PBL Netherlands Environmental
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CLIMATE POLICY AFTER KYOTO

Analytical insights into key issues in the climate negotiations

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PBL Netherlands Environmental Assessment Agency is the national institute for strategic policy analysis in the field of environment, nature and spatial planning. We contribute to improving the quality of political and administrative decision-making by conducting outlook studies, analyses and evaluations in which an integrated approach is considered paramount. Policy relevance is the prime concern in all our studies. We conduct solicited and unsolicited research that is both independent and always scientifically sound.

Preface

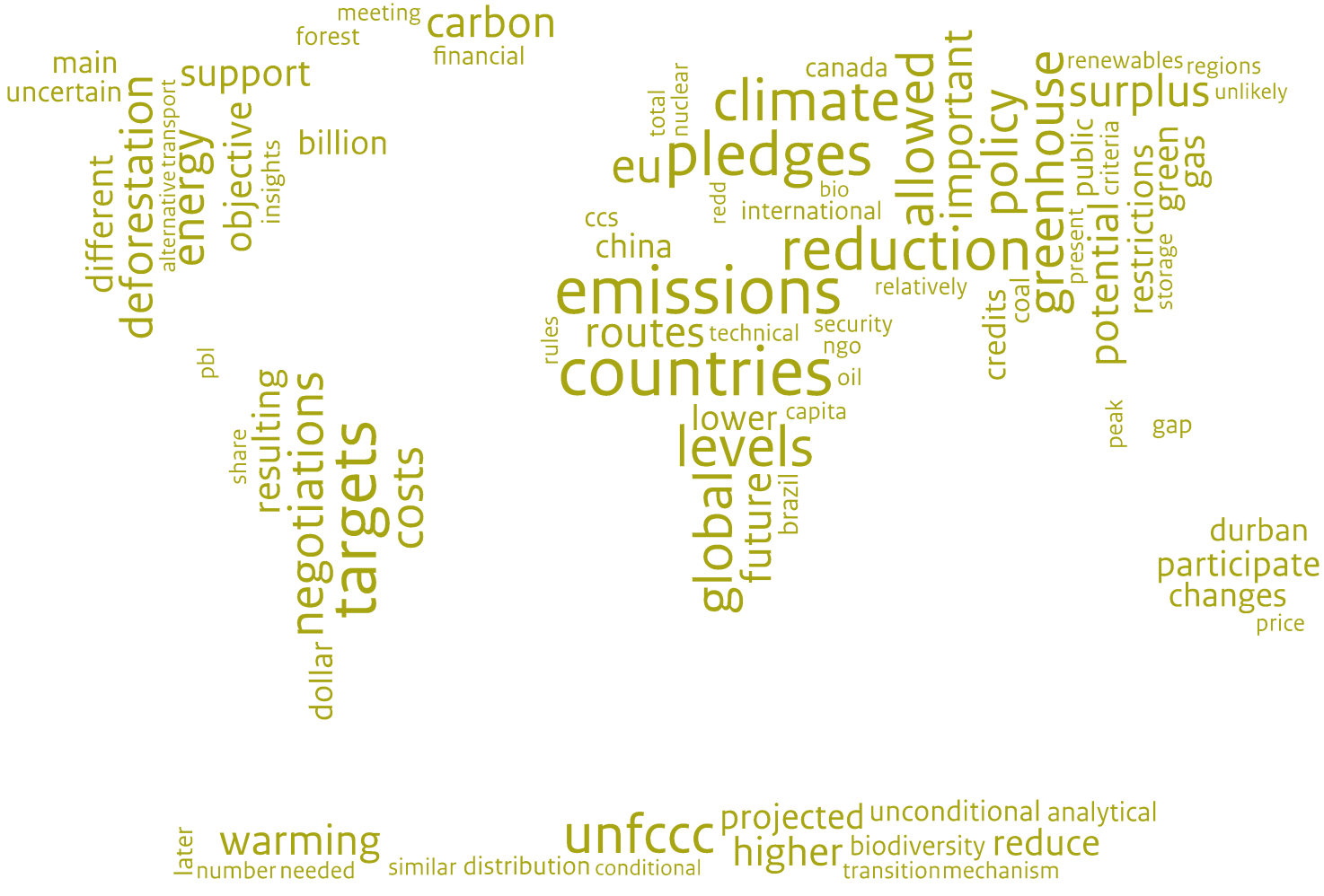
Once again, international climate policy has entered a crucial phase: the next climate negotiation rounds in Durban in December 2011 offer the last chance to agree on a second commitment period. Climate policy negotiators have stated a clear long-term goal: countries should take urgent action to limit global warming to a maximum of 2 °C. As a first step towards reaching this objective, countries made voluntary proposals to reduce greenhouse gas emissions by 2020. How much these proposals will contribute to reaching the long-term climate objective depends to a large extent on the outcome of the next climate negotiation rounds.

The PBL Netherlands Environmental Assessment Agency, over the last few years, published several analyses of how different outcomes of the negotiations would affect emission reductions. In this publication, this material has been combined to provide an overview and assessment of some important issues in the climate negotiations. The publication looks into emission reduction targets for 2020, but also puts these targets in a broader context. The focus is on the EU, but comparisons are also made in relation to other developed countries and major emerging economies.

The report shows that, with the current voluntary emission reduction proposals, limiting global warming to 2 °C will prove very difficult. Moreover, some outcomes of the negotiations could water down global emission reductions. Therefore, to increase the chance of achieving the long-term climate objective, global emissions should be reduced further by 2020 than according to current proposals. Another major challenge lies in organising the institutional arrangements that would make these reductions feasible.

The PBL publication aims to provide a useful point of reference for people interested in climate policy. On the question of whether the 2 °C target can indeed be achieved, much will depend on the clarity with which climate strategies are introduced, and on the creativity in finding ways to make these commitments enduring and firm, in the years to come.

Prof. dr. Maarten Hajer
Director of the PBL Netherlands Environmental Assessment Agency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Main findings

The UNFCCC climate negotiations have become very complex, partly as a result of the complex nature of the climate problem. In the coming years, decisions have to be taken on several important, yet unresolved issues. This report provides analytical insights into a number of these issues, to give a wider audience a better understanding of the climate negotiations. Our main findings are as follows:

- In the UNFCCC negotiations, urgent action was called for to limit global warming to 2 °C, and voluntary pledges to reduce greenhouse gas emissions by 2020 were made by both developed and developing countries. If all countries were to implement their most ambitious reduction pledges, global emission levels, by 2020, would be about 51 Gt CO_2 eq, compared to 56 Gt CO_2 eq under a business-as-usual scenario. Analysis has shown that this emission level is above that of the least-cost emission pathways with a medium chance of reaching the 2 °C objective (50% to 66% probability). This means that reaching the 2 °C objective from this level would be very difficult as it leads to higher long-term costs and depends more heavily on future technological developments.

- Model calculations show that, for the EU to achieve their conditional 2020 reduction target of 30%, the related emission reduction costs (between about 0.1% and 0.3% of GDP) would be well above the average of those of other developed countries (by about 0.05% to 0.15% of GDP), if these countries also were to implement their most ambitious emission reduction pledges. This is partly due to Russia and the Ukraine having pledged emission targets above their business-as-usual emission projections.

- A number of proposals tabled in the negotiations to fill a so-called Green Climate Fund (which has been established to support climate policies in developing countries) would lead to unpredictable revenues, as these would depend on the ambition level of climate policy. A global carbon tax would lead to more predictable funding, but seems very unrealistic in the present negotiations.

- Countries for which emission levels are below their Kyoto target have surplus allowances ('hot air'), which under the Kyoto protocol may be carried over to a following commitment period. This is especially the case in the former Soviet Union and Eastern European countries, but also in some EU15 Member States. If these surplus allowances could be used without restrictions for meeting the 2020 reduction pledges, the environmental effectiveness of reduction targets could be seriously undermined.

- The EU target of reducing deforestation by 50% in developing countries by 2020 is technically possible, but should be regarded as ambitious, if implementation barriers would be taken into account. Such barriers may, for instance, be due to insufficient capacity to measure forest areas and carbon stocks, and a lack of experience in environmental markets, and could be related to established practices and institutional capacity.

- Model projections show that there is sufficient technical potential to reduce emissions by increasing energy efficiency, changing energy supply, implementing end-off-pipe measures and land-use change, in order to limit global warming to 2 °C. Some of these options, such as improving efficiency and bio-energy, combined with carbon capture and storage (CCS), are more critical than others. Estimates of the costs are uncertain, but most studies have found annual investment numbers of between 1% and 2% of GDP.

- The EU has advocated a reduction target of 80% to 95% for developed countries and 50% on a global level, by 2050. In our analysis, we have found that a reduction target of 85% to 90% for developed countries as a group, and 50% globally, would result in similar per-capita emissions for developed and presently developing countries as a whole by 2050.

- Many 'alternative routes' for international climate policies are currently being discussed, such as routes via other multilateral institutions and actors, and 'reframing routes' in which climate policies are mainly a co-benefit of other policy targets, as well as reforms within the UNFCCC itself. None of these routes, individually, could sufficiently replace current climate negotiations under the UNFCCC. Nevertheless, alternative routes could provide additional support for climate policies in societies worldwide.

Summary

Introduction

The UNFCCC climate negotiations show fundamental differences of interests and views between countries about all kinds of topics. In addition, various issues under negotiation are also technically complex. As a result, the climate negotiations have become rather incomprehensible for most people beyond the professional negotiators, lobbyists from NGOs and the business community, who can still oversee the issues at stake. In this context, the Dutch State Secretary of the Ministry of Infrastructure and the Environment has asked the PBL to assess the pledges by developed and developing countries for reducing or limiting their greenhouse gas emissions (Atsma, 2011). As this is only one of the many complex issues, the PBL has taken this opportunity also to present analytical insights into a number of other important issues, to provide a wider audience with a better understanding of the climate negotiations.

This report provides an overview and assessment of different policy options for a number of important issues in the climate negotiations, including the levels of emission reduction needed by 2020 to meet the 2 °C objective; the adequacy of the current pledges; dealing with surplus allowances under the Kyoto protocol; the contribution of reducing deforestation to emission reduction; feeding the Green Climate Fund; the feasibility of a transition to a low greenhouse gas economy, and defining long-term emission targets. Apart from these issues, this report also looks at whether 'alternative routes' to the UNFCCC could contribute to support future climate policies.

Are the current reduction pledges consistent with limiting global warming to 2 °C, the objective mentioned in the last UNFCCC negotiation rounds?

The Cancún conference of 2010 called for urgent action to limit global warming to 2 °C, and voluntary pledges were made by both developed and developing countries to reduce or limit greenhouse gas emissions by 2020. This raises the question of whether these pledges are consistent with the long-term objective. The level of global emissions for 2020 that will be needed to limit global warming to 2 °C strongly depends on the rate by which emissions can be reduced. For the next decades, this will strongly depend on the participation of countries in reducing emissions and on policy inertia. Later in the century, availability of technology to reduce emissions will play an important role. Other important factors that will determine the necessary emission level are the degree of probability of exceeding the climate target and the costs of reducing emissions.

