	-20	-19	-20	-19
United States	18	18	-3	-1	-3	-1
Kazakhstan	-26	-26	-26	-26	-26	-26
<b>Annex I total*</b>	<b>-5</b>	<b>-5</b>	<b>-12</b>	<b>-11</b>	<b>-18</b>	<b>-16</b>

Source: Joint Research Centre (JRC), European Commission, JRC LULUCF tool, version 8 December (2011)

Reduction targets refer to all greenhouse gas emissions relevant under the Kyoto Protocol (Annex A) with the exception of emissions from LULUCF, i.e. the sum of six Kyoto greenhouse gas emissions, weighted by their global warming potential. Annex I countries' base-year emissions were taken from UNFCCC national inventory submissions.

v Excluding the impact of potential LULUCF credits and debits in 2020.

vv Including the impact of potential LULUCF credits and debits in 2020.

\* For Australia, we also included the impact of deforestation emissions added to its targets, which increases the effective reduction targets by 16% and 13% for the unconditional/low and high pledge, respectively.

\*\* For the EU's unconditional and low pledge scenario, we assumed no LULUCF credits to be included.

\*\*\* Excluding Turkey and Kazakhstan.

## Notes

- <sup>1</sup> [http://unfccc.int/files/meetings/durban\\_nov\\_2011/decisions/application/pdf/awgkp\\_lulucf.pdf](http://unfccc.int/files/meetings/durban_nov_2011/decisions/application/pdf/awgkp_lulucf.pdf).
- <sup>2</sup> Usually 1990.
- <sup>3</sup> [http://afoludata.jrc.ec.europa.eu/index.php/models/JRC\\_LULUCF\\_TOOL](http://afoludata.jrc.ec.europa.eu/index.php/models/JRC_LULUCF_TOOL).
- <sup>4</sup> [http://unfccc.int/national\\_reports/annex\\_i\\_ghg\\_inventories/items/2715.php](http://unfccc.int/national_reports/annex_i_ghg_inventories/items/2715.php).
- <sup>5</sup> [http://unfccc.int/meetings/ad\\_hoc\\_working\\_groups/kp/items/5896.php](http://unfccc.int/meetings/ad_hoc_working_groups/kp/items/5896.php).
- <sup>6</sup> Without such a cap, credits from forest management for Norway would amount to almost 30%, and for Russia 10%, from 1990 emission levels.
- <sup>7</sup> For its unconditional and low pledge scenario we assume for the EU no LULUCF credits are included.

# Options for dealing with Kyoto surplus assigned amount units in achieving reduction pledges

## Key findings

- Countries for which emission levels are below their Kyoto target have surplus assigned amount units ('hot air') that, under the Kyoto protocol, can be carried over to the next commitment period. This is especially the case in the former Soviet Union and in eastern European countries, but also in some EU15 Member States.
- Options for addressing the carry-over and use of Kyoto surplus assigned amount units vary from prohibiting carry-over or restricting the use or sale, to no restrictions at all (current Kyoto Protocol rules).
- For no restrictions on carry-over, the ambition level of emission reductions by Annex I countries as a whole could decrease by 2.9 Gt CO<sub>2</sub> eq (equivalent to about 15% of 1990 levels), and for the EU target of 30%, the decrease could be up to 0.8 Gt CO<sub>2</sub> eq (equivalent to 14% of 1990 emission levels).
- If carry-over of surplus assigned amount units (AAUs) would be restricted, such as under the other options, the decreases in ambition levels would be much smaller.
- Without the participation of Russia as largest potential seller and Japan and Canada as potential buyers in a second commitment period, it is unlikely that many surplus AAUs will be traded.
- The EU has stipulated that, for its unconditional target of 20%, Member States cannot use surplus AAUs to achieve their reduction targets. For the EU target of 30%, the rules are still unclear.

## 8.1 Background

According to the Kyoto Protocol, countries with allowances that are not required for achieving their Kyoto target in the first commitment period (2008–2012) could carry-over these surplus AAUs to use or trade in subsequent commitment periods. Because of the economic collapse in certain countries following the dissolution of the Soviet Union and the Eastern Bloc in the 1990s, emissions in these countries have strongly declined. As a result, their emission levels will be below that of their Kyoto targets by the end of 2012, even without additional emission reduction policies. Therefore, these countries have generated a substantial amount of surplus AAUs ('hot air'). In addition, due to domestic policies and the recent economic crisis, surplus AAUs are also expected for western European countries, such as Germany and the United Kingdom. Total surplus AAUs for the first commitment period of the Kyoto Protocol (2008–2012) are in the order of 11.4 Gt CO<sub>2</sub> eq. The annual amount of surplus AAUs by 2020 would be 2.9 Gt CO<sub>2</sub> eq, if all surplus AAUs, following the current Kyoto Protocol rules, could be carried over to the next commitment period and there would be no restrictions on their use and trade, and this use and trade would increase, between 2012 and 2020, with a maximum in 2020. Such a distribution of use and trade of surplus AAUs, over time, would look like a linearly increasing wedge (see Rogelj et al., 2010b; 2010d). An amount of 2.9 GtCO<sub>2</sub> eq in surplus AAUs could have quite an impact on emission reductions by Annex I countries, by 2020. This is

Table 8.1

**Overview of the four options for dealing with surplus AAUs in future commitment periods**

	Option 1	Option 2	Option 3	Option 4
1. Carry-over	Full	Restricted to % of surplus allowance	Full	None
2. Restrictions on sale	Unrestricted	Unrestricted	Full restriction – no sale of AAUs	Not applicable

**Text box 5 Important assumptions for calculating surplus AAUs**

To assess the impacts of the options on actual reduction levels, we used the spreadsheet ‘Surplus AAU Check Tool’, initially developed by the Potsdam Institute for Climate Impact Research (PIK) and further developed by the PBL Netherlands Environmental Assessment Agency. The calculations performed with this tool were based on the following main assumptions:

- The contribution of land-use credits and/or CDM credits towards achieving the Kyoto targets were not taken into account when calculating the level of surplus AAUs;
- A second commitment period of eight years was assumed (2013–2020), in which all countries with Kyoto surplus AAUs would join;
- EU countries with emission levels above their Kyoto targets would not affect the EU’s total aggregated surplus AAUs;
- The use of surplus AAUs was assumed not to be spread out evenly over the 2013–2020 period. Instead, more surplus AAUs were believed to be used later on in the period. This would imply that, in 2020, twice as many of the surplus AAUs would be used, compared to a situation of even distribution over the 2013–2020 period.

why restrictions on carry-over and/or use of surplus AAUs for achieving reduction pledges are of such importance. Russia (about 50%), the Ukraine (22%) and European countries (about 27%), together, have generated nearly all of the currently estimated surplus AAUs for the first commitment period. This chapter shows how the rules for using surplus AAUs would affect actual reduction levels.

In the UNFCCC negotiations<sup>1</sup>, there are basically four options left for dealing with Kyoto surplus AAUs in achieving reduction pledges (Text box 5, for methodology calculations):

- *Option 1* is the status quo, implying no restrictions on carry-over and future use of Kyoto surplus AAUs. As explained above, this would lead to almost 3 Gt CO<sub>2</sub> eq in surplus AAUs by 2020.
- *Option 2* restricts the carry-over of Kyoto surplus AAUs to a percentage of AAUs per country, in the first commitment period of the Kyoto Protocol (2008–2012). The percentages currently proposed are 1%, 2%, 5%, and 10%. This would lead to surplus AAUs varying from 0.1 to 1 Gt CO<sub>2</sub> eq by 2020.
- *Option 3* restricts the use of surplus AAUs for future domestic compliance only. This means that surplus AAUs cannot be sold, and may only be used for

achieving future targets. This would lead to surplus AAUs of between 0.4 and 0.8 Gt CO<sub>2</sub> eq by 2020.

- *Option 4* prohibits carry-over of surplus AAUs altogether, leading to zero surplus AAUs by 2020.
- Table 8.1 summarises the options based on the above categorisation.

## 8.2 Effectiveness of options for emission reductions by 2020

Table 8.2 shows by how much the various options could reduce emission reduction efforts by individual countries by 2020. As the options only affect the reduction targets of countries with projected surplus AAUs, only these countries are shown. This table shows that the choice of future rules regarding surplus AAUs could strongly affect the level of future emission reductions. Option 1 (no restrictions) effectively would reduce the EU target by 0.8 Gt CO<sub>2</sub> eq (equivalent to 14% of 1990 emission levels), and for the Ukraine by as much as 0.6 Gt CO<sub>2</sub> eq (equivalent to 68% of its 1990 emission level). The other options would lead to much smaller impacts on actual reduction targets.

Table 8.2

### Impacts of the options for surplus AAUs carry-over rules on emission reduction targets, in percentage of 1990 levels

Country	% relative of 1990 levels		Reduction in targets for 2020, in % of 1990 levels						
	current pledge		Option 1	Option 2			Option 3 <sup>#</sup>	Option 4	
	low	high		1%	2%	5%			10%
EU27	-20	-30	14	1	2	4	7	1-5 <sup>v</sup> i/1-11 <sup>ii</sup>	0
Australië	29	2	12	2	4	9	12	12	0
Belarus	-5	-10	25	1	2	5	11	0	0
Russia	-15	-25	42	1	2	6	12	0-2	0
Ukraine	-20	-20	67	1	2	6	12	0	0
<b>Total Annex I*</b>	<b>-12</b>	<b>-18</b>	<b>15</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>5</b>	<b>0-2<sup>i</sup>/0-4<sup>ii</sup></b>	<b>0</b>

Source: PIK's Surplus AAU Check Tool and PBL calculations

# Depending on whether the high or the low pledges are assumed; v= domestic compliance for the EU, i = treating the EU as individual Member States, ii = treating the EU as a whole; \* Excluding Turkey and Croatia.

The total impact of surplus AAUs would strongly depend on whether countries will buy such surplus AAUs.

Currently, the largest potential buyers are Japan, the EU and Canada. Japan and Canada have indicated they will not make a new commitment under the Kyoto Protocol. Under current internal EU legislation for achieving its unconditional 20% reduction pledge, surplus AAUs cannot be used for compliance within the EU. Hence, the total impact under Option 1 could be substantially lower, by 2020, than the projected reduction of 3 Gt CO<sub>2</sub> eq. Finally, as Russia has announced also not to participate in a second commitment period, it would not supply any surplus AAUs; effectively halving the total supply.

For its 20% unconditional target, the EU has decided that surplus AAUs cannot be used. The rules for the conditional 30% target are still unclear. If, for the 30% target, surplus AAUs could be used, Option 1 could cause a reduced emission reduction, bringing it below the 20% unconditional target. However, Option 1 would result in supply exceeding demand for surplus AAUs. Therefore, it is likely that this option would result in only part of the surplus AAUs being sold. Most, if not all surplus AAUs would be carried over for use in future commitment periods (if this were allowed).

### Note

<sup>1</sup> All options are presented in the negotiation document: Ad hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP), i.e. the CRP 4 paper (FCCC/KP/AWG/2010/CRP.4/Rev.4). The Durban climate negotiations did not change the existing options.



# Overview of reductions by the ten largest emitting countries

## Key findings

A closer look at the pledges by the ten largest emitting countries and regions revealed the following interesting findings:

- National business-as-usual emission projections are often higher than the PBL/IIASA projections. For non-Annex I countries, which, generally, have set their targets relative to their business-as-usual levels, this implies that the emission reductions when set against PBL/IIASA business-as-usual levels are lower than the actually pledged reductions.
- Brazil has provided a new, higher estimate for its business-as-usual emissions, to which its 36% to 39% reduction pledge is to be applied. This leads to higher greenhouse gas emission levels resulting from its pledges; in particular, due to higher emissions from deforestation, and lower reductions compared to PBL/IIASA business-as-usual emission projections. For this study, we estimated that all reductions would come from REDD activities (about 560 Mt CO<sub>2</sub>).
- As China pledged a CO<sub>2</sub> emissions intensity target, which highly depends on GDP growth, its resulting pledged emission target for 2020 is very uncertain. This target equals 12.9 Gt CO<sub>2</sub> eq for the PBL/IIASA business-as-usual scenario, being a reduction of 4% below the business-as-usual emission projections, whereas for the WEO-2010 scenario, the target equals 11.4 Gt CO<sub>2</sub> eq, being a reduction of 10%.
- The Indian Government has provided estimates of business-as-usual emission levels and emission

reductions resulting from its pledged emissions intensity target. The emission level for 2020 resulting from its pledge is about 13% above the PBL/IIASA business-as-usual projection and 22% above the WEO-2010 business-as-usual emission projections.

- For many Annex I countries it is unclear how much of the reductions will be achieved with offsets, or which accounting rules would apply for forests, and how much additional allowances will be used compared to previous commitment periods.

This chapter presents an overview of the pledges as submitted by the ten largest emitting countries or regions and, for Annex I countries, compares these with climate policy measures as proposed in their national communications.

## 9.1 Pledges by Annex I countries

This section provides a more detailed description of the pledges and resulting emission reductions for the five largest emitting Annex I countries or regions. It also compares the national business-as-usual emission projections as provided by these countries themselves (UNFCCC, 2011a) with the PBL projections. Each Annex I country has provided the UNFCCC (2011a) with a national communication<sup>1</sup> which describes its pledge and the mitigation actions planned for realising it. Countries have provided a maximum of three different scenarios of business-as-usual emission levels:

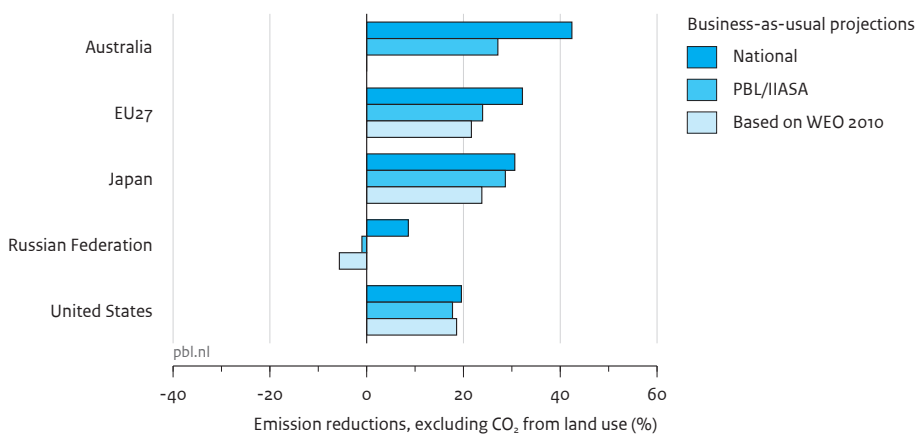


Table 9.1  
**Business-as-usual scenarios provided by Annex I countries**

	NM	WM	WAM
Australia <sup>a</sup>	Yes	Yes	No
EU	Yes	Yes	Yes
Japan	Yes	Yes	No
Russia	Yes	Yes	Yes
United States	Yes	No	No

<sup>a</sup> This refers to the updated 'Australia's Emission Projections 2010' (Australian Government, 2011).

Figure 9.1  
**Greenhouse gas emission reductions from projected business-as-usual levels, for the high pledges by major non-Annex I countries, by 2020**



Source: PBL, based on IEA (2010)

Estimated reductions by Annex I countries, relative to business-as-usual emission projections (without measures).

1. Without measures (NM)
2. With measures (WM)
3. With additional measures (WAM)

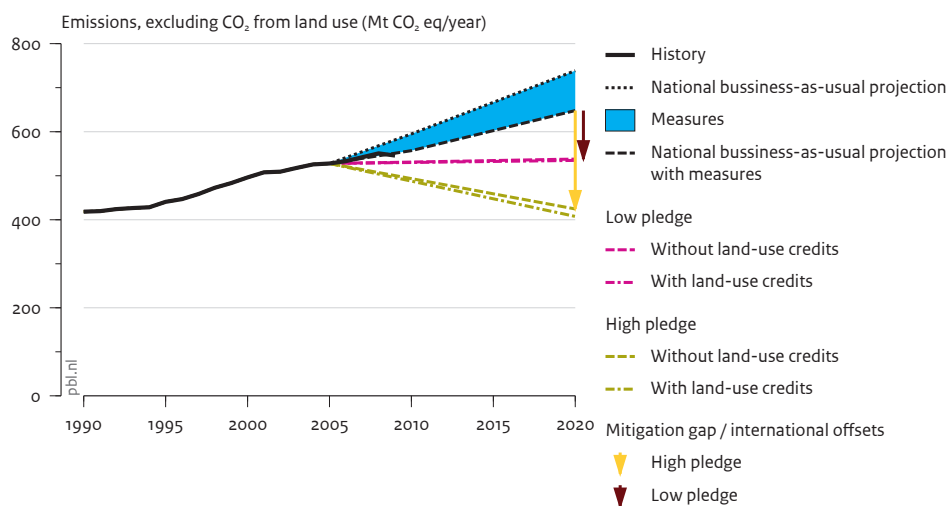
The first scenario contains no climate policy; under the second scenario, climate policy has been implemented or adopted; and in the third scenario climate policy has been proposed but has not been officially accepted. Table 9.1 presents a summary of the business-as-usual scenarios provided by the five largest emitting Annex I countries or regions in their national communications.

This section first provides an analysis of the 'mitigation gap', defined as the difference in emission levels between those of the business-as-usual scenarios with measures and the submitted pledges. Additional measures, as described by the EU and Russia in their national

communications, were also analysed. Further, a brief description is provided of the possible impacts of international offsets, land-use credits and carried over surplus assigned amount units (AAUs), on this gap.

Furthermore, a comparison is made between PBL, WEO-2010<sup>2</sup> (IEA, 2010) and published national business-as-usual emission projections. Figure 9.1 shows that the reductions strongly depend on the applied business-as-usual scenario. Subsequently, these differences are discussed for each country in detail. Appendix B provides data on reductions according to all three business-as-usual emission projections for all Annex I countries.

Figure 9.2  
Mitigation gap in greenhouse gas emissions, for Australia



Source: PBL; Australian Government (2011)

The 'mitigation gap' for Australia is the difference between business-as-usual emission projections including measures and emission levels that would result from achieving the pledges.

### 9.1.1 Australia

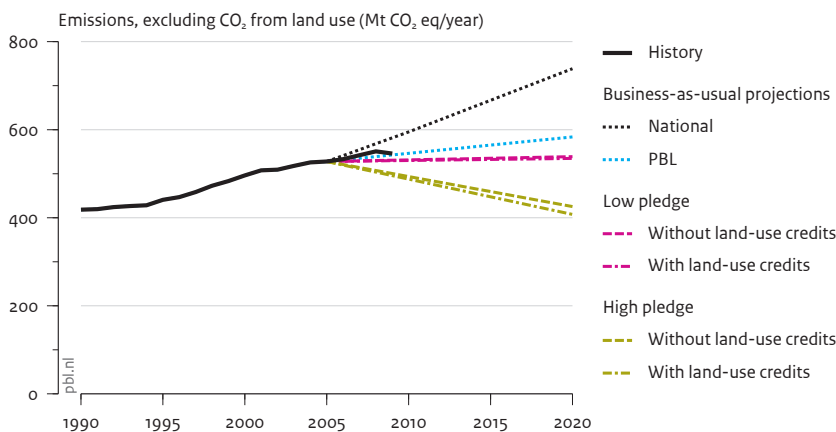
Australia has pledged to decrease its emissions by 5%, 15%, or 25% below its 2000 emission level. Adoption of the 25% reduction target is conditional on a global deal that will be 'capable of stabilising greenhouse gases in the atmosphere at 450 ppm CO<sub>2</sub> or lower, including a clear pathway to achieving an early global peak in emissions, advanced economy reductions in aggregate of at least 25% below 1990 levels by 2020, major developing economies with a collective reduction of at least 20% below business as usual by 2020, and a nomination of a peaking year for major developing economies' (UNFCCC, 2011d). If a global deal is reached that falls short of the 450 ppm objective but under which major developing economies commit to substantially limit emissions and advanced economies take on commitments that are comparable to Australia's (i.e. between 15% and 25% below 1990 levels), Australia has pledged to reduce emissions by 15%. Otherwise, the unconditional 5% target will be implemented.

Australia is the only country for which land-use change and forestry accounting rules in the first commitment period has substantially increased the effective assigned mount units (Article 3.7). Australia has stated that its pledge also accounts for CO<sub>2</sub> emissions from deforestation, to be added to its base-year (2000) emissions, by applying Article 3.7 to future emission levels. This implies that Australia's emission levels resulting from its pledges are based on 2000 greenhouse gas emission levels excluding those from

LULUCF, but including emissions from deforestation. The latter appear to have been based on those reported under the Kyoto Protocol, Article 3.3. This would suggest an emission level from deforestation of about 70 Mt CO<sub>2</sub> eq in 2000, which is in keeping with results by Höhne et al (2011b). Adding these emissions to Australia's energy and industrial greenhouse gas emissions of 496 Mt CO<sub>2</sub> eq gives a total emission level of 566 Mt CO<sub>2</sub> eq, on which the pledges were based. Therefore, this study interprets the 5% reduction target to represent an absolute allowed emission level for 2020 of 538 Mt CO<sub>2</sub> eq, for the 15% target this would be 481 Mt CO<sub>2</sub> eq, and for the 25% target 425 Mt CO<sub>2</sub> eq. The 5% target would translate into a greenhouse gas emission target, excluding emissions from LULUCF, of 29% above 1990 levels, while for the 25% target this would be 2% above 1990 levels. This compares to a target of +8% for the first commitment period.

Early in 2011, Australia updated the emission projections in its Fifth National Communication on Climate Change (Australian Government, 2011). When taking into account the Kyoto measures, Australia's emissions are projected to be 650<sup>3</sup> Mt CO<sub>2</sub> eq for 2020 (Figure 9.2; business-as-usual scenario with measures). The reduction resulting from implementation of the Kyoto measures is projected to be 90 Mt CO<sub>2</sub> eq<sup>4</sup>, which implies that, under the business-as-usual scenario without measures, this is expected to be 740 Mt CO<sub>2</sub> eq. The mitigation gap for Australia between the business-as-usual scenario with Kyoto measures and the high (25%) pledge is 235 Mt CO<sub>2</sub> eq (Figure 9.2). Australia

**Figure 9.3**  
**Comparison between business-as-usual greenhouse gas emissions and pledges, for Australia**



Source: PBL; Australian Government (2011)

Comparison of different business-as-usual emission projections with emission levels resulting from implementation of the pledges.

has land-use debits from the LULUCF accounting rule as well as credits from including declining deforestation emissions in its targets for the 2000–2020 period. Together, these credits and debits slightly increase the emission target (including LULUCF credits), from 29% to 28% above 1990 levels for the unconditional pledge, while the effect on the conditional pledge is marginally larger.

Australia allows international offsets, as the 15% target is conditional on access to deeper and broader carbon markets. The 25% target is conditional on global action that mobilises greater financial resources, including from major developing economies, and results in fully functioning global carbon markets (UNFCCC, 2011d).

Most of the mitigation actions may come from Australia’s new climate legislation; in particular, the Carbon Pollution Reduction Scheme (CPRS) that Australia has set up (Climate Works Australia, 2011). This is an emission trading scheme, similar to the one in the EU. This market encompasses a carbon price floor and ceiling, which are gradually removed. Within this scheme, it is possible to use international offsets up to a level equalling 50% of 2020 emissions. So, depending on the price of national carbon credits, participants in the CPRS will choose to either reduce emissions domestically or buy international offsets.

In a recent study by Climate Analytics and Ecofys (2011), the effectiveness of Australia’s new climate legislation was evaluated. This led to the conclusion that the new policies, by 2020, because of domestic actions, would achieve close to the 5% reduction from 2000 levels, which is Australia’s

‘unconditional’ reduction target. The stringency of the actions under the legislation would need to be increased to achieve the pledged 15% and 25% targets, domestically.

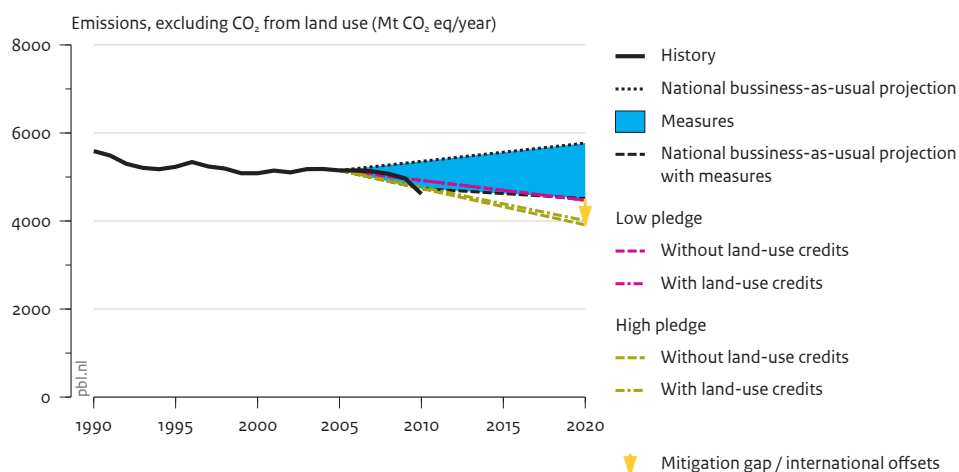
The PBL business-as-usual emission projections is substantially lower than Australia’s own projection: according to the PBL business-as-usual projections, the emission level would reach 580 Mt CO<sub>2</sub> eq by 2020, while the nationally published projection speaks of 740 Mt CO<sub>2</sub> eq (Figure 9.3). There are no WEO-2010 data available on Australia.

### 9.1.2 The European Union

The EU has an unconditional reduction target of 20% below 1990 levels, which is supported by legislation and has been in place since 2009 (Climate and Energy Package<sup>5</sup>). The EU would move to a 30% target as part of a global comprehensive agreement for the period beyond 2012, provided that all Parties contribute their fair share to a cost-effective global emission reduction pathway. This would consist of other developed countries committing themselves to comparable emission reductions and developing countries contributing according to their responsibilities and respective capabilities.

In its 5<sup>th</sup> EC National Communication, the EU published a business-as-usual emission projection, updated by a staff working document with a projection of measures (European Commission, 2011)<sup>6</sup>. For the EU, the mitigation gap between its projection of business-as-usual emissions with additional measures and the high pledge is about 600 Mt CO<sub>2</sub> eq (Figure 9.4). If those additional measures were to

Figure 9.4  
Mitigation gap in greenhouse gas emissions, for the European Union



Source: PBL; European Commission (2011); UNFCCC (2011a)

The mitigation gap for the EU consists of the difference between business-as-usual emission projections with measures and emission levels resulting from the implementation of the pledges.

Business-as-usual emission projection without measures, from the 5<sup>th</sup> EC National Communication (UNFCCC, 2011a) and European Commission (2011); Business-as-usual emission projection with measures, from the EC report 'Progress towards achieving the Kyoto objectives' (European Commission, 2011).

be implemented as planned (European Commission, 2011), the EU could achieve its unconditional target for 2020 of reducing emissions by 20% below 1990. As recent data on 2009 emission levels would lead to a reduction in projected business-as-usual emissions, the mitigation gap for the high pledge could be reduced even further (the 2005 level was used as a starting point for the PBL business-as-usual emission projections).

Apart from implementing additional climate policies, the remaining gap for the conditional pledge could be narrowed by using international offsets, land-use credits or surplus AAUs (all of which do not influence domestic emissions). The EU has stated that it allows the use of a maximum of international offsets (JI and CDM) equal to the amount of 4% and 9% of its 1990 emission level, for the 20% and 30% reduction targets, respectively. Using land-use credits could narrow the gap by about 100 Mt CO<sub>2</sub> eq, which is the maximum estimate from land-use accounting rules for the 30% target. Finally, Kyoto surplus AAUs could provide a maximum of 780 Mt CO<sub>2</sub> eq, if all surplus AAUs would be fully carried-over and used. Under current internal EU legislation, LULUCF credits and Kyoto surplus AAUs can not be used for achieving the 20% target.