To date, models often have concentrated on scenarios in which all countries participate in climate policy. In such a situation, in order to have a medium (50% to 66% probability) to likely (more than 66% probability) chance of staying below 2 °C, most models agree that emissions need to be reduced to between 39 and 46 Gt CO_2 eq by 2020. This is much lower than the projected business-as-usual emission level of about 56 Gt CO_2 eq. With the assumption that not all countries participate in climate policy right from beginning, higher emission levels by 2020 would still be consistent with achieving the 2 °C

objective. Analysis also shows that it may still be possible to limit global warming to 2 °C with medium chance of somewhat higher emission levels than 46 Gt CO_2 eq for 2020, but with risks of higher global costs throughout the century. Before the Cancún climate negotiations of 2010, reduction pledges from all countries were projected to lead to an emission level of between about 49 and 50 Gt CO_2 eq. Since the Cancún climate negotiations, however, new information about published business-as-usual emissions from developing countries – especially Brazil – has led to a higher estimate for this range, approaching 51 to 52 Gt CO_2 eq. Starting from the current pledges for 2020, this would mean that reaching the 2 °C objective will be very difficult, require increased future efforts by all countries, be more costly, and depend more heavily on future technological developments, than in a scenario in which 2020 emission levels would be lower.

Are the current reduction pledges by the EU and the associated costs similar to those by other developed countries and the main emerging economies?

The EU has pledged an unconditional target of 20% and a condition target of 30% below 1990 emission levels, for 2020. The conditional aspect of the more ambitious target entails that other developed countries must commit to comparable emission reductions, and that developing countries also contribute adequately. Certain countries also made unconditional pledges, but most only submitted conditional pledges. Comparing these pledges with those made by the EU shows that the reductions, compared to the business-as-usual scenario, are higher for the EU than the average of the other developed countries, even if the pledges announced by all other developed countries, including the United States, Canada, Japan and Russia, are fulfilled. This is partly due to Russia and the Ukraine having pledged emission targets above their business-as-usual emission projections. As a result, also the costs of achieving the reductions by 2020 are projected to be higher for the EU (between about 0.1% and 0.3% of GDP for the high pledge, depending on whether or not emission trading between regions is allowed) than for the other developed countries (between about 0.05% and 0.15% of GDP). For China and India, the pledges are projected to lead to minor reductions, compared to their business-as-usual scenarios. Consequently, their costs are also much lower and may even be negative if they would be allowed to sell emission credits.

Are current proposals to fill the Green Climate Fund effective and what are the financial consequences for different countries?

The Green Climate Fund has been established to support climate policy in developing countries. Up to October 2011, all current climate funds had gathered a total of USD 13 billion in public money, whereas an annual amount of USD 100 billion by 2020 had been agreed on. Funds should come from both public and private sources. Some typical additional public financing mechanisms are based on taxing emissions, emission trading/CDM projects or the auctioning of allowances (emission credits). The effectiveness – or revenues – of most of these proposals depends on future climate policies. Low revenues (less than USD 2 billion) are to be expected from a tax of 2% on

emission trading, whereas high but unpredictable revenues may be generated by the auctioning of allowances or the taxing of emissions from international aviation and marine transport at a level equal to the carbon price. A global carbon tax would lead to predictable revenues, but seems unlikely due to resistance by many countries. The way costs are divided over regions varies widely between the above proposals, with the highest costs being carried either by the United States, the EU or China.

Which options are on the negotiation table regarding the use Kyoto surplus allowances in order to reach future reduction targets, and how do these affect reduction levels?

In the Kyoto Protocol, it was decided to reward countries for achieving emission levels below their Kyoto target by allowing them to carry over the difference to subsequent commitment periods. This difference is referred to as surplus emission allowances, often called 'hot air'. Most surplus allowances originate from the economic downfall of former Eastern Bloc countries. Options for addressing the carry-over and use of Kyoto surpluses vary from prohibiting carry-over of surplus allowances to restricting their use to having no restrictions on carry-over (current Kyoto Protocol rules). For its 20% unconditional target, the EU has decided that surplus allowances cannot be used by Member States for meeting their target. For the 30% target, the rules are still unclear. In case of no restrictions on carry-over, the ambition level for developed countries as a whole could decrease by 15%, and for the EU up to 14%, of 1990 emission levels (only for the EU 30% target). However, without the participation of Russia as largest potential seller and Japan and Canada as potential buyers in a second commitment period, many surplus allowances are unlikely to be traded. Decreases in ambition level will also be much smaller if the use of surplus allowances for meeting future targets is restricted, like under the other options. Interestingly, restricting the sale of surplus allowances may even benefit the sellers, due to a resulting increase in the carbon price.

What could be expected from reducing emissions through reducing deforestation in developing countries?

Emissions from deforestation are difficult to measure and therefore highly uncertain. Yet, with an estimated total share in CO_2 emissions of between 6% and 25%, deforestation is a very important emission source. Financial support – directly or via the carbon market – could help developing countries avoid deforestation. To establish this support, a REDD+ mechanism is being negotiated. Through this mechanism, value is awarded to carbon reductions by avoiding deforestation, in the form of CO_2 credits. REDD+ refers to five activities for reducing CO_2 emissions in the forestry sector in developing countries, including not only deforestation reductions and afforestation, but also forest management activities.

The EU has called for halving global deforestation by 2020. Models show that the technical potential for REDD+ in developing countries is large enough to reach this target. However, the feasible potential of REDD+ is estimated to be about half the technical potential, due to implementation barriers, such as insufficient capacity to

measure forest areas and carbon stocks, lack of experience in environmental markets, already established practices and institutional capacity. This causes the EU deforestation target to be regarded as ambitious and would require substantial finance flows to deliver.

What would a long-term 2 °C objective imply for the energy system?

Model calculations show that there is sufficient potential to reduce emissions to limit global warming to 2 °C with medium to high likelihood. Increasing energy efficiency, carbon capture and storage, bio-energy and other renewable energy, and reducing non-CO_2 greenhouse gases and nuclear energy, are all important for reducing emissions to low levels. This implies that achieving a 2 °C global target would require a transition towards a completely different energy system. Some options, such as improved efficiency or bio-energy combined with carbon capture and storage (BECCS), are more critical than others to limit global warming to 2 °C.

Saving energy is an important reduction measure, especially in the short term, with many other advantages. Decarbonising the power system could be a first and relatively affordable step and makes a largely all-electric energy system attractive. Policy on the use of bio-energy could be relatively easily implemented in transport, but involves major risks to biodiversity, food security and water overuse. Lifestyle changes could also contribute substantially to reducing emissions. Although estimates about additional investments that would be required in order to limit global warming to 2 °C are uncertain, many studies show numbers of between 1% and 2% of GDP annually.

What would be the implications of developed countries' and global long-term reduction targets for developing countries?

The EU and the G8 have advocated a global reduction target of 50% below 1990 levels, by 2050, combined with an 80% to 95% reduction target for developed countries. Developing countries resisted inclusion of these targets in the Copenhagen Accord. This raises the question of what such targets would imply for developing countries. Our analysis shows that, without side payments from developed to developing countries, an 80% reduction target for developed countries – combined with a 50% global target – would result in lower per-capita emission targets for developing countries for 2050. In such a case, the costs (as share of GDP) of reducing emissions for developing countries could well exceed those for developed countries. An 85% to 90% reduction target for developed countries as a whole, combined with a 50% global target, would result in similar per-capita emission targets for 2050 – and costs – for developed and developing countries. With these targets, emission trajectories for Brazil, South Africa and China show a peak during the 2020–2025 period, and for India this peak is five years later.

Which alternative routes for climate policy are being discussed and what are their potential consequences?

Presently, many 'alternative routes' for international climate policies are being discussed. These routes can be classified into three main groups. One group concerns

reforms within the present UN framework. A second group of alternative routes focuses on institutions or actors outside the UNFCCC. And a third group of options are those that aim to 'reframe' climate policies, in the sense that greenhouse gas emission reductions are a co-benefit of other policy objectives, such as green growth, biodiversity, air quality, development and security of supply. Each of the main groups of proposed alternative routes consists of several sub-routes and shows specific advantages in terms of mobilising support for emission reductions within societies worldwide. Often, however, the degree of societal support and the level of emission reductions resulting from these routes are uncertain. Therefore, these alternative routes currently under discussion should be seen as additions rather than feasible replacements of the UN framework as it exists today.

FULL RESULTS

Setting the stage

Objective of this report

The UNFCCC climate negotiations in Durban in 2011 will take place in turbulent political and economic times. Many parts of the world are facing financial and economic crises and emerging economies are rapidly becoming more important in an economic and political sense. The political and public attention focused on short-term crises does not seem to bode well for global agreement on a long-term problem such as climate change. Nevertheless, the climate negotiations have steadily moved forward over the past twenty years. Further progress, therefore, is to be expected in Durban, as well. At least two signals are hopeful in this respect.

The first signal is that, after high public expectations and a public disappointment about the negotiation results in Copenhagen in 2010, the negotiations now seem to have entered a new phase of pragmatism. As a binding climate agreement by all countries seems out of reach for the near future, 'pledge and review' is the current point of departure for further compromise, with non-binding emission reduction pledges made by countries under the Copenhagen Accord and Cancún Agreements. A second important signal is related to public opinion on climate science. The 2009 'Climategate' affair and subsequent discovery of (relatively few) errors in the IPCC reports raised doubts among the public about the integrity of climate scientists and the IPCC as a multilateral institution integrating climate science and policy-making. Examination of the accusations by an independent body (Inter Academy Council, 2010) led to a tightening of IPCC procedures that could contribute to restoring public trust in climate science. This already seems to be happening , since the European public has appeared to be more concerned about climate change in 2011 than it was in 2009 – and concern

about climate change remains greater than about the economic situation (Eurobarometer, 2011).

At the moment, a final international policy 'solution' to the climate change problem is not within sight. Countries still clearly have very different views on future international climate policy. These different views at least partly originate from the different impacts that both climate change and climate policies have on different countries and sectors. In the negotiations, these differences are reflected in the differences of opinion on all kinds of topics: finance, emission reductions, adaptation to climate change, avoiding deforestation, monitoring, and verification and 'banking' of surplus allowances – to name just a few. Few people beyond the professional negotiators, climate policy analysts and lobbyists from NGOs and business are able to still maintain a comprehensive view of the issues at stake. Within this context, the Dutch State Secretary of the Ministry of Infrastructure and the Environment has asked the PBL to assess the pledges by developed and developing countries for reducing or limiting their greenhouse gas emissions (Atsma, 2011). As this is only one of many complex issues, the PBL has taken this opportunity also to present analytical insights into a number of other important issues, to provide a wider audience with a better understanding of the climate negotiations. According to a scenario note (UNFCCC, 2011) for the climate negotiation round in Panama, in October 2011, these issues relate to clarity on the emission reduction pledges and on the rules for future reduction targets. Such issues include the role of financing (Green Climate Fund) and that of reducing deforestation and the rules for using surplus allowances – all of which are discussed in this report.