The EU's own business-as-usual emission projections are higher than both the PBL and WEO-2010 business-as-usual emission estimates (these last two showing only small

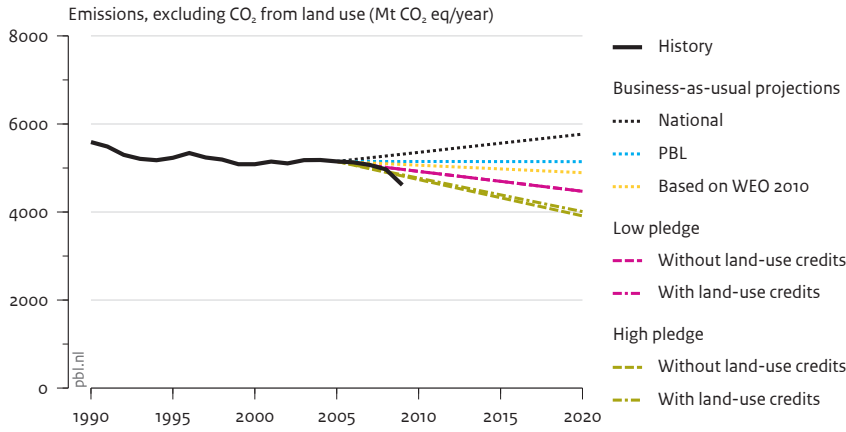
differences, see Figure 9.5). The 5<sup>th</sup> EC National Communication also explains that the impact of the financial crisis of 2009/2010 has not been considered in the projection of 20 of the 27 Member States. However, this effect has been included in the PBL and WEO projections. Moreover, because the WEO-2010 assumes climate policies to have been adopted by the individual governments by mid-2010, the projection for 2020 is lower than the PBL business-as-usual emission projection.

### 9.1.3 Japan

Japan has placed its current climate and energy policy under review following the earthquake, tsunami and nuclear incident of March 2011. Therefore, it is unclear if and how Japan would implement its pledge to reduce emissions by 25% below the 1990 level, by 2020, and how much offsets it will use. Part of its Action Plan for Achieving a Low-Carbon Society is also a long-term target, for 2050, which entails a reduction in greenhouse gas emissions of 50%. In the context of the Kyoto Protocol, has Japan emphasised that it will not participate in a second commitment period under the Kyoto Protocol.

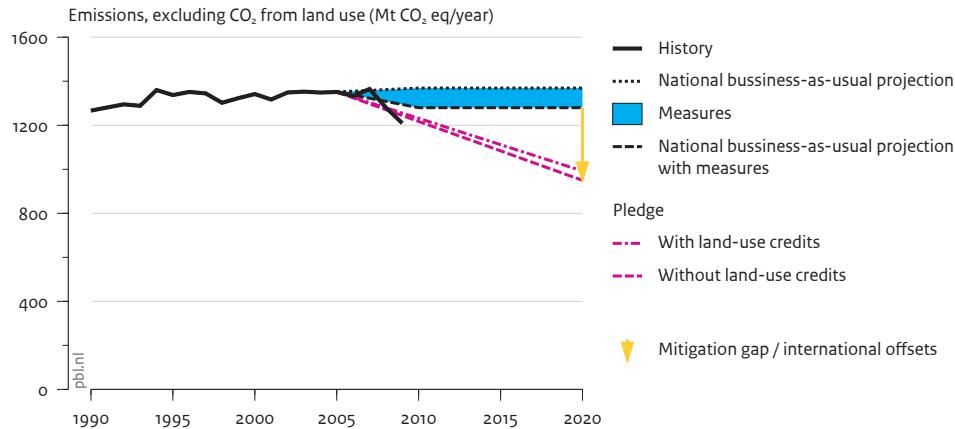
Japan has submitted a business-as-usual emission projection with measures that only run up to 2010. From 2010 onwards, we assumed emissions would stay constant up to 2020, conform the assumptions in the UNFCCC synthesis report (UNFCCC, 2011a). With this assumption, the

**Figure 9.5**  
**Comparison between business-as-usual greenhouse gas emissions and pledges, for the European Union**



Source: PBL; European Commission (2011); IEA (2010); UNFCCC (2011a)  
 Comparison of different business-as-usual emission projections with emission levels resulting from implementation of the pledges.

**Figure 9.6**  
**Mitigation gap in greenhouse gas emissions, for Japan**



Source: PBL; UNFCCC (2011a).  
 The mitigation gap for Japan is the difference between business-as-usual emission projections with measures and the emission levels resulting from the implementation of its pledge.

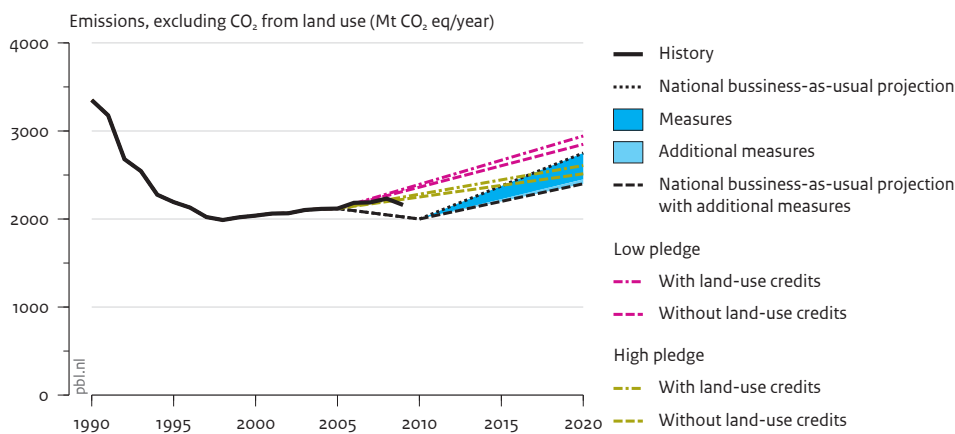
mitigation gap between emission levels following the implementation of measures and the pledge (without land-use credits) would be 290 Mt CO<sub>2</sub> eq (see Figure 9.6). Japan could narrow this gap (but not reduce emissions) by using about 40 Mt CO<sub>2</sub> eq in land-use credits, which is the maximum estimate under the land-use accounting rules. The mitigation gap for the PBL business-as-usual emission projections is very similar, as it is very close to Japan's own projections. The WEO-2010 projections for Japan are about

85 Mt CO<sub>2</sub> eq lower (not shown in figure), as these projections incorporate climate policies only up to 2010.

#### 9.1.4 Russia

Russia has pledged to reduce its greenhouse gas emissions by 15% to 25% against its 1990 level, by 2020, conditional on appropriate accounting of LULUCF and largest emitting countries taking on legally binding obligations. As can be seen in Figure 9.7, emissions decreased dramatically after

Figure 9.7  
**Mitigation gap in greenhouse gas emissions, for the Russian Federation**



Source: PBL; UNFCCC (2011a)  
*There is no mitigation gap for Russia*

1990, due to the economic downturn in the former Soviet Union. Therefore, the pledged reduction targets for 2020 are easily achievable and could even lead to new surplus AAUs by 2020 for the low pledge, on top of Russia’s Kyoto surplus AAUs. Russia has stated not to be on board for a second commitment period under the Kyoto Protocol. In this situation, it is unlikely that Russia will trade these surplus AAUs (see Chapter 8). For Russia, there is no mitigation gap between the business-as-usual emission projections with additional measures and its high pledge (see Figure 9.7). Indeed, the high target has already been achieved as a result of implemented climate policy measures, as described in the fifth national communication.

Figure 9.8 shows that both Russia’s own national and PBL business-as-usual emission projections are below the low pledge for 2020. Based on these PBL projections, by 2020, there would be almost no surplus AAUs for the high pledge (without land-use credits), but for the low pledge (without land-use credits) these AAUs could amount to 360 Mt CO<sub>2</sub> eq. Based on the national business-as-usual emission level, the surplus AAUs could be 100 Mt CO<sub>2</sub> eq for the low pledge (without land-use credits). Using the lower projections that are based on WEO-2010, the high pledge (without land-use credits) could result in higher surplus AAUs of about 490 Mt CO<sub>2</sub> eq. As Russia announced not to participate in a second commitment period<sup>7</sup>, it would not supply any surplus AAUs to other Annex I countries.

The business-as-usual emission projections that are based on WEO-2010 include climate policy and, probably therefore, are lower than the PBL projections.

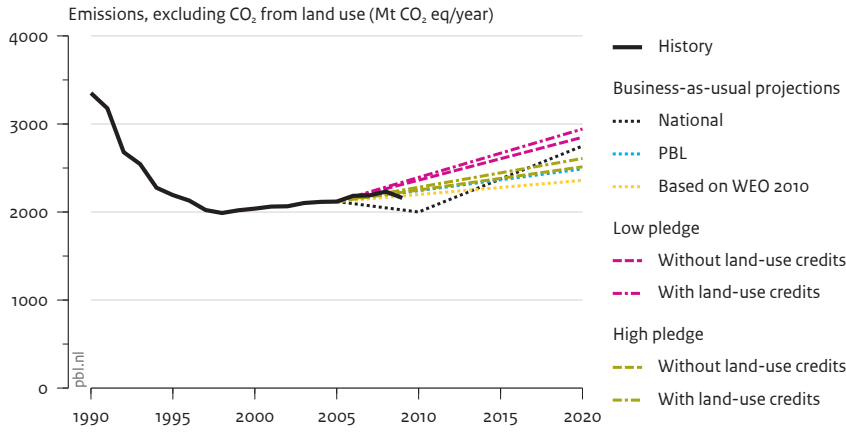
### 9.1.5 The United States

The United States has pledged a reduction target for 2020 of 17% of its 2005 levels, in conformity with anticipated energy and climate legislation, and on the understanding that the final target will be reported to the Secretariat following enacted legislation. The United States confirmed this target during the Bangkok UN workshop, and also confirmed that it is an economy-wide target. It has not integrated this target into law, but federal and state level mechanisms for reducing emissions do exist. The aggregate potential reduction from these mechanisms is estimated to be in the range of 6% to 14% below 2005 levels, with a middle estimate of 9% (Bianco and Litz, 2010). This would fall short of the pledged target of 17% for 2020.

Part of the reduction potential could be realised by including LULUCF credits, but the number of credits actually used is uncertain. It is unclear how the United States exactly intends to deal with this, although it mentioned in its Bangkok presentation that it will undertake a comprehensive land-based approach that takes advantage of the broadest array of mitigation actions.

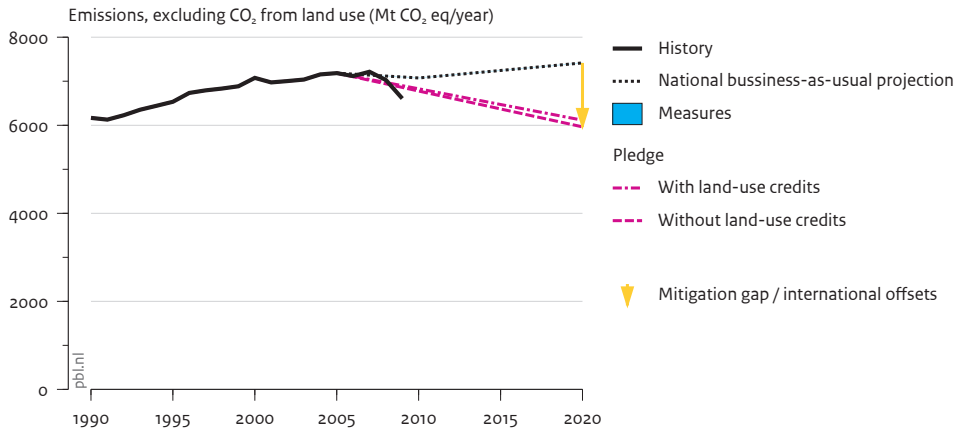
There is no current US federal law that covers emission trading or international offsets, but some states provide credits for emission reductions secured abroad.

**Figure 9.8**  
**Comparison between business-as-usual greenhouse gas emissions and pledges, for the Russian Federation**



Source: PBL; IEA (2010); UNFCCC (2011a)  
 Comparison of different business-as-usual emission projections with emission levels resulting from the implementation of the pledges.

**Figure 9.9**  
**Mitigation gap in greenhouse gas emissions, for the United States**



Source: PBL; UNFCCC (2011a)  
 For the United States, the mitigation gap is the difference between the business-as-usual emission projections with measures and the emission levels resulting from the implementation of the pledges.

The mitigation gap between business-as-usual emission levels with measures and the high pledge is 1.5 Gt CO<sub>2</sub> eq without land-use credits (Figure 9.9). The United States could narrow this gap by using 150 Mt CO<sub>2</sub> eq in land-use credits, which is the estimated maximum from land-use accounting rules included in this study. This gap is similar to those in other business-as-usual emission projections for the United States.

Table 9.2

### Pledged greenhouse gas reductions of Brazil compared to the national business-as-usual projections of 2010 and 2009

2020 (Mt CO <sub>2</sub> eq)	National projection in the National Decree No. 7390 (2010)			National projection by the Ministry of the Environment (2009)		
	Business as usual	Range of reduction	Percentage of reduction	Business as usual	Range of reduction	Percentage of reduction
<b>Nationally Appropriate Mitigation Actions (NAMAs)</b>						
<b>Land-use-related CO<sub>2</sub> emissions</b>	1,404	887	63%	1,084	669	62%
Agriculture/livestock	730			627	133-166	21-26%
Energy	868	234	27%	901	166-207	18-23%
Industry and Waste	234			92	8-10	9-11%
Other greenhouse gas emissions	1,832	281-372	15-20%	1,620	307-383	19-25%
<b>Total greenhouse gas emissions</b>	<b>3,236</b>	<b>1,168-1,259</b>	<b>36.1-38.9%</b>	<b>2,703</b>	<b>975-1,052</b>	<b>36.1-38.9%</b>

## 9.2 Pledges by non-Annex I countries

As explained briefly in Chapter 3, the mitigation action plans by non-Annex I countries are very diverse; some countries have included detailed domestic actions, others have provided overall intensity targets, some of which combined with additional measures, and often the submissions include additional clauses, such as dependence on international finance, technology, and capacity-building support by developed countries. Moreover, business-as-usual emission levels on which reduction targets are based are not always officially reported by governments. A detailed description of the reductions for major non-Annex I economies is given below.

### 9.2.1 Brazil

Brazil is projected to be responsible for about 5% of global emissions by 2020. A large share of emissions (about 45%) comes from the forestry sector. As part of the Copenhagen Accord, but subsequent to the actual negotiations, Brazil submitted the mitigation action plan (pledge) to the UNFCCC, containing voluntary domestic actions to reduce its greenhouse gas emissions by 36% to 39% against the national business-as-usual emission level. Brazil did not specify a business-as-usual projection along with this pledge, but its ministry of the environment<sup>8</sup> already had published such a projection in 2009, in which it also presented measures that would lead to emission reductions of between 36% and 39%. During the Bangkok workshop in April 2011, however, Brazil clarified that its reduction targets were to be compared against business-as-usual levels as published in Brazil's National Decree No. 7390 of December 2010 (Presidency of the Republic of Brazil, 2010). These business-as-usual emission levels are higher than those previously reported. These changes can be explained by:

- additional emission sources that were added to the historical and future emissions from industrial processes;
- planned policies that had explicitly been excluded;
- increases in deforestation emissions, caused by the addition of more areas (Mata Atlântica, Caatinga e Pantanal), and because the application of other assumptions and/or methodology;
- a higher estimated growth of the energy sector than was assumed in previous projections.

In the updated business-as-usual projection, land use-related CO<sub>2</sub> emissions are projected to be about 20% higher by 2020 (Figure 9.10) than in the earlier projections. Since emission reductions are stated against business-as-usual levels, this new business-as-usual projection implies both a higher pledged emission level and higher absolute reductions (Table 9.2). Contributions by the REDD programme, therefore, increased from 670 Mt CO<sub>2</sub> to about 890 Mt CO<sub>2</sub> (Table 9.2). Despite the increased reductions because of REDD, the target for total land-use CO<sub>2</sub> emissions for 2020 has increased by 100 Mt CO<sub>2</sub> compared to the earlier announced 515 Mt CO<sub>2</sub>.

#### Emission reductions from land use

The forestry sector is a large emission source for Brazil, representing about 45% of total emissions projected for 2020. Most of these emissions come from the largest two forestry areas, the Amazon Rainforest and the Cerrado. The national business-as-usual projection for CO<sub>2</sub> emissions from land use is higher than the PBL/IIASA projections (see Text box 6 and Figure 9.10). According to the national projections, this would result in a reduction target for CO<sub>2</sub> emissions from land use of 890 Mt CO<sub>2</sub> eq, and of 560 Mt CO<sub>2</sub> eq for the PBL/IIASA projections (Figure 9.10; right-hand graph).



**Text box 6 Comparison between REDD and ARD estimates from national projections and IIASA G4M model projections for Brazil**

Brazil provided estimates of gross emissions from deforestation and from other sources within Brazil. These can be compared to estimates from IIASA's global forestry model G4M (Kindermann et al., 2006; 2008) (see table below). While the estimates of gross emissions from deforestation in 2005 were similar for both sources, differences exist in the assumed gross area loss. Brazil's national projection is about 16% higher than the IIASA's forestry G4M model projection (see Appendix A.2) (as part of the PBL/IIASA business-as-usual projections), which has been derived from FAO data. This implies that for the national estimate, on average, a lower emission factor per hectare was applied.

The difference in gross emissions from deforestation between the two sources is much higher for 2020. The national estimate projects deforestation rates to be about 5% higher by 2020, compared to 2005. The IIASA's forestry model suggests a 30% annual decline in forest area due to deforestation by 2020. The national estimate of gross emissions from deforestation, thus, is 35% higher than that of IIASA, even though emission per hectare, by 2020, will be much higher according to IIASA. The higher emissions per hectare would be more than compensated by the much larger deforested area according to the national estimates (about 80% larger than the estimate by IIASA).

As Brazil's nationally appropriate mitigation actions (NAMAs) do not provide numbers for afforestation and re-growth of forests, net deforestation data equal gross deforestation data. The IIASA estimates show that including afforestation and re-growth could lead to a much smaller deforested area, although the effect on emissions would be small.

Year	Activity	National estimates			IIASA estimates		
		Area [Tha]	Emissions [Mt CO <sub>2</sub> ]	Emissions per ha [tCO <sub>2</sub> /ha]	Area [Tha]	Emissions [Mt CO <sub>2</sub> ]	Emissions per ha [tCO <sub>2</sub> /ha]
2005	Gross deforestation	-3,355	1,337	399	-2,903	1,267	437
	Afforestation, revegetation				173	-2	
	Existing forest				389,495	-501	
	<b>Net deforestation</b>	<b>-3,355</b>	<b>1,337</b>		<b>-2,730</b>	<b>764</b>	
2020	Gross deforestation	-3,523	1,404	399	-1,983	1,073	541
	Afforestation, revegetation				1,466	-24	-16
	Existing forest				353,605	-185	
	<b>Net deforestation</b>	<b>-3,523</b>	<b>1,404</b>		<b>-517</b>	<b>863</b>	

NB: negative values describe the loss of forest area (gross deforestation), positive values depict gains (afforestation), 'net deforestation' represents the sum of the two; signs of emission data follow the rational that positive values describe emissions from biosphere to atmosphere, negative values represent emission removals from atmosphere to biosphere.

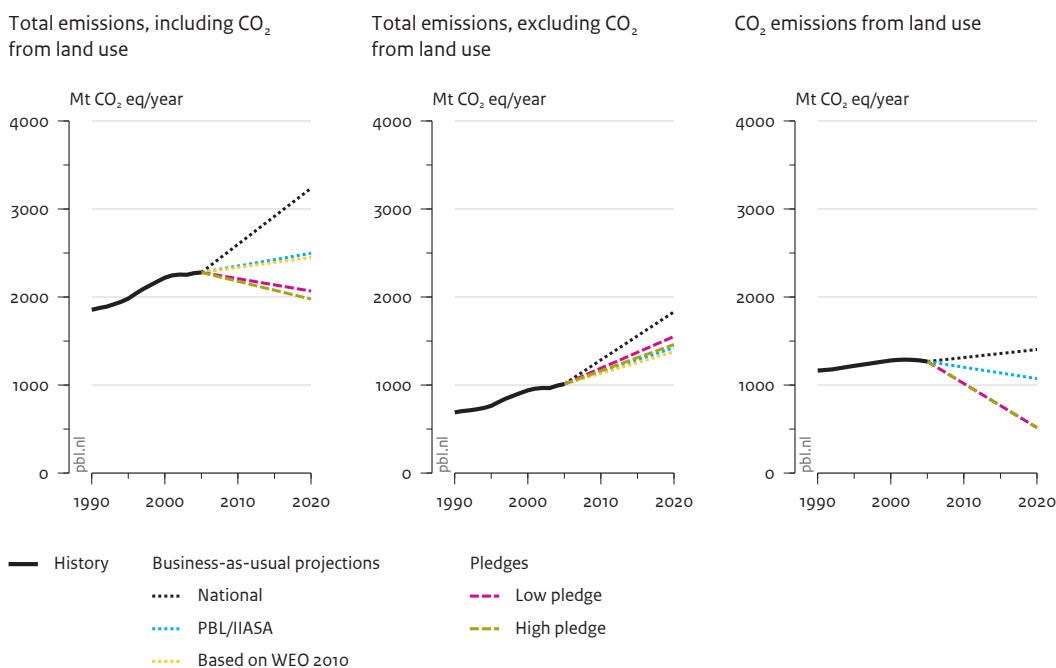
**Emission reductions related to energy, agriculture, industry and waste**

The updated business-as-usual emission projections for all greenhouse gases, excluding CO<sub>2</sub> from land use, also show an increase. In its published decree, Brazil specified the business-as-usual projections for agriculture, industry and waste (Table 9.2), as well as its emission reduction target for the energy sector (27% below business-as-usual projections). The most important policies for achieving this

target are those on agriculture, biofuels and the use of alternative energy sources. However, the resulting emission levels for all greenhouse gases (excluding CO<sub>2</sub> from land use) exceed those in both the PBL/IIASA and WEO-2010 business-as-usual projections (which are very similar, see Figure 9.10, middle graph). Moreover, the pledged reduction in emissions from energy, industry, agriculture and waste are expected also to result in a small amount of surplus emission allowances.

Figure 9.10

Comparison between business-as-usual greenhouse gas emissions and pledges, for Brazil



Source: PBL; IEA (2010); Presidency of the Republic of Brazil (2010)

Comparison of different business-as-usual emission projections with emission levels resulting from the implementation of the pledges.

**Total emission reductions according to Brazil’s pledge**

The total pledge for all greenhouse gas emissions (including emissions from deforestation) lead to reductions of 17% to 21% according to the PBL/IIASA business-as-usual emission projections, and to similar reductions according to projections by the WEO. These reductions are substantially lower than those pledged from national business-as-usual projections by Brazil (see Figure 9.10, left-hand graph). Figure 9.10 also shows that all reductions are due to reduced emissions from deforestation, as the contribution of the REDD programme (about 557 Mt CO<sub>2</sub>) are expected to exceed the required total reduction in all greenhouse gases (430 and 521 Mt CO<sub>2</sub> eq for the low and high pledge scenario).

**9.2.2 China**

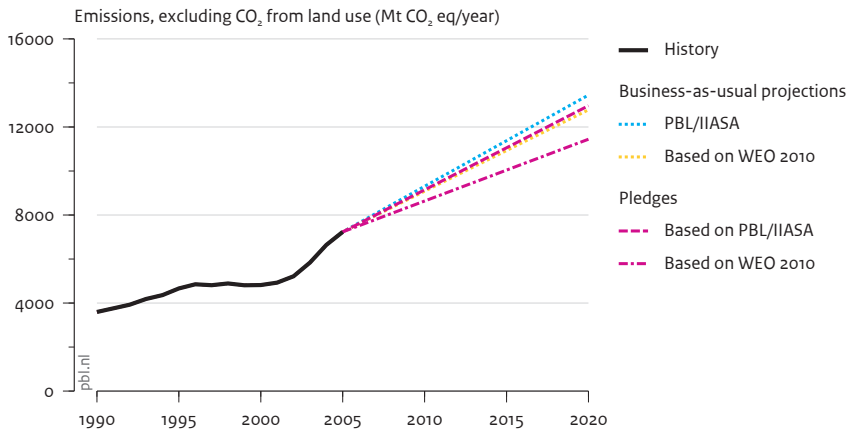
China, since 2010, has been the largest emitter of greenhouse gas emissions and is projected to continue in this position come 2020. China is responsible for almost 27% of global business-as-usual emissions. Although it could be regarded as a developing country in some ways, it could play a crucial role in addressing climate change, as it has become one of the world’s major economic powers. China has experienced high economic growth and emissions are expected to grow accordingly. However,

China also invests in the development of clean energy sources and infrastructure. Minister Xie Zhenhua recently stated that China plans to invest 2 trillion yuan – about USD 313 billion – in low-carbon development projects, under its five-year plan up to 2015. China’s pledge consists of three targets:

- lowering carbon dioxide emissions per unit of GDP by 40% to 45% by 2020, compared to the 2005 level (CO<sub>2</sub> intensity target);
- increasing the share of non-fossil fuels in primary energy consumption to around 15% by 2020 (non-fossil target);
- increasing the forested area by 40 million hectares and forest stock volumes by 1.3 billion cubic meters by 2020, from 2005 levels (forestry target).

As China has not provided a national business-as-usual projection, we based the reductions resulting from the above targets on the PBL/IIASA and WEO-2010 business-as-usual projections (see Figure 9.11). Under the PBL/IIASA business-as-usual scenario, China’s economy is assumed to continue to grow strongly by an average annual 8.8% in the period from 2005 to 2020.

Figure 9.11  
**Comparison between business-as-usual greenhouse gas emissions and pledges, for China**



Source: PBL; IEA (2010)  
 Comparison of different business-as-usual emission projections with emission levels resulting from the implementation of the pledges.

**Reduction in emissions from the energy sector**

It is difficult to assess how the CO<sub>2</sub> emission intensity target would affect the 2020 emission level, because this depends on future GDP growth (which is uncertain): higher economic growth would make it easier to achieve the intensity target (assuming that business-as-usual emissions remain constant). The GDP growth projection was adjusted upwards over the last few years. This was due, for instance, to the fact that the 11th five-year plan (2006–2010) aimed for an annual GDP growth of 7.5%, while the actual growth was 10.6%. The 12th five year plan (2011–2015) aims at an annual GDP growth of 7%. Another complicating factor in the assessment was that China uses GDP data defined in domestic currency (the yuan) to calculate CO<sub>2</sub> intensity, whereas in our model, only USD are used to compare GDP levels between countries. In our calculations, we kept future exchange rates between the yuan and USD at a constant level, so that economic growth rates measured in local currency and USD are the same.

The non-fossil energy target overlaps with the intensity target. Their combined effect is calculated as the maximum reduction of both targets. This is a conservative estimate, because achieving the intensity target could also lead to additional energy efficiency improvements, compared to business-as-usual developments. According to TIMER model calculations, the non-fossil energy target would lead to an emission reduction of 0.5 Gt CO<sub>2</sub> eq (about 3.5% of business-as-usual emissions), which is slightly lower than the projected reduction of 0.6 Gt CO<sub>2</sub> eq from the 45% intensity target (about 4% of business-as-usual emissions). However, the non-fossil target is expected to lead to higher

reductions than the 40% intensity target. Therefore, China’s low pledge leads to a reduction of 0.5 Gt CO<sub>2</sub> eq and the high pledge to one of 0.6 Gt CO<sub>2</sub> eq.

For the WEO-2010 business-as-usual projections, the calculated emission reductions from the 40% to 45% intensity target are higher: between 4% and 10% of business-as-usual emissions for all greenhouse gases by 2020. This difference can be explained by lower GDP projections, with an average annual GDP growth rate of about 8% for the 2005–2020 period. This finding is consistent with the 10% difference in energy-related CO<sub>2</sub> emissions between the Current Policies Scenario (the Reference Scenario) and the 450 ppm scenario of the WEO-2010 (IEA, 2010), whereby the latter assumes a 45% reduction in CO<sub>2</sub> intensity and a 15% share of non-fossil energy in primary energy consumption for 2020.