This report provides an overview and analytical assessment of some of the important issues in and around the climate negotiations.

Structure of the report

One of the most noteworthy issues discussed in the negotiations is that of the emission reduction proposals (pledges) for 2020, within the context of the overall objective of the UNFCCC, which is to avoid dangerous anthropogenic climate change. The Cancún Agreements state that deep cuts in global greenhouse gas emissions are required with a view to reducing global greenhouse gas emissions so as to keep the increase in the global average temperature below 2 °C above pre-industrial levels, and that countries should take urgent action to meet this long-term goal. The question is whether the current pledges will be sufficient for achieving such a target. In order to answer this question, Chapter 2 determines the 2020 emission levels that would be consistent with a 2 °C target, followed by an assessment of the current pledges in relation to these emission levels.

Chapter 3 follows up with some cost projections for the pledges. In particular, we focused on the costs for the EU versus other regions. The reduction levels crucially

depend on whether countries implement their unconditional or their more ambitious, conditional pledges, and on the more detailed agreements about which rules to adopt.

Chapters 4, 5 and 6 further elaborate several key topics that determine the 2020 emission reductions and associated regional costs. These topics include issues related to the Green Climate Fund (Chapter 4), the carry-over and use of surplus allowances ('hot air') from the Kyoto period (2008–2012) (Chapter 5), and the role of reducing deforestation in developing countries (Chapter 6).

Chapter 7 provides a detailed discussion of the technological pathways for achieving emission reductions, in order to explore what would be needed to achieve the 2 °C objective. These long-term transition pathways link the long-term climate objective to short-term emission goals.

Chapter 8 focuses on emission reduction trajectories from a global perspective, and discusses what could be an equal burden distribution for long-term emission reductions between developed and developing countries. Starting point for this is an examination of the costs and per-capita emissions of these reductions.

Finally, after having explored the climate negotiations in more detail, Chapter 9 zooms out again and looks at the context of the climate negotiations: Which 'alternative routes' are proposed compared to the status quo in the climate negotiations, and how could they contribute to support future climate policies?

Which emission level must be reached by 2020 to limit global warming to 2 °C, and what can we expect?

This chapter is based on Den Elzen et al. (2011b), Van Vliet et al. (2011), and Van Vuuren and Riahi (2011).

Ambitious long-term climate targets are subject of the UNFCCC negotiations, as are short-term pledges made by national governments. One of the main questions is whether these targets and pledges are consistent with each other.

During the climate negotiations in Cancún, in December 2010, it was decided that deep cuts in global greenhouse gas emissions would be required in order to keep the increase in global average temperature below 2 °C above pre-industrial levels, and that countries should take urgent action to meet this long-term objective. The consideration of bringing this target down further towards 1.5°C as part of a review planned for the 2013–2015 period, is also mentioned in the Cancún Agreements. Countries have made voluntary pledges to reduce or limit the increase in greenhouse gas emissions by 2020. This chapter deals with the question of whether these short-term pledges are consistent with the agreed long-term 2 °C objective. This report does not focus on the 1.5 °C objective, but, generally speaking, the 2020 emission levels would be about the same as those for achieving the 2 °C objective, although the chances of achieving the more stringent objective would be smaller, and emission reductions after 2020 would have to be achieved much faster.

To assess whether the pledges made by countries would be sufficient to achieve the long-term UNFCCC objective, we first looked at the level to which emissions by 2020 should be reduced to keep the 2 °C objective within reach, and also determined the flexibility in this emission level. Next, we compared this level with the level that could be expected from the reduction proposals. This topic is also covered by the UNEP's Emissions Gap Report (UNEP, 2010), a well-known literature assessment used here as a benchmark.

To which level should global emissions be reduced by 2020 to achieve the 2 °C objective?

The level of 2020 global emissions that would be consistent with achieving the 2 °C objective depends on technology development, inertia in emission reductions, the probability of exceeding the 2 °C objective, the costs of reducing emissions and the participation of countries.

Different greenhouse gas concentrations in the atmosphere correspond to different likelihoods of temperature increases staying below the 2 °C objective. Given the long atmospheric lifetime of CO_2, these concentration levels correspond more or less with certain cumulative emission budgets over this century. Still, there are various emission pathways that have a medium or likely chance of achieving the 2 °C objective. For example, it would be possible to take little action in the short term, if this is compensated for by increased actions taken during the remainder of the century. The opposite is also a possibility: take early action and rely less on reductions during the remainder of the century. Clearly, there would be limits to these possibilities, as the pace with which emissions can be reduced depends on capital lifetimes and time-consuming processes of social transformation. Decision makers will have to determine an effective yet feasible 2020 emission level by balancing: i) expectations on future technology development and implementation, ii) short-term inertia in emission reductions, iii) participation of countries in reducing emissions, iv) the probability of the temperature objective being exceeded, and v) emission reduction costs.

The pace at which emissions could be reduced depends on the participation of countries and sectors, and on the lifetimes of installations.

The participation of countries and sectors (e.g. international aviation and maritime transport) to an important degree determines how fast emissions could be reduced in the following decades. Generally, studies show that the 2 °C objective may only be achieved if all large emitting countries participate in reducing emissions within the following decades. Later in the century, the availability and implementation of technology to reduce emissions will also play an important role. Regarding the pace of implementation, there are constraints on how fast high-carbon energy infrastructure can be replaced with low-carbon infrastructure (e.g. replacing fossil-fuel-fired power plants with renewable energy production). An important constraint is the lifetime of such power plants. Generally, the decision to replace an installation with one that is less carbon-intensive is made not until at the end of the installation's (economic) lifetime, due to the high costs that would be involved in earlier replacement. Therefore, the lifetime of installations plays an important role in the pace at which emissions could be reduced, and consequently also will have an effect on the necessary 2020 emission level.

The possibility of 'negative' CO_2 emissions later in the century is of crucial importance for the 2020 emission level needed to achieve the 2 oC objective.

Several options would result in a net removal of CO_2 from the atmosphere. This includes reforestation and the use of bio-energy combined with carbon capture and storage

(BECCS; Chapter 7). The question of whether such technologies (BECCS, particularly) in the long term could be used on a large scale plays an important role in determining short-term emission targets. The use of BECCS not only depends on the physical potential for applying CCS and biofuels (each potential with its own uncertainties) but also on the societal acceptance of these technologies. However, it should be noted that, even with large-scale application of BECCS, emissions in other sectors also need to be reduced substantially.

So-called concentration (or even temperature) overshoot pathways create some room for short-term emission reductions.
The climate system is slow to respond to changes in emissions. This implies that postponing emission reductions for a short while, followed by more steep reductions within a few decades, will have very little effect on the climate system. Such 'overshoot' pathways, therefore, may create more flexibility in short-term emission reductions – with very little consequences for climate change. Obviously, it would also be possible to delay reductions even further (and compensate for this later on) but this would increase the likelihood of global warming exceeding 2 °C.

Most least-cost emission pathways consistent with achieving the 2 °C objective restrict 2020 emission levels to no more than 46 Gt CO_2 eq. Pathways with emissions of up to 50 Gt CO_2 eq by 2020 may still be possible, but would lead to additional costs throughout the century.
For the recent UNEP Emissions Gap Report, an extensive literature survey of least-cost emission pathways was performed which showed that, for a likely chance (more than 66% probability) of staying below 2 °C, emissions should be between 39 and 44 Gt CO_2 eq by 2020. For a medium chance (50% to 66% probability) of staying below 2 °C, emissions should be 42 to 46 Gt CO_2 eq by 2020. The lower end of this range implies a higher probability of achieving the 2 °C objective, and less dependency on technologies such as BECCS later in this century, but higher costs in the short term (with the higher end of the range having opposite implications). However, studies show that even emission levels of up to 50 Gt CO_2 eq could have a medium chance of achieving the 2 °C objective, if higher costs would be acceptable during the entire 21st century. Such scenarios, however, also depend more heavily on advanced future technologies that involve negative emissions and on the ability of other sectors to achieve very low emission levels.

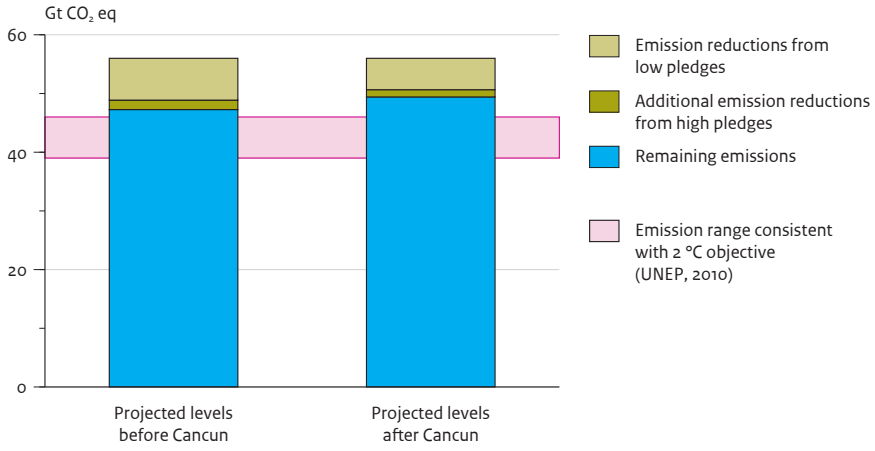
Which global emission level can be expected from the pledges?

Emission levels depend on if either the low or high pledges are implemented.
As part of the Copenhagen Accord, both developed and developing countries have submitted emission reduction proposals or pledges. Some countries, as well as the EU, have submitted both an unconditional and a more ambitious conditional pledge. Others

have only submitted a conditional pledge (e.g. Japan). In the case of developed countries, the more ambitious pledges are conditional on all parties making comparable reduction efforts. For developing countries, conditionality generally consists of adequate financial and technological support from developed countries. In this report, the 'high pledges' refer to the conditional pledges (implemented by all countries). The 'low pledges' refer to pledges under a scenario in which countries with an unconditional pledge implement this pledge, while all other countries implement their only (conditional) pledges.

New information following the climate negotiations in Cancún leads to a 2 Gt CO_2 eq upward adjustment of the estimated emission level resulting from the pledges, bringing it to between 51 and 52 Gt CO_2 eq.
Several studies were performed to determine the effect of these pledges and actions on greenhouse gas emissions, as summarised in the UNEP Emissions Gap Report for the Cancún negotiations (UNEP, 2010). The PBL also published its calculations before the UNFCCC conference in Cancún, and concluded that, if the reduction pledges by developed and developing countries were to be fully implemented, global greenhouse gas emissions would amount to between 49 and 50 Gt CO_2 eq by 2020 (Den Elzen et al., 2010). The negotiations are an ongoing process and, following the Cancún negotiations, two workshops were held; one at the Bangkok climate talks in April 2011 and one in Bonn in June 2011, as mandated in the Cancún Agreements. Both workshops allowed developed countries to clarify the assumptions and conditions of their proposed emission reduction pledges. They also allowed developing countries to clarify assumptions made in relation to their pledges and actions, and to indicate the support needed for implementation of their proposed actions. As developing countries expressed their reduction pledge relative to their projected business-as-usual emission level, the emission levels resulting from their pledges will greatly depend on these emission projections. Therefore, the most important updates since our earlier assessment concern updated national emission projections. Most of these updates have led to higher projections; for instance, for India, Brazil and Mexico. Moreover, insights into emission developments, especially in China, have also been revised. Based on these changes, the updated emissions resulting from the high and low pledges are 51 and 52 Gt CO_2 eq, respectively, by 2020. These estimates were based on adopted strict accounting rules that would avoid a net increase in emissions from (a) credits awarded for carbon removals from existing forests, and (b) the use of surplus emission allowances (Chapter 5). Using lenient accounting rules would increase these emission levels; especially, due to the carry-over and use of surplus allowances from the 2008–2012 period (Chapter 5).

Figure 2.1
Projected global greenhouse gas emission reductions, 2020



Source: Based on PBL FAIR/IMAGE/TIMER model calculations

The emission range consistent with the 2 °C objective assumes least-cost pathways; higher emission levels could be possible at higher costs throughout the century. The emission levels resulting from the pledges assume strict accounting rules for land use and surplus allowances.

Pledges and the likelihood of achieving the 2 °C climate objective

The current pledges are not likely to be sufficient to achieve the 2 °C objective.
As indicated above, it is difficult to determine which range of 2020 emission levels would be sufficient to achieve the 2 °C objective. The UNEP Emissions Gap Report indicated a level of 39 to 46 Gt CO_2 eq – based on least-cost pathways with full participation. Compared to these pathways, the gap might be of the order of 5 to 13 Gt CO_2 eq (Figure 2.1). However, higher emission levels may still limit global warming to 2 °C, but at higher costs and with reduced flexibility. This implies that the current pledges will not put the 2 °C objective definitively out of reach, but that increased future efforts from all countries would be needed and that achieving the 2 °C objective will be more costly and would depend more heavily on future technological developments. Unfortunately, there may be other factors that could result in even less reduction (Chapters 4 to 6).

Opportunities for further emission reductions include implementation of national climate policies and emission reductions in the international aviation and shipping sectors.

There are several opportunities to further reduce emissions by 2020 to increase the likelihood of achieving the 2 °C objective, apart from the options of increasing the ambition levels of the pledges and reducing emissions in countries without pledges. One of such opportunities could be for countries to implement emission reduction actions (in their national climate plans) that go beyond the pledged levels that were submitted to the UNFCCC. Another promising opportunity is setting targets for the international shipping and aviation sectors (which currently are not included in the country pledges).

THREE

Efforts and costs for the EU versus other world regions

This chapter is based on Den Elzen et al. (2011a) and Mendoza Beltran et al. (2011b).

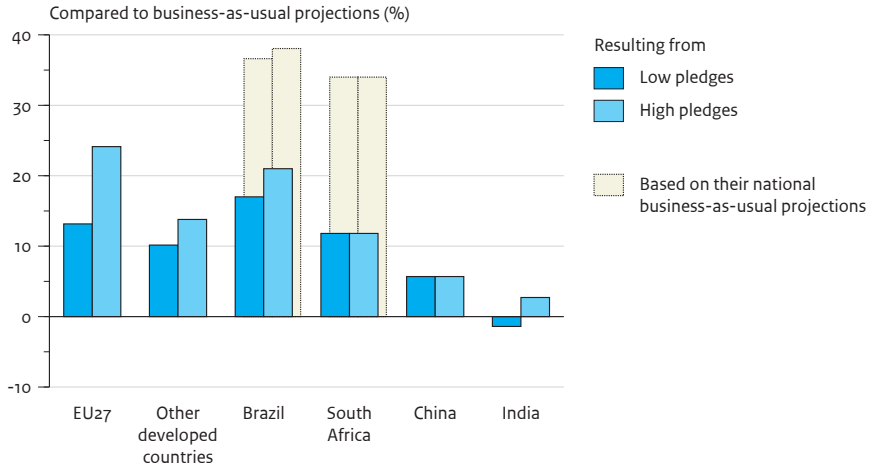
EU reduction pledges relative to those of other countries

The EU has committed to an unconditional reduction target of 20% below 1990 levels, by 2020. The EU would move towards the conditional reduction target of 30%, if other developed countries commit to comparable emission reductions and developing countries also contribute adequately. This chapter compares the reduction efforts and associated costs for the EU with those for the rest of the developed countries and the individual BASIC countries (Brazil, South Africa, India and China).

The EU reduction pledges compared with projected business-as-usual emission levels are higher than the average of the pledges by other developed countries.
Figure 3.1 compares EU's 20% target with the low pledges of all other developed countries (assuming countries with only one (conditional) pledge implement this pledge) and the major emerging economies, and compares the 30% target with other high pledges (whenever two pledges were submitted). If the United States, Canada, Japan and Russia, which have announced not to be on board for a second commitment period under the Kyoto Protocol, do not fulfil their pledge, the reduction as presented in Figure 3.1 under 'other developed countries', will be much less. To enable a good comparison, all pledges are depicted against projected 2020 business-as-usual levels.

Our analysis has shown that the reduction pledges of the EU, relative to projected business-as-usual levels, would lead to reductions that are higher than the average reductions in the other developed countries, especially for the high pledges (Figure 3.1). This is partly due to Russia and the Ukraine having pledges that are above their projected business-as-usual emissions. The difference would be even larger if credits

Figure 3.1
Greenhouse gas emission reduction targets, 2020



Source: Based on Den Elzen et al. (2011a)

Reductions by Brazil and South Africa that are based on their national business-as-usual projections are higher than when based on PBL business-as-usual projections. This is because the business-as-usual projections by the PBL are lower than these countries' national projections. The variation in costs for individual countries in the category of 'Other developed countries' is large and could for some countries even be negative (such as for Russia and the Ukraine).

were to be awarded for carbon removals from existing forests, which would mainly decrease the reduction target for other developed countries. It should be noted, however, that reductions compared to business-as-usual emissions are model-dependent, but take into account various national circumstances and predicted future growth, whereas simpler, transparent indicators, such as per-capita emissions, may not adequately represent national circumstances for all countries.

This figure also shows that, for the EU, the low and high pledges relative to the projected 2020 level are lower than 20% and 30%, respectively. This reflects the fact that emissions in the EU are currently below the 1990 level, due to existing climate policies and other factors, such as the economic collapse of the former Eastern European countries in the late 1990s.

For comparison, the pledges made by Brazil, South Africa, China and India are also given. The pledge made by Brazil after COP15 in Copenhagen 2009 resulted in a reduction target of 37% to 39% relative to the projected 2020 business-as-usual level. However, after the COP16 in Cancún 2010, Brazil substantially increased its projected

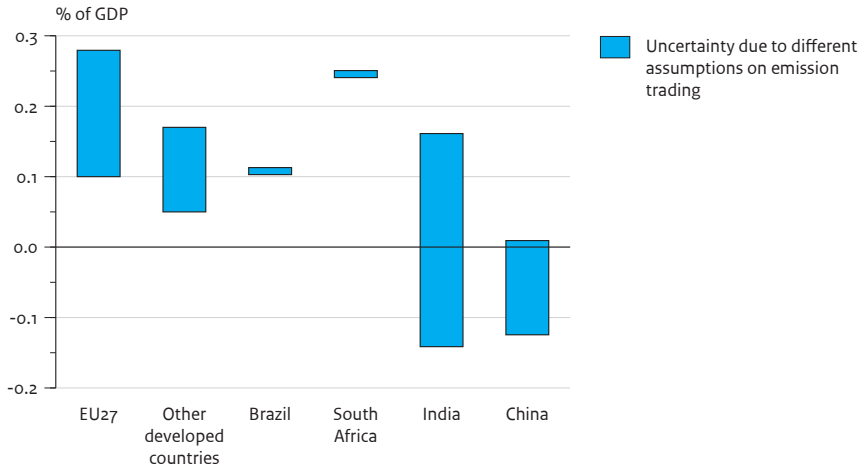
business-as-usual level – in particular for deforestation – thereby also increasing its allowed emission level. Brazil's actual reduction target compared to the original projected emission level (and projected emission levels from international organisations) therefore decreases to between 17% and 21%. The pledge made by South Africa also strongly depends on the business-as-usual projection that it is compared to; its national projections are given, as well as those by the PBL. China and India have submitted less stringent pledges than the other countries shown. It should be noted that these two countries do have national climate plans in addition to the international pledges, which are estimated to be more ambitious than their pledges.

EU costs relative to those for other countries

The costs for the EU to achieve its conditional reduction target are higher than the average costs for other developed countries.
Estimating the cost of technologies that can be applied to reduce emissions provides a first approximation of the emission reduction costs (Text Box 1). Figure 3.2 shows the range of such cost projections by 2020 for several assumptions about restrictions on emission trading and the use of surplus allowances (Chapter 5). Costs are presented for the high pledges only. For the low pledges, the costs for the EU, by 2020, will be below those for all other developed countries; for the EU, costs will be between 0.04% and 0.08% of GDP, whereas for all other developed countries these will be between 0.07% and 0.13%. Emission reduction costs will be higher if all countries have to meet their pledges domestically (which is the case for the high end of the ranges depicted in Figure 3.2). In such a case, the flexible Kyoto mechanisms, such as emission trading and CDM, cannot be used. For the low end of the ranges, there are no restrictions on emission trading and surplus allowances can be fully used to meet 2020 pledges (note that the latter also means that global reductions become watered down).

When interpreting the costs as depicted in Figure 3.2, it should be kept in mind that these are the costs for the high pledges, and that, for emerging economies, these pledges are often conditional on financial support. This means that costs for these emerging economies would partly be financed by developed countries. Figure 3.2 does not show the possible impact of financial support (apart from emission trading and CDM, which are included). Keeping this in mind, it shows that the direct costs to achieve the EU 30% pledge, expressed as share of GDP, are on average well above such costs for the other developed countries. Given that the EU emission reduction targets, compared to business-as-usual levels, are higher for the EU than on average for the other developed countries, this was to be expected. Costs for Brazil and especially South Africa are projected to be similar to the average costs for developed countries – explaining the demand for international financial support. For India and China, costs may even be negative, which means that these countries may profit from emission trading.

Figure 3.2
Greenhouse gas emission reduction costs for high pledges, 2020



Source: Based on Den Elzen et al. (2011a)

Costs of Brazil and South Africa are based on PBL business-as-usual projections and do not include international financing other than emission trading and CDM. However, their pledges are conditional on international financing and costs may therefore be partly financed by developed countries. The uncertainty due to different assumptions on emission trading is very low for Brazil and South Africa because these countries are assumed to reach their target by domestic reductions only.