**Reduction in emissions from land use**

For the evaluation of the pledged forest coverage and volume targets, IIASA’s forestry model business-as-usual estimates were used. This showed that these targets would not lead to reductions from IIASA business-as-usual levels – although the European Climate Foundation (2010) has projected that a reduction of 150 Mt CO<sub>2</sub> eq could be achieved (also see Text box 7). However, as China has not provided a baseline emission projection for its forests, any additional land-use credits were difficult to estimate. Carbon accumulation from existing forests could be as high as 633 Mt CO<sub>2</sub> eq, but this would not be the result of specific mitigation efforts (Text box 7).

### Text box 7 Comparison between ARD estimates from national projections and IIASA model projections for China

China plans to increase its forest coverage by 40 Mha between 2005 and 2020, which would be about 2.5 Mha per year. This is similar to the average of the historical rate of net forest area change as reported in FAO FRA 2010 (FAO, 2010) and also similar to the projected rate of afforestation estimated by IIASA's G4M forestry model (see table below).

This implies that, rather limited additional afforestation beyond the business-as-usual situation is to be expected on top of the forest coverage target. The potential for greenhouse gas removals from afforestation, is in any case, is very small by 2020. This is due to moderate growth rates in afforestation and resulting emission removals from the temperate zone, in the short term (from 2011 to 2020).

The second Chinese forestry target relates to the management of carbon stocks in existing forests. China has pledged to increase forest stock volumes by 1.3 billion cubic metres by 2020. Assuming default values for wood density and carbon content, this would result in annual removals of about 68 Mt CO<sub>2</sub> eq by 2020. G4M business-as-usual estimates project a far higher increase in carbon storage in China's existing forests for 2020 (see table below), resulting from forest regeneration. Despite uncertainties in both estimates that need to be considered (e.g. disturbances), comparison between national and IIASA projections shows that the additionality of the forest management plan needs to be assessed carefully, similar to the afforestation pledge. The planned increase in growing stock in existing forests will very likely occur (to an even larger degree) without additional measures. This would have to occur on top of a relatively high baseline, in order to lead to additional emission reductions

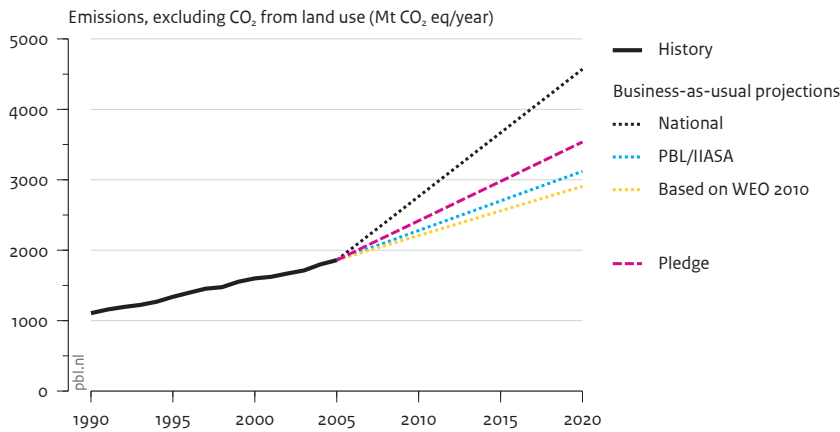
Year	Activity	National estimates			IIASA estimates		
		Area [Tha]	Emissions [Mt CO <sub>2</sub> ]	Emissions per ha [tCO <sub>2</sub> /ha]	Area [Tha]	Emissions [Mt CO <sub>2</sub> ]	Emissions per ha [tCO <sub>2</sub> /ha]
2005	Gross deforestation				-137	26	186
	Afforestation, revegetation				3,196	-52	
	Existing forest				148,228	-448	
	<b>Net deforestation</b>				<b>3,058</b>	<b>-474</b>	
2020	Gross deforestation				-20	7	330
	Afforestation, revegetation	2,667			2,599	-214	-82
	Existing forest	147,311	-68	-0.5	147,311	-425	-3
	<b>Net deforestation</b>	<b>2,667</b>			<b>25,78</b>	<b>-633</b>	

NB: negative values describe the loss of forest area (gross deforestation), positive values depict gains (afforestation), 'net deforestation' represents the sum of the two; signs of emission data follow the rational that positive values describe emissions from biosphere to atmosphere, negative values represent emission removals from atmosphere to biosphere.

### Pledged total emission reductions

As land-use targets are not expected to lead to additional reductions, China's pledged total emission reduction equals a reduction by about 4% below PBL/IIASA business-as-usual projections. This would result in a greenhouse gas emission level of 12.9 Gt CO<sub>2</sub> eq by 2020. Using the WEO-2010 projections, the emission level by 2020 would amount to between 11.4 and 12.3 Gt CO<sub>2</sub> eq. The reason for the higher WEO-2010 estimated reductions is a lower projected GDP growth.

Figure 9.12  
**Comparison between business-as-usual greenhouse gas emissions and pledges, for India**



Source: PBL; IEA (2010); Planning Commission, Government of India (2011)  
 Comparison of different business-as-usual emission projections with emission levels resulting from the implementation of the pledges.

**9.2.3 India**

India has an upcoming economy and is expected to contribute about 6% to global emissions by 2020. India’s pledge consists of reducing its emission intensity by 20% to 25% from 2005 levels, by 2020. In addition to this target, India has a forestry target which is part of its national plan. A projection of the related additional emission reductions is elaborated in Chapter 6.

The emission reductions expected to result from the intensity target depend on projected GDP growth and business-as-usual emissions (similar to those of China). The Planning Commission of the Government of India (2011) has published two business-as-usual scenarios; one with 8% and one with 9% annual GDP growth. The PBL/IIASA projections of India’s GDP growth are in between these two percentages. The Indian Government has provided estimates of emission reductions based on a 20% to 25% reduction in emission intensity from 2005 levels, by 2020, for both business-as-usual scenarios. We used the scenario of 8% annual GDP growth to estimate emission levels resulting from the 20% to 25% intensity targets and business-as-usual levels (Figure 9.12).

According to the PBL/IIASA business-as-usual scenario, emission intensity by 2020 will improve by almost 35% below 2005 levels, resulting in an emission level of 3.1 Gt CO<sub>2</sub> eq by 2020, compared to 4.6 Gt CO<sub>2</sub> eq according to India’s national business-as-usual scenario (see Figure 9.12). The difference between the two could, for instance, be caused by differences in assumptions on autonomous energy efficiency improvement or on renewable energy

use. The Indian projected emission level resulting from the pledges is about 13% above the PBL/IIASA business-as-usual emission level and 22% above the level of WEO-2010. As to date, there are no strict rules on the additionality of offsets for non-Annex I countries, surplus allowances may arise if emission levels resulting from India’s pledge rise above PBL/IIASA’s projection of the business-as-usual level. We assumed that, in this situation, these surplus allowances could be sold as offsets (certified reductions).

### Text box 8 Comparison of ARD estimates from national projections and IIASA model projections for India

In its domestic climate plan, India has presented its intention to afforest 6 Mha of degraded forest land up to 2020. Assuming a constant afforestation rate, this would result in 0.6 Mha of annual afforestation. The afforestation rate was about 0.4 Mha in 2005, according to the IIASA G4M model, with a slightly decreasing trend for 2020 (see table below). The G4M baseline projects that 22% of 6 Mha would be in additional afforestation.

National data assign a removal of 19.1 Mt CO<sub>2</sub> to the afforestation area, which will be accumulated up to 2020. Similar annual emission removals were also estimated by IIASA's G4M forestry model (see table below). However, accumulated removals (not shown) would be much lower, as the G4M model assumes slowly increasing carbon fixation by new planted trees. It is not very likely that high growth rates could be achieved on degraded land.

Concluding, additional emission removals, under the IIASA baseline scenario, could amount to between 22% (based on area) and 0% (based on emission levels) of the national estimate (600 Mt CO<sub>2</sub>). However, given these large uncertainties, this has not been quantified here.

Year	Activity	National estimates			IIASA estimates		
		Area [Tha]	Emissions [Mt CO <sub>2</sub> ]	Emissions per ha [tCO <sub>2</sub> /ha]	Area [Tha]	Emissions [Mt CO <sub>2</sub> ]	Emissions per ha [tCO <sub>2</sub> /ha]
2005	Gross deforestation				-85	18	212.6
	Afforestation, revegetation				401	-6	
	Existing forest				55,288	-45	
	<b>Net deforestation</b>	<b>0</b>	<b>0</b>		<b>316</b>	<b>-33</b>	
2020	Gross deforestation				-91	19	213.3
	Afforestation, revegetation	600	-19.1	-31.8	463	-25	-53.6
	Existing forest				54,118	-41	-0.8
	<b>Net deforestation</b>	<b>600</b>	<b>-19.1</b>		<b>372</b>	<b>-46</b>	

#### 9.2.4 Indonesia

Indonesia is a middle-income developing country with an expected emission level for 2020 that is about 3% of the global emission level. Just like Brazil, Indonesia has a large potential to reduce its greenhouse gas emissions by decreasing the rate of deforestation. In addition, it could also limit emissions from peatlands by improving peatland management. Around 50% of emissions in 2005 were from peatlands and due to deforestation. Indonesia submitted an unconditional pledge to reduce emissions by 26%, from its business-as-usual emission projections. Indonesia also entered a high, conditional pledge of 41%, announced prior to the conference in Copenhagen and also presented at the Bangkok conference (April 2011). This pledge is conditional on international support. Indonesia has also published two national studies that contain projections of national

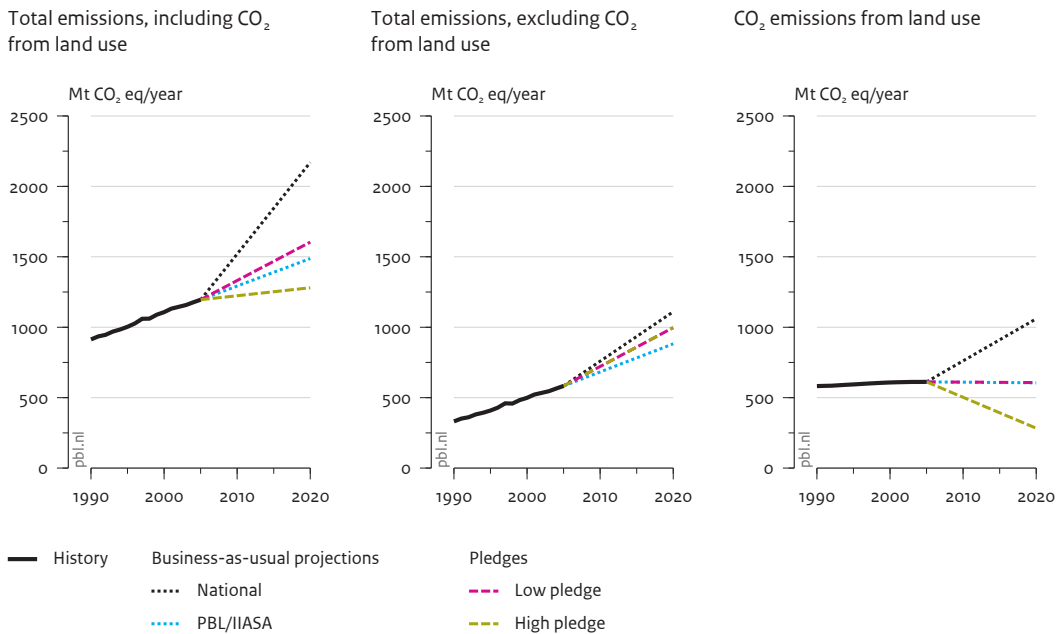
business-as-usual emission levels (DNPI, 2009; Ministry of Finance, 2009). From these two studies, we used that by the Ministry of Finance for our evaluation. The DNPI study, which has higher business-as-usual emission projections, is described in Chapter 5 about risks that could widen the emission gap.

#### Reduction in emissions from energy, industry, transportation, agriculture and waste

Indonesia has pledged to increase its energy efficiency and use of renewable energy, and to reduce waste and to shift towards low-emission modes of transportation. Indonesia's own business-as-usual projection for emissions, excluding CO<sub>2</sub> from land use, is higher than that of PBL/IIASA. We assumed that, for the low pledge, 80% of reductions will be achieved by land-use mitigation actions,

Figure 9.13

**Comparison between business-as-usual greenhouse gas emissions and pledges, for Indonesia**



Source: PBL; Ministry of Finance, Indonesia (2009)

Comparison of different business-as-usual emission projections with emission levels resulting from the implementation of the pledges.

based on the study by DNPI (2009). Additional reductions related to the high pledge are expected to be fully achieved in the land-use sector. Therefore, there is only one target for non-land-use related CO<sub>2</sub>. The emission level resulting from this target is 115 Mt CO<sub>2</sub> eq higher than the PBL/IIASA business-as-usual projection, which means that this target would result in surplus allowances.

**Reduction in emissions from land use**

Indonesian land-use emissions are the result of deforestation, peat lands and land-use emissions. The PBL/IIASA business-as-usual projections of net deforestation emissions contain emissions from deforestation as well as certain emission sinks. Only the estimates for peatland emissions were taken from the Indonesian national estimates, as these were not included in the IIASA G4M model (see Text box 9). Contrary to the result from measures related to energy and industry, the high pledge LULUCF target does result in reductions compared to the IIASA business-as-usual projection (see Figure 9.13). The low pledge is very close to the PBL/IIASA business-as-usual projections, so no reductions are expected for this pledge. These results are similar to those in the WEO-2010 business-as-usual projection. It should be emphasised that emissions from deforestation and peatlands are very

uncertain, as can be seen from the difference between results from the two national studies in Text box 9.

**Emission reductions according to the total pledge**

Both national business-as-usual projections – including and excluding CO<sub>2</sub> from land use – are higher than those of PBL/IIASA (see Figure 9.13). The combined emission reductions from land use and other sectors, for the low pledge, result in an emissions may increase by 8%, compared to PBL/IIASA business-as-usual emission projections, while its high pledge would result in an emission reduction of 14%. These figures are much lower than Indonesia’s pledged percentages of 26% to 41% below the business-as-usual level.

### Text box 9 Comparison between REDD and ARD estimates from national projections and IIASA G4M model projections for Indonesia

Indonesia has published two national studies containing land-use emission estimates (DNPI, 2009; Ministry of Finance, 2009). For our evaluation, we used the emission data from its Ministry of Finance Green Paper, according to which LULUCF CO<sub>2</sub> emissions are projected to amount to 615 Mt CO<sub>2</sub> by 2020. It is unclear which LULUCF categories were included in this estimate. As these emissions are much higher than the deforestation emissions projected by IIASA, we assumed that the 615 Mt consists of deforestation emissions only, without emission removals by re-growth (see table below). The national estimate, however, may include other emissions than those from deforestation (e.g. from degradation and fire), emissions that were not estimated by IIASA. This lack of information made the figures difficult to compare. What could be compared (with caution) was the relative trend from 2005 to 2020, for both estimates. While the national estimate expects an increase in emissions of 12% for the period between 2005 and 2020, IIASA projections assume emissions to decrease by 27% during the same period.

Year	Activity	National estimates			IIASA estimates		
		Area [Tha]	Emissions [Mt CO <sub>2</sub> ]	Emissions per ha [tCO <sub>2</sub> /ha]	Area [Tha]	Emissions [Mt CO <sub>2</sub> ]	Emissions per ha [tCO <sub>2</sub> /ha]
2005	Gross deforestation				-503	167	332
	Degradation, fire						
	Afforestation, revegetation				0	0	
	Existing forest				8,3640	-440	
	<b>Net deforestation</b>		<b>550</b>		<b>-503</b>	<b>-273</b>	
2020	Gross deforestation				-407	160	394
	Degradation, fire						
	Afforestation, revegetation				0	0	
	Existing forest				76,846	-358	-5
	<b>Net deforestation</b>		<b>615</b>		<b>-407</b>	<b>-198</b>	

NB: negative values describe the loss of forest area (gross deforestation), positive values depict gains (afforestation), 'net deforestation' represents the sum of the two; signs of emission data follow the rationale that positive values describe emissions from biosphere to atmosphere, negative values emission removals from atmosphere to biosphere.

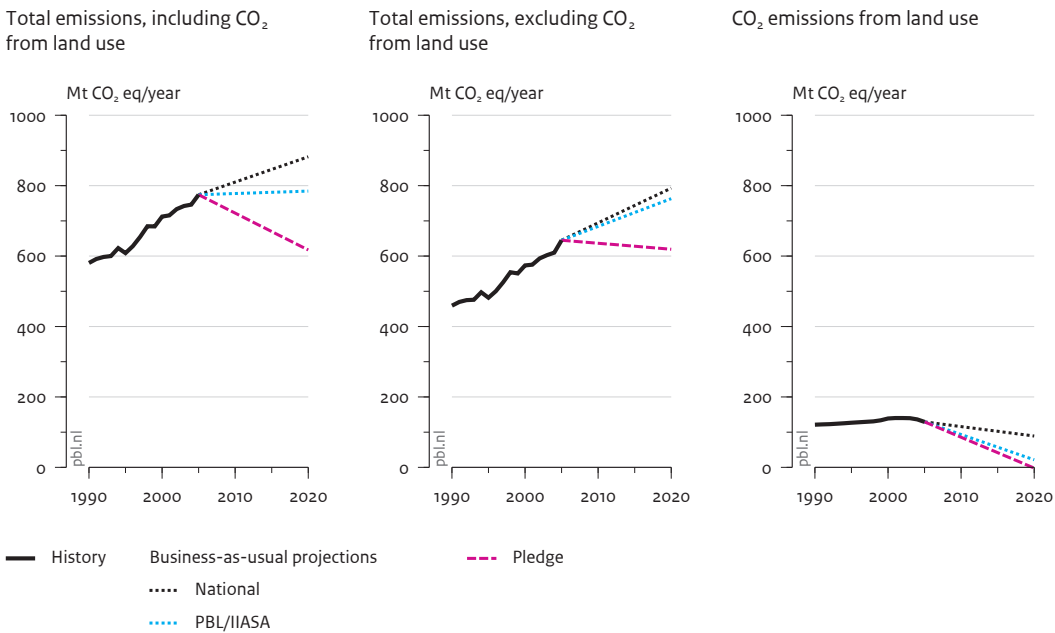
The DNPI report provides rather detailed national data on current and future emissions from forests and peatlands. A comparison between these national estimates and estimates by the G4M model shows that the emission factor used by IIASA was much lower (see table below). A possible explanation could be that the G4M model spreads emissions from, for instance, soil carbon decomposition and wood products over several years. The emission factor based on FAO data on average forest carbon stock lies between the IIASA and national estimates (not shown). However, FAO data only accounts for forest biomass. The deforestation rate assumed by IIASA, for 2005, is about 0.5 Mha, which corresponds to FAO average data (annually 0.3 Mha between 2000 and 2005 and 0.6 in between 2005 and 2010), while the national estimates assume the higher deforestation rate of 1.1 Mha for 2005. Higher emission factors and higher gross deforestation rates both lead to higher emissions from deforestation. Therefore, the national estimates result in emissions from deforestation that are more than four times those according to the estimates by IIASA.

Large differences exist for afforestation, as well. The G4M model assumes that there is no potential for emission removals through afforestation, whereas national estimates are rather optimistic. An explanation for this difference might be due to definitions applied; national estimates of emissions from forest degradation and fires more or less cancel out emission removals through afforestation and revegetation. According to IIASA's estimates, the emissions from forest degradation and emission removals from afforestation and revegetation are zero.



Year	Activity	National estimates			IIASA estimates		
		Area [Tha]	Emissions [Mt CO <sub>2</sub> ]	Emissions per ha [tCO <sub>2</sub> /ha]	Area [Tha]	Emissions [Mt CO <sub>2</sub> ]	Emissions per ha [tCO <sub>2</sub> /ha]
2005	Gross deforestation	-1,100	763	694	-503	167	332
	Degradation, fire		321				
	Afforestation, revegetation	400	-246	-62	0	0	
	Existing forest				83,640	-440	
	<b>Net deforestation</b>	<b>-700</b>	<b>838</b>		<b>-503</b>	<b>-273</b>	
2020	Gross deforestation	-1,100	763	694	-407	160	394
	Degradation, fire		321				
	Afforestation, revegetation		-356		0	0	
	Existing forest				76,846	-358	-5
	<b>Net deforestation</b>	<b>-1,100</b>	<b>728</b>		<b>-407</b>	<b>-198</b>	

Figure 9.14  
**Comparison between business-as-usual greenhouse gas emissions and pledges, for Mexico**



Source: PBL; SEMARNAT (2009)

Comparison of different business-as-usual emission projections with emission levels resulting from the implementation of the pledges.

### 9.2.5 Mexico

Mexico was one of the first developing countries to ratify the Kyoto Protocol. Emissions from Mexico are expected to account for about 1.5% of global emissions by 2020. Mexico has a climate policy for the 2009–2012 period and, as part of the Cancún Agreements, it has pledged to decrease greenhouse gas emissions by 30% against its business-as-

usual emission projections. The mitigation actions are conditional on adequate financial and technological support provided by developed countries, as part of a global agreement. In its national plan, Mexico has presented a business-as-usual projection that is close to that of PBL/IIASA (see Figure 9.14).

### Text box 10 Comparison between REDD and ARD estimates from national projections and IIASA G4M model projections for Mexico

According to Mexico's nationally appropriate mitigation actions (NAMAs), emissions from the forestry sector will show a net zero emission balance by 2020. IIASA's G4M model suggests a decline in business-as-usual emissions from the forestry sector. This would result in a 75% lower emission level by 2020, compared to 2005 levels (see table below). In absolute numbers, the Mexican pledge would translate into a reduction of 89 Mt CO<sub>2</sub> using national data and 21 Mt CO<sub>2</sub> using IIASA data. This difference is due i) to business-as-usual emissions being constant according to the national estimates, while these are decreasing according to IIASA, and ii) to a 45% higher estimate by IIASA of emissions from deforestation, compared to national data. As is true for comparisons for all countries, figures can only be compared if they include the same activities. However, for Mexico it is unknown which activities are included in its national estimate. More national information about changes in forest areas and emissions in the situation of 2005 and the projection for 2020 would be needed for a more accurate comparison.

Year	Activity	National estimates			IIASA estimates		
		Area [Tha]	Emissions [Mt CO <sub>2</sub> ]	Emissions per ha [tCO <sub>2</sub> /ha]	Area [Tha]	Emissions [Mt CO <sub>2</sub> ]	Emissions per ha [tCO <sub>2</sub> /ha]
2005	Gross deforestation		89		-417	129	310
	Afforestation, revegetation				219	-5	
	Existing forest				52,803	-63	
	<b>Net deforestation</b>	<b>0</b>	<b>89</b>		<b>-197</b>	<b>61</b>	
2020	Gross deforestation		89 <sup>a</sup>		-171	66	380
	Afforestation, revegetation				191	-20	-104
	Existing forest				48,821	-25	-1
	<b>Net deforestation</b>	<b>0</b>	<b>89</b>		<b>20</b>	<b>21</b>	

NB: negative values describe the loss of forest area (gross deforestation), positive values depict gains (afforestation), 'net deforestation' represents the sum of the two; signs of emission data follow the rational that positive values describe emissions from biosphere to atmosphere, negative values emission removals from atmosphere to biosphere.

<sup>a</sup> The 2006 emission level for deforestation is assumed to remain constant.

#### Emission reductions, excluding CO<sub>2</sub> from land use

Mexico has not explicitly indicated how it plans to reduce its emissions – excluding CO<sub>2</sub> from land use. Because the reduction target for forestry is known, the remaining reductions of 144 Mt CO<sub>2</sub> eq must come from the other sectors (see Figure 9.14). This represents a reduction of 19%, based on PBL/IIASA's non-land-use business-as-usual emission projections.

#### Reduction in emissions from land use

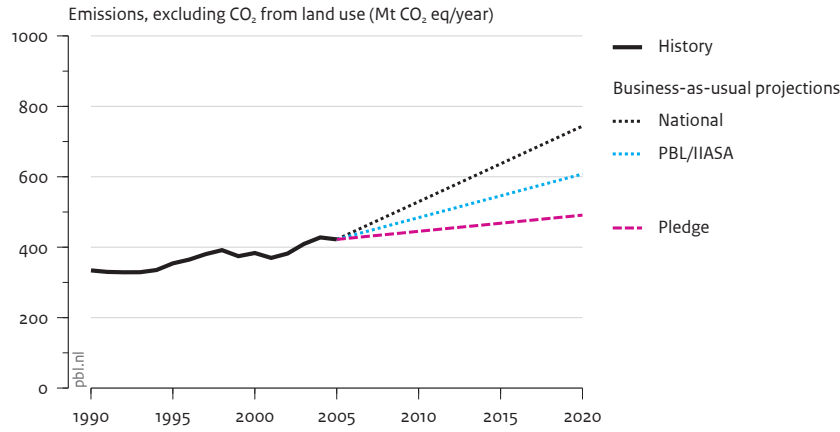
In its national communication, Mexico indicated that the potential reduction in emissions from the forestry sector through reforestation and forest management would offset deforestation. Net emissions from forestry in 2006 amounted to 89 Mt CO<sub>2</sub> eq, which we assumed to remain

constant up to 2020. Because Mexico expects to have a zero emission balance by 2020, the reduction in these emissions would also be 89 Mt CO<sub>2</sub> eq. The IIASA business-as-usual projections indicate a 21 Mt CO<sub>2</sub> eq emission level from deforestation and afforestation/reforestation (see Text box 10).

#### Total emission reductions from pledge

The PBL/IIASA projections show somewhat lower emission reductions than those pledged by Mexico itself (see Figure 9.14). The pledge is 30% against the national business-as-usual projections and 21% against PBL/IIASA projections.

Figure 9.15  
**Comparison between business-as-usual greenhouse gas emissions and pledges, for South Africa**



Source: PBL; Scenario Building Team (2007)

Comparison of different business-as-usual emission projections with emission levels resulting from the implementation of the pledges.

### 9.2.6 South Africa

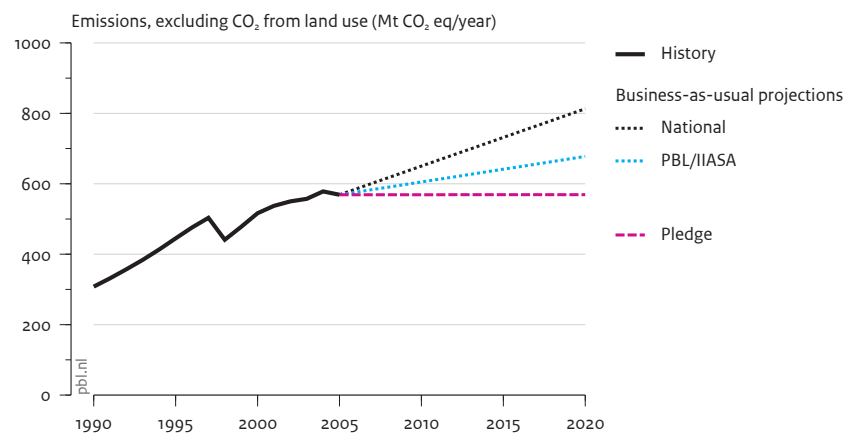
South Africa is expected to contribute about 3.5% to global emissions by 2020. President Zuma announced a 34% reduction target against business-as-usual emission levels for 2020, together with a 42% reduction target for 2025. This pledge has also been submitted to the UNFCCC. The extent to which related mitigation actions will be implemented depends on support being provided by developed countries, regarding financial resources, the transfer of technology, and capacity building. The business-as-usual emission projection related to the pledges was based on a national study (Scenario Building Team, 2007; Winker et al., 2011).