Share in reduction efforts by developed and developing countries

How to determine whether pledged reduction levels are fair?

It is not easy to determine what would constitute a fair distribution of emission reduction efforts. The context of countries differs greatly; for instance, with respect to current levels of efficiency, economic development and growth, economic structure, technology, and financial situation. Based on these differences, countries tend to have very different views on what would constitute a fair distribution of reduction targets. Some countries emphasise the need for equal per-capita emission rights (or even for compensation for historical emissions) while others propose to start from the status quo.

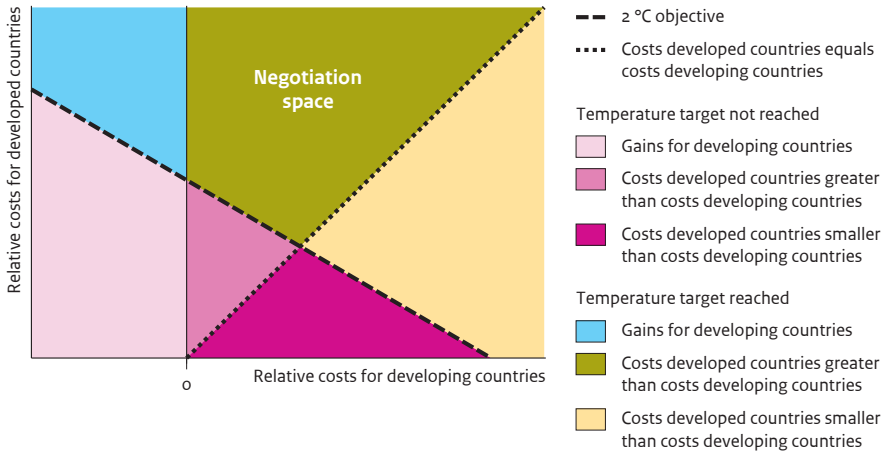
TEXT BOX 1: Estimating the costs of emission reductions

Different types of models may be used for estimating the costs of climate policy. Partial equilibrium models, such as the IMAGE/TIMER model used for the costs calculations here, focus on the competition between different technologies for meeting the demand for goods and services. Such models derive cost estimates from detailed descriptions of the energy and land-use systems. In contrast, general equilibrium models focus on the economy as a whole and the interactions between the various sectors. These models do not focus on direct costs, but on changes in economic production and consumption levels or welfare. Both types of models have their strengths and weaknesses. The direct emission reduction costs calculated by partial equilibrium models are somewhat less uncertain, but neglect the fact that, by changing prices, indirect effects may occur within the economy. For instance, reducing emissions is likely to lead to a shift in consumption and production from carbon-intensive goods and services to those that are less carbon-intensive. Macroeconomic costs will also result from redistribution of financial flows and changes in fossil-fuel trade (e.g. losses in export revenues from fossil-fuel exporters). Market failures (e.g. market power, R&D externalities and existing taxes on energy use) may also cause a difference between direct cost and macroeconomic cost. As a result, macroeconomic costs may be higher or lower than direct emission reduction costs. Recent simulations with a general equilibrium model projected an average welfare loss for developed countries by 2020 that would be equivalent to a reduction in national income of between 0.2% and 0.3%, for both low and high pledges (Bollen et al., 2011). These projections are of a similar level to that of the direct costs as presented in Figure 3.3. Welfare losses in the EU are projected to be above the average of those in developed countries. In the major emerging economies, on average, economic welfare tends to increase somewhat. This is especially the case for India, which will profit from cheaper fossil fuels as an oil and coal importer.

A pragmatic framework to explore the negotiation space based on three 'first-order' principles for an acceptable distribution of efforts.

Mendoza Beltran et al. (2011b) propose a pragmatic framework to explore the negotiation space between developed and developing regions (Figure 3.3). This framework starts from a set of 'first-order' principles that are likely to be agreed upon by most parties as the minimum conditions. However, the framework is intended to be a basis for further defining the acceptable negotiation space. The set of minimum criteria used in this first elaboration are: i) emission levels are consistent with achieving the 2 °C objective; ii) costs (share of GDP) for developing countries should not be higher than those for developed countries, and iii) costs for both developed and developing countries should not be negative. The last two of these principles can be seen as minimum interpretations of the notion of common but differentiated responsibilities,

Figure 3.3
Framework showing the negotiation space between developed and developing countries



Source: Mendoza Beltran et al. (2011b)

A minimum number of environmental and equity criteria are only being met in the green area.

the cornerstone of the UNFCCC (negative costs do not seem consistent with a notion of common responsibilities).

If one accepts these conditions, the negotiation space is already significantly constrained, as is shown in Figure 3.3. In this figure, the upper right green area assumes stringent targets in both developed and developing regions, and thus a likely chance of meeting the 2 °C objective – and corresponding higher costs of emission reductions. The bottom left part of the figure represents very small reductions with low costs and a small chance of meeting the 2 °C objective. Somewhere between these two areas the probability of achieving the 2 °C objective crosses the likely–unlikely threshold. This is represented by a dashed line (note that in practice it is very difficult to determine the exact threshold, see Chapter 2). The area where the 2 °C objective is unlikely to be achieved is indicated in violet.

The diagonal dotted line shows where the costs for developed countries equal those for developing countries. All cost combinations below this line imply that those for developing countries exceed those for developed countries (the yellow area). The vertical line represents zero costs for the developing region, while the blue area represents gains for them as a group. Combinations of reduction targets that end up in the green area meet all criteria. This framework shows that the negotiation space is much smaller than when considering environmental criteria alone.

Evaluating the pledges with the presented framework implies that both developing and developed countries should increase their ambition levels.

The previous chapter and Figure 3.2 suggest that the reductions in current pledges are in the pink area of Figure 3.3. The projected average costs for most emerging economies are lower than those for developed countries, but emission levels by 2020 resulting from these pledges do not correspond with the level that would be required in order to have a likely chance of limiting global warming to 2 °C. To keep costs for developing countries lower than for developed countries, financial support from developed countries could play an important role.

The Green Climate Fund

This chapter is based on Hof et al. (2011).

Background

The Green Climate Fund has been established to support climate policy in developing countries.
At the COP16 in Cancún, it was decided to establish a Green Climate Fund to support climate change projects – projects aimed at emission reductions as well as climate change adaptation – in developing countries. As for the size of this fund, both the Copenhagen Accord and the Cancún Agreements state that, by 2020, an annual amount of USD 100 billion should be mobilised in aid of this goal. How this funding will be raised is still an open question. The Copenhagen Accord only mentions that funding will come from a wide variety of sources, public and private, bilateral and multilateral, including alternative sources of finance, and that a significant portion of such funding should flow through the Copenhagen Green Climate Fund.

Public incentives so far have raised USD 13 billion, whereas the total target is USD 100 billion annually, by 2020.
Since September 2011, 24 international public climate finance initiatives have been started, with focus areas on emission reductions, adaptation and/or REDD (Chapter 6). Combined, these initiatives currently hold about USD 13 billion in funds, of which about USD 2 billion has been made available for specific projects[1]. Although these initiatives relate to financing projects between 2010 and 2012, and private funding may also play a role, the numbers show that additional financing mechanisms are necessary to mobilise an annual funding of the order of 100 USD billion, by 2020.

Projected revenues from proposed financing mechanisms

Some of the typical proposed financing mechanisms are based on taxing emissions, emission trading or auctioning allowances.

Many financing mechanisms have been proposed that could be used to raise revenues for the Green Climate Fund. This chapter discusses projected revenues and distribution of costs for four typical public financing proposals:

- a tax on emission trading;
- the auctioning of emission allowances (Norwegian proposal);
- a global carbon tax with a basic exemption (Swiss proposal);
- a tax on international aviation and shipping emissions (bunker fuel emission tax).

The first proposal – the tax on emission trading – would actually be a broadening of the main financing mechanism of the current Adaptation Fund. Instead of a tax of 2% on the share of proceeds of Clean Development Mechanism (CDM) projects, a tax would now also be raised on Joint Implementation projects and emission trading. The second, Norwegian proposal suggests withholding 2% of permits from the emission allocations of developed countries and auctioning them off by an appropriate international institution. The third, Swiss proposal suggests a global carbon tax of USD 2 per tonne of CO_2 on energy-related CO_2 emissions, with a basic exemption for each country of USD 1.5 per tonne of CO_2 per capita. Finally, the carbon tax on bunker fuel emissions is set at the projected market price of carbon for 2020. It should be noted that there are many more proposed financing mechanisms, which means that this chapter does not explore all options.

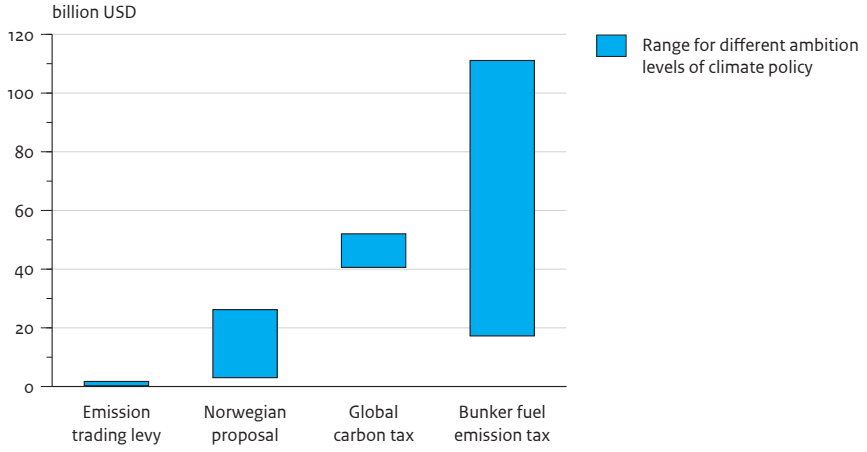
Revenues from financing proposals depend on future climate policies.

For each proposal, it is clear that revenues depend on the ambition level of emission reductions and the related carbon price. For the global carbon tax, the reason for this is that revenues will decrease with lower emission levels (as the tax base decreases). For the bunker fuel emission tax and the Norwegian proposal, revenues increase with lower emission levels, as these depend on the global carbon price, which in turn is determined by the stringency of the emission reduction targets. The revenues of the tax on emission trading, finally, not only depend on the global carbon price, but also on the quantity of emission credits traded. In each case, it means that the effectiveness of the instrument can only be fully evaluated once the overall climate policy is known. For this reason, we evaluated each of the proposals for both the low and high pledges, but also for more ambitious reductions consistent with achieving the 2 °C objective (Chapter 2).

Low revenues to be expected from a tax on emission trading; higher but unpredictable revenues from Norwegian proposal and bunker fuel emission tax.