#### Emission reductions from the total pledge

As land-use-related emissions in South Africa are very low, we did not evaluate contributions from REDD. The national business-as-usual emission projection for South Africa is higher than that according to the PBL/IIASA projection (see Figure 9.15). Therefore, emission reductions that are based on PBL/IIASA business-as-usual projections are lower (19%) than those based on South Africa’s own projections (34%).

Figure 9.16

### Comparison between business-as-usual greenhouse gas emissions and pledges, for South Korea



Source: PBL; Presentation of South Korea, Bangkok climate negotiations

Comparison of different business-as-usual emission projections with emission levels resulting from the implementation of the pledges.

#### 9.2.7 South Korea

South Korea has pledged to reduce emissions by 30%, by 2020, against business-as-usual levels. This is likely to be achieved almost fully by a cap-and-trade system. This system will start in 2015 and cover a large portion of South Korea's emissions, and is likely to force industry to cut 236 Mt CO<sub>2</sub> eq reductions, representing a 29% reduction against the business-as-usual emission level (Sterk and Mersmann, 2011). During the UNFCCC workshop in Bangkok, South Korea presented its national business-as-usual emission projection. These are higher than the projections by PBL/IIASA (see Figure 9.16), which implies that the total pledge is 16% below the PBL/IIASA business-as-usual projection.

#### Notes

- <sup>1</sup> [http://unfccc.int/national\\_reports/annex\\_i\\_natcom/submitted\\_natcom/items/4903.php](http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/4903.php).
- <sup>2</sup> More specifically, the Current Policies Scenario (previously called the Reference Scenario), in which no change in policies as of mid-2010 is assumed. In this scenario, recent commitments (Copenhagen pledges) are not included.
- <sup>3</sup> 690 Mt minus 40 Mt to correct for emissions from deforestation, as reported in 'Australia's Emissions Projections 2010'.
- <sup>4</sup> 109 Mt – 18.4 LULUCF mitigation measures to achieve the Kyoto target as reported in 'Australia's Emissions Projections 2010'.
- <sup>5</sup> [http://ec.europa.eu/clima/policies/package/index\\_en.htm](http://ec.europa.eu/clima/policies/package/index_en.htm).
- <sup>6</sup> See Table 14 in [http://ec.europa.eu/clima/policies/g-gas/docs/draft\\_annex\\_en.pdf](http://ec.europa.eu/clima/policies/g-gas/docs/draft_annex_en.pdf).
- <sup>7</sup> In a communication dated 8 December 2010, which was received by the UNFCCC secretariat on 9 December 2010, Russia indicated not to intend to assume a quantitative emission limitation or reduction commitment for the second commitment period (UNFCCC, 2011c).
- <sup>8</sup> [http://www.mma.gov.br/estruturas/182/\\_arquivos/cenarioemissoes\\_182.pdf](http://www.mma.gov.br/estruturas/182/_arquivos/cenarioemissoes_182.pdf).



# Conclusions

The main aim of this report is to analyse the pledges put forward by Parties to the Cancún Agreements, including all new information that has become available since the Cancún climate negotiations (2010). The report specifically focuses on the emission gap and on uncertainties and risks, in particular, those due to the accounting rules for the forestry sector and for surplus AAUs. Moreover, it describes in more detail, the emission implications of the pledges and mitigation actions by the ten largest emitting countries. This report is an update of the PBL report 'Evaluation of the Copenhagen Accord' (Den Elzen et al., 2010a). The major updates consist of new business-as-usual emission projections for countries, including those provided by the countries themselves, updated estimates for credits from land use, land-use change and forestry (LULUCF) and surplus assigned amount units (AAUs). In addition, this report includes a more detailed analyses of pledges for the ten largest emitting countries.

## Key findings

- The low and high pledges submitted by Annex I countries in the Cancún Agreements are estimated to lead to a respective total reduction in emissions by 2020 (all greenhouse gases excluding LULUCF) of 12% and 18% of 1990 levels. This is lower than the range of 25% to 40% reported by the IPCC to be consistent with scenarios stabilising at 450 ppm CO<sub>2</sub> eq.
- If the Annex I countries with only a conditional pledge and that have announced not to be on board for a second commitment period under the Kyoto Protocol would not implement their pledges, and the others implement their low (unilateral) pledges, the total reduction by 2020 for Annex I countries would diminish to 5% of 1990 levels.
- The low and high pledges submitted by non-Annex I countries in the Cancún Agreements are estimated to lead to a respective total emission reduction by 2020 of 3% and 4% below PBL/IIASA business-as-usual emissions (including CO<sub>2</sub> from LULUCF). This is also lower than the 15% to 30% reported in the literature to be consistent with scenarios stabilising at 450 ppm CO<sub>2</sub> eq.
- Since the Cancún climate negotiations, new information has become available through business-as-usual emission projections published by non-Annex I countries themselves. This has led to a 1.0 to 1.5 Gt CO<sub>2</sub> eq higher emission level, estimated from the pledges for 2020, for these countries, especially for Brazil, China and India.
- The emission gap, by 2020, between emission levels resulting from pledges and those consistent with a likely chance of achieving the 2 °C climate target, ranges from 7 to 11 Gt CO<sub>2</sub> eq. For a medium chance of achieving the 2 °C target, the range is 5 to 9 Gt CO<sub>2</sub> eq. These estimates are about 2.5 Gt CO<sub>2</sub> eq higher than was calculated in our earlier study (Den Elzen et al., 2010a), and can be explained by the higher business-as-usual emission projections published by developing countries themselves and by those of Russia and the Ukraine.

- A major risk that could lead to a wider emission gap in 2020 relates to pledges being conditional on international mitigation actions and on the availability of international support. If the conditional pledges would not be achieved, emissions would increase by 2.4 Gt CO<sub>2</sub> eq (about 70% of which would come from Annex I countries). Furthermore, carry-over and the use of Kyoto surplus AAUs could increase emissions by up to 2.9 Gt CO<sub>2</sub> eq.
- For non-Annex I countries, the most important uncertainty relates to pledges formulated as intensity targets. This could increase emissions by about 2.6 Gt CO<sub>2</sub> eq (but may also lead to lower emission levels). Other important uncertainties are the contributions from REDD+ actions (which could either increase or decrease emissions by 1.5 Gt CO<sub>2</sub> eq) and business-as-usual emission developments (which could increase emissions by 2.6 Gt CO<sub>2</sub> eq, but may also lead to lower emission levels).
- A risk difficult to attribute to Annex I or non-Annex I countries is that of double counting of offset emissions, something that could increase emissions by 0.9 to 1.1 Gt CO<sub>2</sub> eq.
- A few selected mitigation options could reduce the emission gap by 4.1 Gt CO<sub>2</sub> eq. Assuming that surplus AAUs will not be used and strict land-use accounting rules are implemented, these options (all are additional to, rather than supporting the achievement of existing pledges) include: i) additional emission reductions in China and India, which are presented in their national plans, but are not included in their pledges; ii) reductions in emissions from deforestation; iii) emission reductions in countries currently without pledges; iv) ensuring strict additionality of offsets; v) reductions in emissions from international shipping; and vi) reduction in emissions from HFCs.
- As China has pledged a CO<sub>2</sub> emissions intensity target without providing reference projections of its GDP growth (which is uncertain), the emission level that would result from its pledge is very uncertain. The resulting emission level for 2020 would be 12.9 Gt CO<sub>2</sub> eq according to the PBL/IIASA business-as-usual GDP growth projection, which is a reduction of 4% below PBL/IIASA business-as-usual emission projections, whereas the WEO-2010 projects 11.4 Gt CO<sub>2</sub> eq, with a reduction of 10% below WEO-2010 business-as-usual emission levels.

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# Appendix A.

## Model description and assumptions

### A.1 PBL models

For the analysis, we used the FAIR model and the IMAGE modelling framework, including the global energy model TIMER<sup>1</sup>. Short descriptions of the models are provided below.

#### The FAIR model

The integrated modelling framework FAIR 2.3 (Den Elzen et al., 2008; 2011a) was used for the quantitative analysis of emission reductions and abatement costs at the level of 26 regions. The model uses data on business-as-usual greenhouse gas emissions from the IMAGE land-use model and TIMER energy model. The aggregated demand-and-supply curves for emission credits were derived from marginal abatement cost curves (MACs) based on the same models. More specifically, the MAC curves for energy- and industry-related CO<sub>2</sub> emissions were determined with the TIMER energy model by imposing a carbon tax and recording the induced reduction in CO<sub>2</sub> emissions. MAC curves from the EMF21 project (Weyant et al., 2006) were used for non-CO<sub>2</sub> greenhouse gas emissions. These curves were made consistent with the business-as-usual emission levels used here and made time-dependent, in order to account for technology change and removal of implementation barriers (Lucas et al., 2007).

#### The IMAGE modelling framework

The IMAGE model is an integrated assessment model, consisting of a set of linked and integrated models, which, together, describe important elements in the long-term dynamics of global environmental change, such as air pollution, climate change, and land-use change (Bouwman et al., 2006). The most important subsystems are the 'socio-economic system' and the 'Earth system'. In the socio-economic system, detailed descriptions of energy and food consumption and production are developed, using TIMER and agricultural trade and production models. The two main links

between the socio-economic system and the Earth system are land use and emissions. The land-cover submodels in the Earth system simulate the change in land use and land cover, at 0.5 x 0.5 degrees (driven by demand for food, timber and biofuels, and changes in climate). For the demand for agricultural products, the IMAGE model often uses scenarios from agro-economic models. A crop module based on the FAO agro-ecological zones approach computes the spatially explicit yields for the different crop groups and for grass, as well as the areas used for their production, as determined by climate and soil quality. Where expansion of agricultural areas is required, a rule-based 'suitability map' determines which grid cells are selected. The Earth system also includes a natural vegetation model to compute changes in vegetation in response to climate change. Land-use related emissions come from both land use (e.g. methane emissions from animals) and land-use change. Emissions from the latter depend on the carbon fluxes between vegetation, and carbon stocks in soils and in the atmosphere. The IMAGE model accounts for feedbacks within the system, such as the impacts of changes in temperature, precipitation and CO<sub>2</sub> concentrations on crop and grass yields, net primary productivity and migration of natural ecosystems.

#### The TIMER model

TIMER is an energy system model that is part of the IMAGE integrated assessment framework. The TIMER energy model describes the long-term dynamics of the production and consumption of about 10 primary energy carriers for 5 end-use sectors in 26 world regions (Van Vuuren et al., 2006; 2007a). The model's behaviour is mainly determined by substitution processes of various technologies based on long-term prices and fuel preferences. These two factors drive multinomial logit models that describe investments in new energy production and consumption capacity. The demand for new capacity is limited by the assumption that capital goods are only replaced at the end of their technical

Table A.1  
List of data sources used by the models

Data	Year	Source
<b>Grid level data</b>		
Land area	2000	JRC (2000)
Forest area	2010	FAO (2010)
Forest NPP	-	Cramer et al (1999)
Built up land	2010-2050	Tubiello and Fischer (2007)
Biomass map	2005	Kindermann et al (2008)
Population density	1990-2050	CIESIN (2005)
Population density	1990-2050	Grübler et al (2007)
<b>Country level data</b>		
PPP	2005	World Bank (2005)
Discount rates	2004	Benitez et al (2004)
Corruption factor	2005	Kaufmann et al (2005)
Fraction of long life products	2000–2010	FAO (2010)

lifetime. The long-term prices that drive the model are determined by resource depletion and technology development. Resource depletion is important for both fossil fuels and renewables (for which depletion and costs depend on annual production rates). Technology development is determined by learning curves or through exogenous assumptions. Emissions from the energy system are calculated by multiplying energy consumption and production flows with emission factors. A carbon tax can be used to induce a dynamic response, such as increased use of low- or zero-carbon technologies, energy efficiency improvement and end-of-pipe emission reduction technologies.

## A.2 IIASA land-use models

To produce consistent projections of CO<sub>2</sub> emissions from forestry activities at country level, a combination of two different models is used; an economic land-use model (GLOBIOM) and a detailed forestry model (G4M) (Kindermann et al., 2006; 2008). The economic land-use model GLOBIOM is located in the centre of the framework. The model uses recent business-as-usual projections based on results of the POLES energy model for future bio-energy demand and related assumptions on population growth, economic development (GDP), and technical progress rates, such as macro-economic drivers. GLOBIOM represents the forestry, agriculture, bio-energy and livestock sectors in 28 world regions.

For business-as-usual and policy scenarios, the economic land-use model projects domestic production and consumption, net exports and prices of timber and agricultural products. Sector-specific information from the economic model is used by the forest model to

project greenhouse gas emissions and removals for detailed land management options. The forestry model is applied to estimate emissions and removals from forest management and afforestation/reforestation activities. Based on a business-as-usual projection, it also provides abatement cost curves for the selected land-use activities.

The models use several input data sources, some are available for each grid, some represent country aggregates and others are global. The data supporting the values in Table A.1 are known for each grid. Some of the values are also available for time series.

Introducing a carbon price incentive to generate carbon abatement cost curves means that forest owners are paid for any carbon that is stored in forest living biomass above a business-as-usual level, but that they have to pay a tax, if the amount of carbon in forest living biomass is below the business-as-usual level. Business-as-usual levels are determined assuming forest management without a carbon price incentive.

In the G4M model, mitigation measures in forestry are considered to be:

- reductions in deforestation area;
- increases in afforestation area;
- changes in rotation lengths of existing managed forests in different locations;
- changes in the ratio between thinning and final fellings;
- changes in harvest intensity (amount of biomass extracted in thinning and final felling activities).

These activities are not adopted independently by forest owners. The model manages land dynamically and one activity affects the other. The model calculates the



optimal combination of measures. The introduction of a CO<sub>2</sub> price gives an additional value to the forest through the carbon stored and accumulated in it. The increased value of forests under a regime that involves a CO<sub>2</sub> price changes the balance of land-use change through the net present value (NPV) generated by land-use activities towards forestry. In general, it is therefore assumed that the introduction of a CO<sub>2</sub> price leads to a decrease in deforestation and an increase in afforestation. However, this may not all happen at the same level of intensity. Less deforestation increases land scarcity and, therefore, may decrease afforestation relative to a business-as-usual situation.