Figure 4.1 depicts the range of projected revenues from the options, by 2020, for different ambition levels of future climate policy. Revenues from the proposals vary widely. Revenues from the tax on emission trading are projected to be very small: less

Figure 4.1
Projected global revenues per financing mechanism, 2020



Source: Hof et al. (2011)

Revenues depend on whether the low pledges are implemented or emissions are reduced to a level consistent with that needed to achieve the 2 °C objective.

than USD 2 billion in all cases. This is not surprising, as the current tax on CDM projects has only generated about USD 140 million since 2009[2]. The revenues from the other proposals would be more substantial. In the case of the Norwegian proposal and the bunker fuel emission tax, however, revenues are very uncertain as indicated by the wide ranges. Of the four proposals analysed, only a global carbon tax would generate predictable funding. It should be noted, however, that the bunker fuel emission tax could also be set at a fixed level instead of a one equal to the global carbon price, which would increase the predictability of revenues.

Distribution of costs

Cost distribution differs widely between the proposals, with either the United Sates, the EU or China incurring the highest costs.

Table 4.1 shows, for each proposal, what the costs would be for the EU, the United States and the BASIC countries, again assuming climate policies that vary between the low pledges and those consistent with achieving the 2 °C objective. As may be expected, costs are higher for proposals with higher revenues. The distribution of costs related to the bunker fuel emission tax depends on how emissions are allocated to countries. In the case of aviation, we allocated emissions according to bunker fuel sold, and for

Table 4.1
Distribution of the costs of four typical financing mechanisms, in billion USD

	Tax on emission trading		Norwegian proposal		Global carbon tax		Bunker fuel emission tax*	
	low pledges	2 °C target	low pledges	2 °C target	low pledges	2 °C target	low pledges	2 °C target
USA	0.0	0.2	0.0	10.7	8.8	11.5	2.7	17.6
EU	0.1	0.3	-0.2	7.6	5.8	7.1	5.4	35.2
Brazil	0.0	0.0	-0.4	0.0	0.2	0.4	0.4	2.4
India	0.0	0.2	0.2	-0.2	0.3	0.6	0.8	5.4
China	0.0	0.4	0.8	-0.3	12.0	15.3	2.1	13.7
South Africa	0.0	0.0	-0.1	0.0	0.6	0.7	0.6	3.6

Source: Hof et al. (2011)

The most important reason for the differences in total costs is caused by the fact that financing mechanisms that generate more revenues (Figure 4.1) also involve higher costs.

** For the bunker fuel emission tax, figures are not available for certain countries. Therefore, figures relate to South America instead of Brazil, to South Asia instead of India, and to Africa instead of South Africa.*

shipping according to the value of imported goods. With such allocations, the EU would incur about a third of the global costs (USD 5 to 35 billion, depending on the scenario). Costs for the United States would be about half of those for the EU and about 40% of those for China. With a global carbon tax (including the basic tax exemption), China is projected to incur the highest costs with USD 12 to 15 billion. The reason for this is the projected high growth in emissions. Costs for the United States are projected to be about USD 10 billion and for the EU USD 6 to 7 billion. It is very uncertain what the additional costs would be for separate regions under the Norwegian proposal (auctioning of emission rights). Costs even may be negative for some countries, due to the interference in the carbon market (as for all countries, 2% of their allowances would be withheld and auctioned, causing a slight increase in the total supply of credits on the international market).

Combining proposals does not necessarily increase predictability of funds.
High and predictable revenues are relatively strong elements of the global carbon tax. The same predictability could be achieved for the bunker fuel emission tax. The distribution of costs is obviously more subjective and countries are likely to have diverging views on this. One also needs to realise that, although the mechanisms analysed here were proposed, there might be large political and administrative obstacles to implementing them. This would especially be the case for a global carbon tax. Importantly, a low carbon price on the carbon market (e.g. resulting from the current low pledges) would undermine the generation of funding for all financing proposals analysed here, except for the global carbon tax. A combination of proposals to make revenues less unpredictable could also be an option. However, since revenues

decrease with less stringent targets for all proposals that depend on carbon price, combining these proposals would not increase the predictability of revenues.

Notes

1 From http://www.faststartfinance.org and http://www.climatefundsupdate.org (accessed 3 October 2011).

2 http://www.climatefundsupdate.org (accessed 3 October 2011).

Options for dealing with surplus emission allowances from the first Kyoto period

This chapter is based on PBL work in cooperation with members of the European Taskforce on Modelling and Assessment (ETMA) and the EU Expert Group on Further Action (EGFA) in 2011.

Background

Total surplus allowances for the Kyoto period (2008–2012) mainly originate from the economic collapse in the former Eastern Bloc countries.

According to the Kyoto Protocol, countries with allowances not required for meeting their Kyoto target for the first commitment period could carry-over these surplus allowances to be used or sold in subsequent commitment periods. Because of the economic collapse in certain countries that ensued from the dissolution of the Soviet Union and the Eastern European countries in the 1990s, emissions in these countries have strongly declined. As a result, their emissions will be below their Kyoto targets by the end of 2012, even without additional emission reduction policies. Therefore, these countries will have generated a substantial amount of surplus allowances ('hot air'). In addition, due to domestic policies and the recent economic crisis, surplus allowances are also expected for western European countries, such as Germany and the United Kingdom. Total surplus allowances for the first commitment period of the Kyoto Protocol (2008–2012) are estimated to lead to 3 Gt CO_2 eq in surplus allowances by 2020, which compares to 56 Gt CO_2 eq in expected global emissions by 2020. This is why rules for carry-over and use of surplus allowances for meeting future reduction pledges are of such importance. Russia (about 50%), the Ukraine (22%) and European countries (about 27%) have generated practically all of the surplus allowances. This chapter shows how the rules for using surplus allowances affect the actual reduction levels, the direct costs of reducing emissions and the carbon price, in order to contribute to the elaboration of the EU position on surplus allowances.

Table 5.1
Overview of the four options for using surplus allowances 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 surplus allowances	Not applicable

The amount of surplus allowances by 2020 could vary between zero and 3 Gt CO_2 eq, depending on the applied option to deal with surplus allowances.

In the UNFCCC negotiations, there are basically four options left of how to deal with Kyoto surplus allowances in meeting future reduction pledges:

- **Option 1** is the status quo, implying no restrictions on using Kyoto surplus allowances (to either sell or use for meeting future reduction targets). This leads to about 3 Gt CO_2 eq in surpluses by 2020 (Text Box 2, for methodology calculations).
- **Option 2** restricts the carry-over to a percentage of the total surplus allowance of Kyoto. The percentages currently proposed are 1, 2, 5, and 10. This leads to surpluses varying from 0.1 to 1 Gt CO_2 eq by 2020.
- **Option 3** restricts surplus allowances to be used for future domestic compliance only. This means that surplus allowances cannot be sold, and may only be used for reaching future targets. This leads to 0.4 to 0.8 Gt CO_2 eq in surpluses by 2020.
- **Option 4** prohibits carry-over of surplus allowances altogether, leading to zero surpluses by 2020.

These four options differ with respect to the rules on carry-over and on selling surplus allowances. Table 5.1 summarises the options based on this categorisation.

Impact of options for effective reduction levels by 2020

The actual reductions for developed countries as a whole could decrease by 15% from their 1990 emission levels, for the current option, but much less for the alternative options.

Table 5.2 shows by how much the different options could reduce the emission reduction efforts for individual countries by 2020. As the options only affect the reduction targets of countries with projected surplus allowances, only these countries are shown. This table clearly shows that the choice of rules regarding surplus allowances could strongly affect the ambition level of future emission reductions. Option 1 (no restrictions) effectively reduces the target of the EU by 14% of its 1990 emission level, and for the Ukraine by as much as 68%. The other options lead to much smaller impacts on the actual reduction targets.

Text Box 2: Important assumptions for calculating surplus allowances

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. These calculations depend on the following main assumptions:

- The contribution of land-use credits and/or CDM credits to reach Kyoto targets are not taken into account when calculating the level of surplus allowances;
- A second commitment period of eight years is assumed (2013–2020), in which all countries with Kyoto surplus allowances join;
- EU countries with emission levels above their Kyoto targets will not affect the total aggregated surplus allowances for the EU;

The use of surplus allowances is assumed not to be spread out evenly over the 2013–2020 period. Instead, more surplus allowances will be used later in the period. This implies that twice the surplus allowances will be used in 2020 compared to an even distribution over the 2013–2020 period.

Table 5.2

Impacts of the options for surplus allowances carry-over rules on the emission reduction target as percentage of 1990 levels

	Reduction of target for 2020 as % of 1990 levels								
	current pledge low	current pledge high	Option 1	Option 2				Option 3#	Option 4
				1%	2%	5%	10%		
EU27	20%	30%	14%	1%	2%	4%	7%	1–5%v i/ 1–11%ii	0%
Australia	-7%	8%	9%	1%	3%	7%	9%	0%	0%
Belarus	5%	10%	27%	1%	2%	6%	12%	0%	0%
Russian Fed.	15%	25%	42%	1%	2%	6%	12%	0–2%	0%
Ukraine	20%	20%	68%	1%	2%	6%	12%	0%	0%
Total developed countries *	12%	18%	15%	1%	1%	3%	5%	0–2%i/ 0–4%ii	0%

Source: Surplus AAU Check Tool of PIK and the PBL

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

Impacts of surplus allowances could be much smaller if countries were restricted in the purchase of these allowances or if Russia would not join a second commitment period.

The total impact of surplus allowances strongly depends on whether countries are buying such surpluses. Currently, the largest potential buyers are Japan, the EU and Canada. Japan, Canada and Russia have indicated that they will not make a new commitment under the Kyoto Protocol. Under current EU legislation to meet its

unconditional 20% reduction, surplus allowances cannot be used for compliance within the EU. Hence, the total impact of option 1 could be substantially lower, by 2020, than the projected 3 Gt CO_2 eq. Finally, the total supply of surpluses would also be halved if Russia would not participate in a second commitment period (thus not supplying any surpluses); a situation that seems likely, based on current positions.

Having no restrictions put on the use of surplus allowances could imply that the 30% conditional EU target in effect would involve less reduction than the 20% unconditional EU target.
The EU has decided that, for its 20% unconditional target, surplus allowances cannot be used. The rules for the conditional 30% target are still unclear. If, for the 30% target, surplus allowances could be used, option 1 could bring the actual reduction of this target below the 20% unconditional target. However, option 1 would result in supply exceeding demand for surplus allowances. Therefore, it is likely that this option would result in only part of the surplus allowances being sold. Most, if not all, surplus allowances would be carried over for use in future commitment periods (if this were allowed).

If Russia does not join a second commitment period, the amount of surplus allowances will be halved for option 1.
Under the currently more likely scenario of Russia not participating in a future commitment period, surplus allowances would be halved. In such a scenario, the EU would become the largest potential trader in surplus allowances. However, if the EU implements its 20% unconditional 2020 target, it will not be purchasing any surplus allowances, leaving a very thin surplus allowance market.

Costs and carbon market impacts of the various options

Restricting supply may benefit those selling surplus allowances.
Option 1a in Table 5.3 shows that expectations about no restrictions on carry-over and sale of surplus allowances are confirmed; it would cause over-supply, driving the carbon price down to zero. If, however, large surplus holders would be able to coordinate their actions and strategically limit the amount of surplus they sell, this would maximise their revenues. Assuming broad participation in the second commitment period, all options that would substantially limit the carry-over or sale of surplus allowances (option 2 with a 1% and 2% cap, variant I of options 3 and 4) also result in higher carbon prices. Moreover, these options would result in higher global emission reduction costs and larger benefits for countries that are selling carbon credits. As large surplus holders would not be able to coordinate their actions, it may be in their own interest to have rules limiting the supply of surplus allowances.

Text Box 3: Important assumptions for calculating costs and carbon prices

For the cost and carbon price calculations, the following important assumptions were made:

- Under option 1, both Kyoto surplus allowances and new surplus allowances can be sold. We investigated two variants: (1) the default case, where sellers of surplus allowances do not coordinate their actions (no seller coordination), leading to an over-supply of allowances driving down the carbon price; (2) the optimal supply case in which supply is limited in order to maximise profits.
- There is only one international carbon price for credits from CDM and JI projects and surplus emission allowances, although we did distinguish domestic carbon prices for certain regions or countries (e.g. the EU). This approach is also common in other carbon trade models.

Domestic carbon prices may be higher than the international carbon price, due to the assumption that 60% of the emission reduction target for developed countries needs to be achieved domestically, after using credits for land use and forestry, which is based on the EU's announced intention to achieve 60% of its conditional (30%) pledge through domestic emission reductions.

Table 5.3

Implications of the options for rules on carry-over of surplus allowances, abatement costs and carbon prices, assuming all countries implement their high pledges

	Carbon price (USD/tCO_2)	Total emission reduction costs in billion USD			
OPTION	International	Global	Developed countries excl. Russia & Ukraine	Russia & Ukraine	Developing countries
Option 1a. Full use & unrestricted supply of allowances	0	45	23	0.9	22
Option 1b. Full use & coordinated supply of allowances	14	45	26	–4	24
Option 2. Cap on carry-over					
1%	26	60	53	–14	20
2%	21	58	52	–15	21
5%	8	53	35	–5	24
10%	4	50	29	–3	24
Option 3. Domestic use only:					
variant i v	34	54	39	–8	17
variant ii v	23	47	28	–5	22
Option 4. No carry-over	29	61	56	–14	19

Source: Based on PBL FAIR/IMAGE/TIMER model calculations

Reducing CO_2 emissions from the forestry sector: What can be expected from REDD+ by 2020?

This chapter is based on Mendoza Beltran et al. (2011a).

Background

Deforestation accounts for 6% to 25% of total CO_2 emissions.
Currently, forests cover 31% of the world's total land area. However, this area is decreasing. Over the past two decades, around 260 million hectares of forest (or 7% of the total forest area) have been converted to other uses (mainly agriculture), or were lost due to natural causes. Deforestation practices, such as forest clearing, and slash and burn, lead to CO_2 emissions, thus contributing to climate change. According to different estimates, deforestation accounts for 6% to 25% of total CO_2 emissions, worldwide. Therefore, tackling deforestation may substantially contribute to addressing climate change, as well as achieve other co-benefits (such as biodiversity conservation).

Financial support could help developing countries to avoid deforestation and improve the use of their forest resources.
The main reason why deforestation and inefficient use of forest resources occur is because the land can be used for more tangible and profitable activities, such as agriculture, mining and infrastructure development. This implies that valuation of forests and financial support could help to avoid deforestation and improve the use of forest resources. One of the possibilities to do so is to assign value to carbon emission reductions from avoided deforestation via CO_2 credits. These credits could then be used for achieving national reduction targets, or be sold to other countries for meeting their reduction targets. To establish a mechanism to regulate this under the UNFCCC, the REDD+ mechanism is being negotiated.

The term REDD+ refers to five activities for reducing CO_2 emissions in the forestry sector.
Under the Kyoto protocol, CDM projects could take place in the forestry sector but only for afforestation and reforestation. In recent climate negotiations and most recently during COP16 in December 2010 at Cancún, countries have recognised and agreed on the importance of other activities in the forestry sector to reduce greenhouse gas emissions. These include:

a. *reduction in deforestation*
b. *reduction in forest degradation*
c. *conservation of forest*
d. *sustainable management of forest*
e. *afforestation/reforestation.*

Under the UNFCCC, these activities are referred to as REDD+, the abbreviation REDD standing for the first two types of activities (a and b) and "+" for the last three (c, d, e).

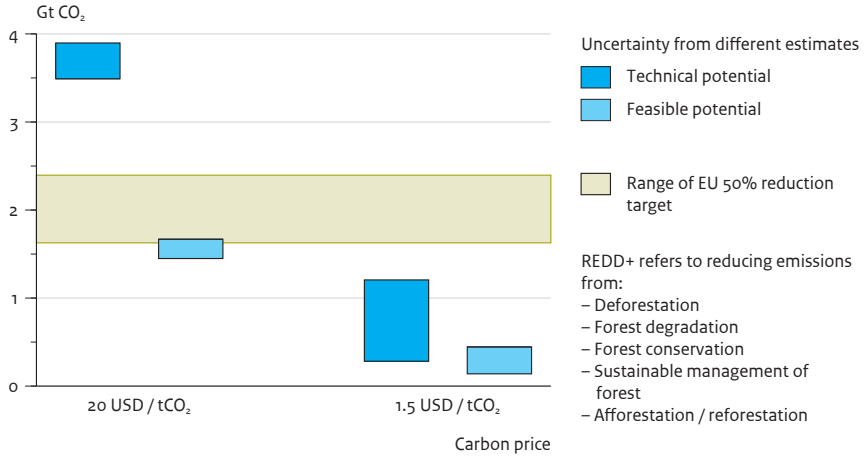
The EU aims to halve global deforestation by 2020.
The EU has called for halving deforestation, from current levels, by 2020. Interpreting this target as a 50% global reduction in deforestation emissions below 2005 levels, implies an emission reduction of 1.6 to 2.4 Gt CO_2 by 2020 (the exact reduction is uncertain due to uncertainty in 2005 deforestation emission levels). This illustrates the importance of REDD+ as an emission reduction option.

REDD+ potential in developing countries

Different circumstances between countries mean different possibilities for REDD+.
Most losses of carbon-richest forests take place in developing countries (Eliasch, 2008). During UNFCCC negotiations, parties acknowledged the different circumstances between countries that could undertake REDD+ activities. Some of the differences are historical development of the forestry sector, the amount of forest carbon stocks and their quality, institutional and traditional context, capacity for undertaking international business, capacity to measure forest areas and carbon stocks, experience in environmental markets and, in general, different governance capacities. These factors influence countries' capacities to effectively and efficiently measure, report and verify the development of their forestry sectors.

Potential supply of REDD+ credits depends on technical and feasible potential as well as on the question of ownership of the credits.
The amounts of REDD+ credits that could realistically be generated and supplied by developing countries depend on many factors, three of which we considered here. The first is the level of ongoing deforestation activities and the technical means to reduce them. This determines the technical potential for reducing emissions. The second factor relates to the barriers to the implementation of REDD+ programmes and policies, which

Figure 6.1
Global REDD+ potential, 2020

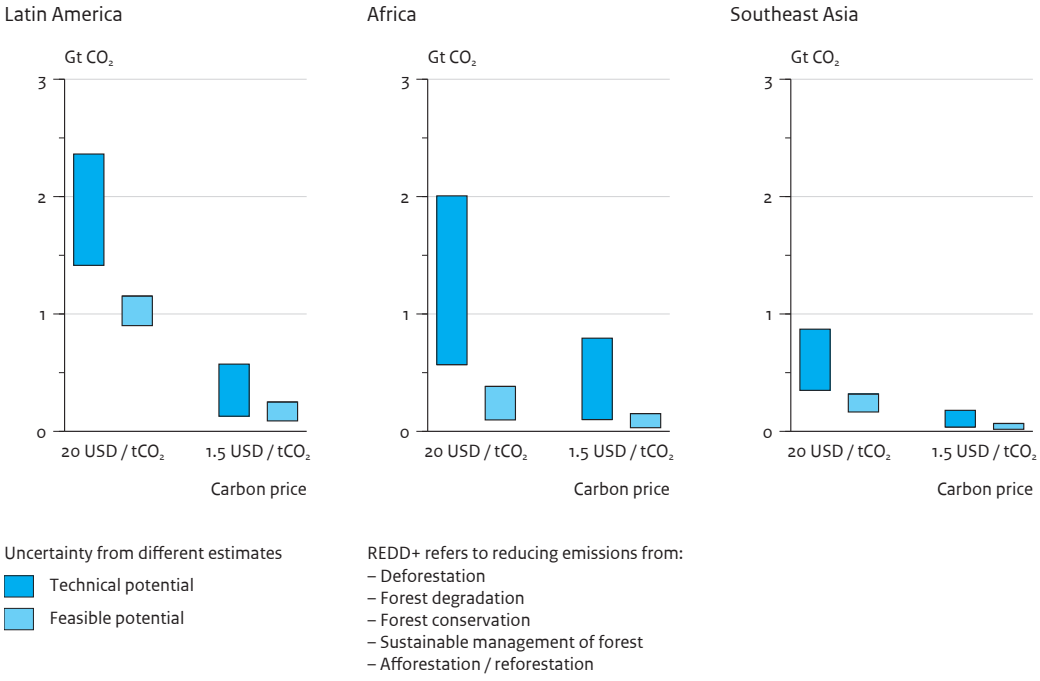


Source: Mendoza Beltran et al. (2011a)

determine the feasible potential. Finally, the third factor influencing supply is that of accountability. Who owns the REDD+ credits? Would that be the developing countries that undertake the REDD+ projects or the countries that finance them (as these can be different countries)? Related to this question is the issue of international financing of REDD+ actions and the mechanisms/sources used to finance them.

Feasible potential of REDD+ might be about half the technical potential.
Several estimates of the technical reduction potential at different costs have been published, based on different models. Figure 6.1 shows the potential for three of such models and two carbon prices (20 and 1.5 USD/tCO_2). The maximum reduction in emissions from deforestation that could technically be achieved by 2020 varies from 3.5 tot 3.9 GT CO_2 against the higher price and 0.3 to 1.2 Gt CO_2 against the lower price. The influence of the carbon price is thus far larger than of the uncertainty related to the models included here. Circumstances with respect to governance and accountability in developing countries may imply that the full technical potential cannot be used. Some very preliminary estimates have been made on how supply could be reduced as a result of national circumstances. We used these projections to estimate the feasible potential of REDD+ (although it should clearly be noted that this is very uncertain). The maximum feasibility for reduction in deforestation by 2020 is now reduced to around 0.3 (low price) to 1.6 Gt CO_2 (high price). Further problems around the ownership of REDD+ credits may involve more restrictions on their supply.