The costs of mitigation policies are quantified by the construction of MAC curves for mitigation policies related to the land-use sector. Parameterisation of the MAC curves is harmonised with assumptions made by the FAIR models in order to ensure consistency.

## Note

- <sup>1</sup> The model names are acronyms. FAIR = Framework to Assess International Regimes for the differentiation of commitments; IMAGE = Integrated Model to Assess the Global Environment; TIMER = The Targets IMage Energy Regional model.

# Appendix B.

## Annex I reduction efforts compared with business-as-usual emission projections

### B.1 Business-as-usual projections used to evaluate the pledges and actions

To evaluate the pledges and actions for all countries, we used three different business-as-usual projections. The first, main projections are taken from the PBL and IIASA models as described in Appendix A, and are called the 'PBL/IIASA projections'. The second type of projection relates to the business-as-usual projections published by individual countries themselves, and are called 'national projections'. The third and final projection, called the 'WEO-2010 projection', was used for comparison and is based on CO<sub>2</sub> emission data from the World Energy Outlook 2010. Neither national nor WEO-2010 projections are available for all countries.

All three business-as-usual projections were harmonised at the same historical data from 1990 to 2005. Historical Annex I emissions for all Kyoto greenhouse gases between 1990 and 2005 were based on national emission inventories that were submitted to the UNFCCC (2009a). For non-Annex I countries these were not available; therefore, for all Kyoto greenhouse gas emissions, we used data from the CAIT database version 4.0 (<http://cait.wri.org/>). These greenhouse gas emissions are excluding CO<sub>2</sub> from land use. Data on land-use related CO<sub>2</sub> emissions were taken from the IIASA models for both Annex I and non-Annex I countries. Historical data on emissions from international shipping were taken from Owen and Lee (2005) and the IMO greenhouse gas study of 2009 (Buhaug et al., 2009).

#### B.1.1 Business-as-usual emissions based on PBL and IIASA models

The PBL/IIASA projections were used for the main results in this report and were based on the PBL models FAIR, TIMER and IMAGE and the IIASA models G4M and GLOBIOM. The data on emissions from energy, industry,

household, transport, agriculture, waste and non-CO<sub>2</sub> emissions from land-use were taken from the PBL models. Data on CO<sub>2</sub> emissions from land use were taken from the IIASA models and divided into three different categories: deforestation, afforestation/reforestation (AR) and forest management (FM).

Before the output from these models could be used, two adjustments to the model projections were necessary. First, as the output of the PBL models were on a regional level, we downscaled the emission and GDP projections to a country level, which was done according to the method described in Van Vuuren et al (2007b). Second, an adjustment was made for emissions from international aviation, as these were included in the regional transport data. The PBL model output was corrected using ratios between emissions from international aviation and other greenhouse gases, taken from the WEO-2010 projections.

Finally, the business-as-usual projections were constructed by applying the data on emission growth from the models mentioned above to the emission level of 2005, the last year of the historical dataset. Shipping emissions were taken from Owen and Lee (2005) and the IMO greenhouse gas study of 2009 (Buhaug et al., 2009).

#### B.1.2 Business-as-usual emissions based on national publications

National business-as-usual projections were provided by all Annex I countries and the following non-Annex I countries: Mexico, Brazil, South Africa, India, South Korea, Indonesia, Costa Rica, Chile, Israel, Singapore, and Papua New Guinea. Emission levels projected for 2020 according to these national projections were used together with those at the end point of the historical dataset in 2005. This differs from the method used to construct the PBL/IIASA projections, which is based on emission growth.



Table B.1

The emission targets resulting of the pledges of Annex I countries for 2020, relative to the national business-as-usual emission projections as provided by countries themselves, and the PBL and WEO business-as-usual emission projections

Emissions in Mt CO <sub>2</sub> eq (excl. LULUCF CO <sub>2</sub> )	Business-as-usual emissions			Reduction below business-as-usual emissions Low pledge			Reduction below business-as-usual emissions High pledge		
	National	WEO-2010	PBL	National	WEO-2010	PBL	National	WEO-2010	PBL
Australia	739		584	-27%		-8%	-43%		-27%
Belarus	210		115	-37%		15%	-40%		9%
Canada	850		751	-29%	-20%	-19%	-29%	-20%	-19%
Croatia	50		35	-41%		-16%	-41%		-16%
EU27	5,769	4,893	5,144	-23%	-9%	-13%	-32%	-20%	-24%
Iceland	6		3	-60%		-30%	-60%		-30%
Japan	1,369	1,247	1,331	-31%	-24%	-29%	-31%	-24%	-29%
New Zealand	85		82	-37%		-35%	-44%		-42%
Norway	73		50	-52%		-30%	-59%		-40%
Russia	2,750	2,359	2,489	4%	21%	14%	-9%	7%	1%
Switzerland	55		51	-23%		-17%	-33%		-27%
Ukraine	755		567	-1%	52%	31%	-1%	52%	31%
United States	7,416	7,325	7,249	-20%	-19%	-18%	-20%	-19%	-18%
Kazakhstan	465		193	-41%		41%	-41%		41%
<b>Annex I total (excl. Turkey)</b>	<b>20,594</b>		<b>18,646</b>	<b>-19%</b>		<b>-10%</b>	<b>-24%</b>		<b>-16%</b>

Source: Annex I countries' nationally submitted business-as-usual greenhouse gas emissions are based on national communications to the UNFCCC

### B.1.3 Business-as-usual emissions based on world energy outlook 2010

The WEO-2010 projections only include CO<sub>2</sub> emissions from energy and industry, other emissions were taken from the PBL and IIASA models. This also applies to the non-energy use CO<sub>2</sub> emissions from cement production. The WEO-2010 emissions were only available for the United States, countries from the European Union as a group, Russia, Japan, China, India and Brazil. All other countries are part of different regions that could not be downscaled. Therefore, these were not used in our evaluation. The expected emission growth between 2005 and 2020 according to the WEO-2010 projections was applied to the historical 2005 level, as was done for the PBL/IIASA projections.

## B.2 Annex I reduction efforts compared with business-as-usual emission projections

The paragraphs above describe the differences between business-as-usual projections as provided by countries to the UNFCCC and those by the PBL and WEO models. Table B.1 shows a comparison between emission reductions resulting from the pledges against the

business-as-usual emission projections as provided by Annex I countries themselves and those according to the PBL and WEO projections

In general, nationally submitted business-as-usual projections are higher than PBL projections, as can be seen in Table B.1. Most national projections are based on historical emissions up to 2007; therefore, the economic crisis may not be fully accounted for in the business-as-usual projections as presented by the countries themselves, resulting in a higher emission level by 2020. The time line of the PBL model projections start in 2005, and explicitly incorporates effects of the economic crisis. The WEO-2010 projections include more recent historical emissions, up to 2008, and incorporate already implemented climate policy. Except for the United States, the PBL business-as-usual projections are higher than those of the WEO-2010 because of the two differences described. We did not have enough information to explain the difference for the United States.

### Note

<sup>1</sup> [http://unfccc.int/national\\_reports/annex\\_i\\_natcom/submitted\\_natcom/items/4903.php](http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/4903.php).

# Glossary

## **Allowances (or 'credits')**

The maximum amount of greenhouse gas emissions that would be allowed for achieving the targets for the first Kyoto commitment period (2008–2012) or subsequent commitment periods.

## **Business as usual**

Refers to a future without new climate policies. Business-as-usual future emission projections, therefore, are projected emission levels assuming no new climate policies are implemented. The GDP projections do not include any possible effects of future climate policy.

## **Clean Development Mechanism (CDM)**

The Clean Development Mechanism (CDM) is one of the three flexibility mechanisms under the Kyoto Protocol. CDM allows Annex I countries to invest in emission reduction projects in non-Annex I countries. Annex I countries investing in CDM projects receive certified emission credits for reductions achieved by their reduction projects in non-Annex I countries that may be used to offset their domestic emissions. In this way, CDM may help Annex I countries reach their emission reduction targets. A reform of the Clean Development Mechanism (CDM) is currently under discussion.

## **CO<sub>2</sub> emission intensity**

The level of carbon dioxide (CO<sub>2</sub>) emissions per unit (in USD) of GDP.

## **CO<sub>2</sub> equivalent concentration**

CO<sub>2</sub> equivalence expresses the radiative forcing of other anthropogenic forcing agents in terms of the equivalent CO<sub>2</sub> concentration that would result in the same level of forcing. In this report, the definition of what constitutes this CO<sub>2</sub> eq concentration includes the radiative forcing of the Kyoto greenhouse gases tropospheric ozone and sulphur aerosols.

## **CO<sub>2</sub> equivalent emissions**

The concept of CO<sub>2</sub> eq emissions is used for expressing the emissions of the six Kyoto greenhouse gases (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCs, PFCs and SF<sub>6</sub>) in a single number. This is done by weighing the emissions of these gases using their Global Warming Potential (GWP) over a 100-year period. The GWP represents a relative measure of how much heat

a greenhouse gas traps in the atmosphere over a certain time period.

## **Conditional Pledge**

This refers to a country's pledge that is contingent on a number of factors, such as the ability of national legislatures to enact the necessary laws, ambitious action from other countries, realisation of financing and technical support.

## **Commitment period**

This refers to the period within which countries have committed to reducing their CO<sub>2</sub> eq emissions below certain levels. The first commitment period was from 2008 to 2012; the second period is still under consideration. In the Durban climate negotiations it was agreed that there will be a second period for the Kyoto Protocol, but no decision was made on whether this should be a five-year period (2013–2017) or an eight-year period (2013–2020).

## **Copenhagen Accord**

The 15<sup>th</sup> Conference of the Parties to the UNFCCC took note of this agreement in Copenhagen, Denmark, in December 2009. The Accord includes two appendices listing the pledges by Annex I and non-Annex I countries, which are analysed in this report.

## **Double counting**

In the context of this report, double counting refers to a situation in which the same emission reductions are counted towards achieving two countries' pledges.

## **Emission intensity**

The level of greenhouse gas emissions per unit (in USD) of GDP.

## **Emission pathway**

The trajectory of annual global or regional greenhouse gas emissions over time.

## **Emission trading**

One of the three flexibility mechanisms under the Kyoto Protocol allows trade in emission allowances between countries. Emission trading may also apply to trade in emission credits between businesses, such as within the EU ETS. A precondition for emission trading is the

presence of a cap on the allowable emissions for each country or business joining the cap-and-trade system. If actual emissions are below the allowance level, excess allowances may be sold to countries/companies that are experiencing difficulties in reaching their target.

#### **FAIR**

Framework to Assess International Regimes for the differentiation of commitments (FAIR)

#### **G4M**

Global Forestry Model (G4M)

#### **High pledges**

These pledges refer to a country's most ambitious and conditional emission reductions by 2020. In this report, the high pledges scenario refers to a scenario under which all countries implement their high pledges for 2020.

#### **IMAGE**

Integrated Model to Assess the Global Environment (IMAGE)

#### **Joint Implementation (JI)**

One of the three flexibility mechanisms under the Kyoto Protocol. Similar to CDM, except for the fact that emission reduction projects under JI take place in an Annex I country, rather than a non-Annex I country.

#### **Lenient Rules**

This refers to pledges with maximum Annex I 'lenient LULUCF credits' and surplus assigned amount units (AAUs).

#### **Likely chance**

Used to convey the probability of achieving targets to limit temperature increases with a likelihood of over 66%.

#### **Low pledges**

In this report, as in the UNFCCC documents (e.g. UNFCCC, 2011d), the term 'low pledges' refers to a scenario in which all countries with only one (conditional) emission reduction pledge for 2020 implement those pledges and all countries with both an unconditional and conditional pledge implement their least ambitious (unconditional) pledges. It should be noted that not the low pledge scenario, but the unconditional pledge scenario leads to the highest emission levels for 2020 (lowest reductions) that would result from achieving the pledged reductions, as described below.

#### **LULUCF accounting rules**

Land use, land-use change and forestry (LULUCF) accounting rules may result in additional credits (or

debits) from land-use change activities, such as forest management. Annex I countries could use these LULUCF credits to achieve their pledges and thereby lower the reduction target for greenhouse gas emissions.

#### **Medium chance**

Used to convey the probability of achieving targets to limit temperature increases with a likelihood of between 50% and 60%.

#### **Pledge**

For the purpose of this report, pledges include targets for Annex I (developed) countries and actions for non-Annex I (developing) countries, as put forward by the Parties in the Cancún Agreements.

#### **Strict Rules**

Pledge scenarios for which the impact of 'lenient LULUCF credits' and surplus assigned amount units (AAUs) are set to zero.

#### **Surplus emission allowances**

The term surplus emission allowances is used in this report only for non-Annex I countries. These countries generate surplus emission allowances if the emission level that results from their pledge is above the business-as-usual emission projection.

#### **Surplus assigned amount units (AAUs)**

Following the first commitment period of the Kyoto Protocol (2008–2012), Annex I countries holding AAUs that would not be required for complying with their commitments, would be allowed to carry-over such surplus AAUs to the next commitment period, or they could bank them for future use or sale. These allowances are referred to as surplus AAUs. There is also the possibility that new surplus AAUs are created during the second commitment period. This would be the case when the emission level resulting from a pledge ends up above the level of the business-as-usual emission projection.

#### **TIMER**

The IMAGE Energy Regional model (TIMER)

#### **Unconditional pledge**

Similar to the UNEP reports (2010, 2011), the unconditional pledge scenario in this report also includes countries that have only provided a conditional pledge; for these countries we have assumed the business-as-usual estimate to be their unconditional pledge. In this scenario, for countries that have submitted both an unconditional and a conditional pledge, we have assumed that only their least ambitious (unconditional) pledges will be implemented.


**UNFCCC**

The United Nations Framework Convention on Climate Change is an international environmental treaty with the objective to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

**USD**

United States dollars. This report refers to the 2005 exchange rates for USD.





This policy study is a publication by

**PBL Netherlands Environmental Assessment Agency**

Mailing address

PO Box 30314  
2500 GH The Hague  
The Netherlands

Visiting address

Oranjevuitensingel 6  
2511VE The Hague  
T +31 (0)70 3288700

[www.pbl.nl/en](http://www.pbl.nl/en)

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