Figure 6.2
Regional REDD+ potential, 2020



Source: Mendoza Beltran et al. (2011a)

The feasible REDD+ potential may not suffice to reach the EU 50% reduction target at carbon prices below 20 USD/tCO_2.

The EU target of halving deforestation by 2020 would be achievable and affordable when based on the technical REDD+ supply of credits, according to all models. However, assuming that feasibility constraints could halve the potential implies that, under more realistic assumptions that include a carbon price of below 20 USD/tCO_2, a 50% reduction target should be regarded as very ambitious. This result is very uncertain, given that the feasibility factors are merely estimates – but it does indicate the difficulty involved in seriously reducing the rate of deforestation.

The feasible REDD+ potential is highest in Latin America, followed by Africa and Southeast Asia.

Figure 6.2 shows the potential for REDD+ in Latin America, Africa and Southeast Asia at high and low prices of carbon. Latin America appears as the main supplier of REDD+ credits at higher prices, followed by Africa and Southeast Asia. The technical potential is highest for Africa at low prices, but, due to higher estimates for implementation

barriers, the feasible potential is lower than for Latin America. The regional uncertainties in REDD+ potential and costs are much higher than at the global level.

REDD+ credits supply and demand

REDD+ actions may be used to reach developing countries' emission reduction targets.
Some developing countries have mentioned their interest in using REDD+ actions in order to meet their pledged emission reduction targets. However, how they are planning to meet their REDD+ targets has not been described in detail. Brazil, for example, has proposed a plan to reduce, by 2020, the annual rate of deforestation in the Amazon by 80% of the average rate over the 1996–2005 period, and according to other reduction rates for other forest areas. Indonesia has proposed to cut emissions by 26% below business-as-usual projections in all sectors, including forestry. The contribution of REDD+ has not been specified, but is expected to be high, as about 80% of their emissions come from deforestation and peat lands. Costa Rica aims for an emission reduction of 100% by 2021 and for Mexico this is 30% by 2020, both including forestry emissions. China and some African countries have mainly proposed actions to increase their forest area and managed forest area.

Medium and short-term demand for REDD+ credits from developed countries is very uncertain.
The EU has indicated the possible use of REDD+ credits for reaching reduction targets, but only under strict regulation and safeguards and only in the long term as part of the European Union Emission Trading System. This suggests that the demand for credits from the European Union may be low, by 2020. The United States expressed their intention to use REDD+ credits. However, at present, their position on this matter is unclear. Norway has actively shown support for reducing deforestation emissions in developing countries and has expressed its objective to meet one third of its reductions using international flexibility mechanisms. Norway and Australia, currently, are the largest donor countries for fast funding of REDD+ Readiness[1] activities (pledged and deposited). However, most of these funds are direct public financing initiatives which do not result in CO_2 credits. All in all, the above suggests the demand for REDD+ credits from developed countries is very uncertain, at least until 2020.

Of the USD 2.5 billion pledged, USD 250 million has been disbursed for financing REDD+ readiness.
At present, there are several funds to manage the financial flows for REDD+ actions in developing countries, such as the Forest Carbon Partnership Facility (FCPF), the UN-REDD Programme, the Amazon Fund, the Congo Basin Forest Fund, the Forest Investment Program and the International Forest Carbon Initiative. The first two are some of the most relevant examples of multilateral funds. They help developing countries implement their national REDD+ strategies and provide the funds for such a purpose. Currently, countries have pledged USD 2.5 billion for these funds combined,

while around USD 250 million has been disbursed. REDD+ funding has proven to be complex and slow.

Engaging governments, the private sector and local communities could be important, short-term steps to prepare for larger REDD+ action.

There are different ways to include REDD+ in an international agreement. REDD+ could be included in a post-2012 climate agreement through a fund or market-based mechanism. In the case of fund-based mechanisms, it is often difficult to assess whether proposed sources of funding would be sufficient. Under the right conditions, market-based mechanisms (e.g. cap and trade) would be able to mobilise the financial resources necessary, including resources from the private sector. However, given the high uncertainty of estimates on emissions from deforestation in developing countries and uncertainty in demand, the creation of markets for REDD+ in the short term would probably be premature. Therefore, market-based mechanisms are unlikely to provide the bulk of the finance for REDD+ actions in the near future. Engaging governments, the private sector and local communities could be important steps for linking REDD+ to carbon markets and, in this way, create more sustainable financing.

Note

1 REDD+ readiness relates to the efforts a country is undertaking, with the support of multilateral or bilateral initiatives, to build its capacity to be ready for a REDD+ mechanism. From: http://www.un-redd.org/AboutUNREDDProgramme/FAQs/tabid/586/Default.aspx.

The transition towards a low greenhouse gas economy

This chapter is based on Van Vuuren et al. (2009).

Background

In order to limit global warming to 2 °C, emission reductions after 2020 are in fact far more important than the emission level of 2020 (Chapter 2). Beyond 2020, a very ambitious transition towards a low greenhouse gas economy will be required. In this context, it should be noted that historically, emissions have been constantly increasing. For emission pathways consistent with achieving the 2 °C objective, emissions need to be reduced by around 50% by 2050, and must reach a level close to zero, or even be negative, by 2100 (Figure 7.1). In other words, an unprecedented decoupling of emissions and growth in economic activities needs to be sustained for many decades. Crucial question relate to which emission reduction measures could contribute to such reductions, and what are important considerations in designing a transition towards a low greenhouse gas economy.

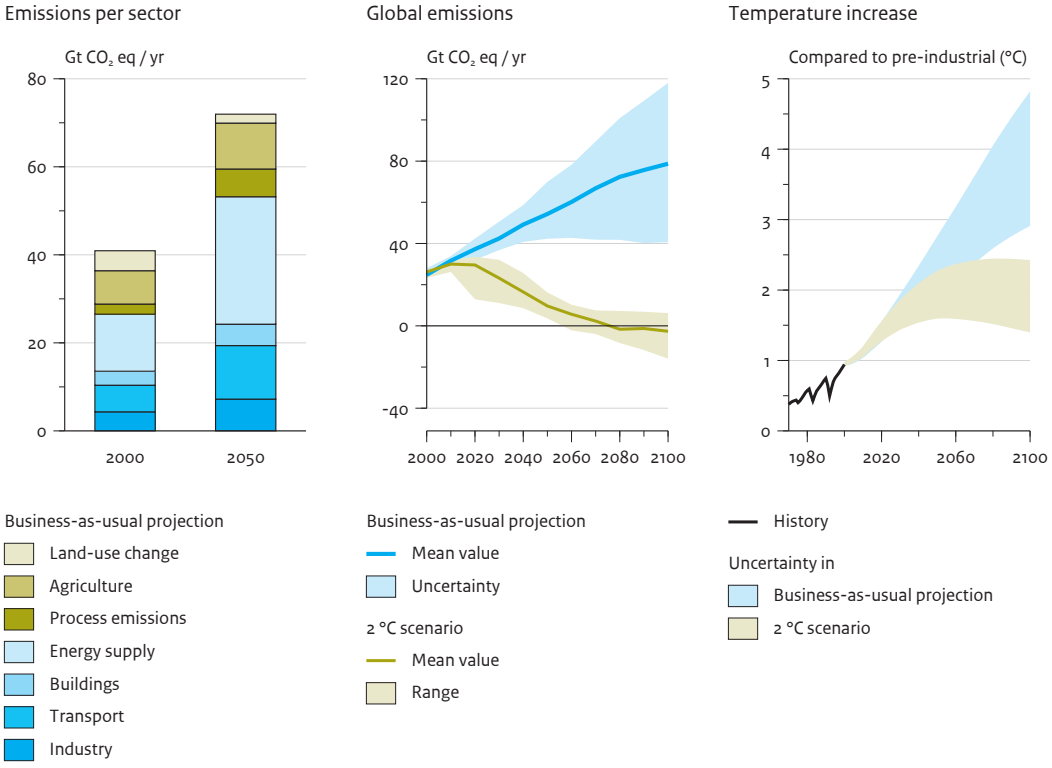
Different options necessary for reducing greenhouse gas emissions

There is sufficient potential to reduce emissions by increasing energy efficiency, changing energy supply, implementing end-off pipe measures, and land-use change to limit global warming to 2 °C, with medium likelihood.

In addition to changes in economic structure and lifestyle, there are four major ways of reducing emissions: increasing energy efficiency, changing energy supply, implementing end-off pipe measures, and land-use change. Different model studies show that

Figure 7.1

Global greenhouse gas emissions and temperature increase



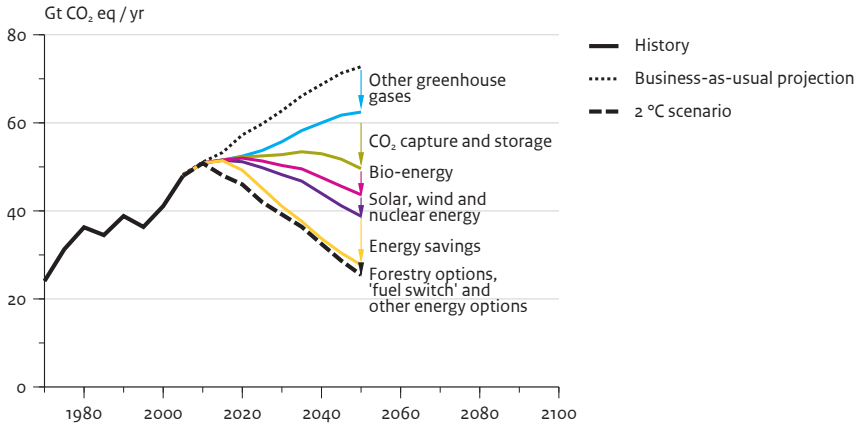
Source: Based on Fisher et al. (2007) and Van Vuuren et al. (2008)

sufficient emission reduction potential is available to achieve the required emission reductions for meeting the 2 °C objective.

Carbon capture and storage, bio-energy, renewable and nuclear energy, reducing non-CO_2 greenhouse gases, and increasing energy efficiency are all important for reducing emissions to low levels.

Figure 7.2 illustrates, for one particular 2 °C scenario, which options could be used for bringing about the required emission reductions, keeping costs as low as possible. It shows that, to limit global warming to 2 °C, a broad portfolio of emission reduction measures will be needed. In other words, there is no silver bullet, as the potential of individual technologies is limited. Moreover, some technologies are confined to certain sectors or regions. Energy efficiency, carbon capture and storage (CCS), large-scale bio-energy use and other renewable energy, nuclear energy, and a reduction in non-CO_2 greenhouse gases all contribute significantly to total emission reductions. The

Figure 7.2
Global contribution of reduction measures to achieve a low greenhouse gas economy



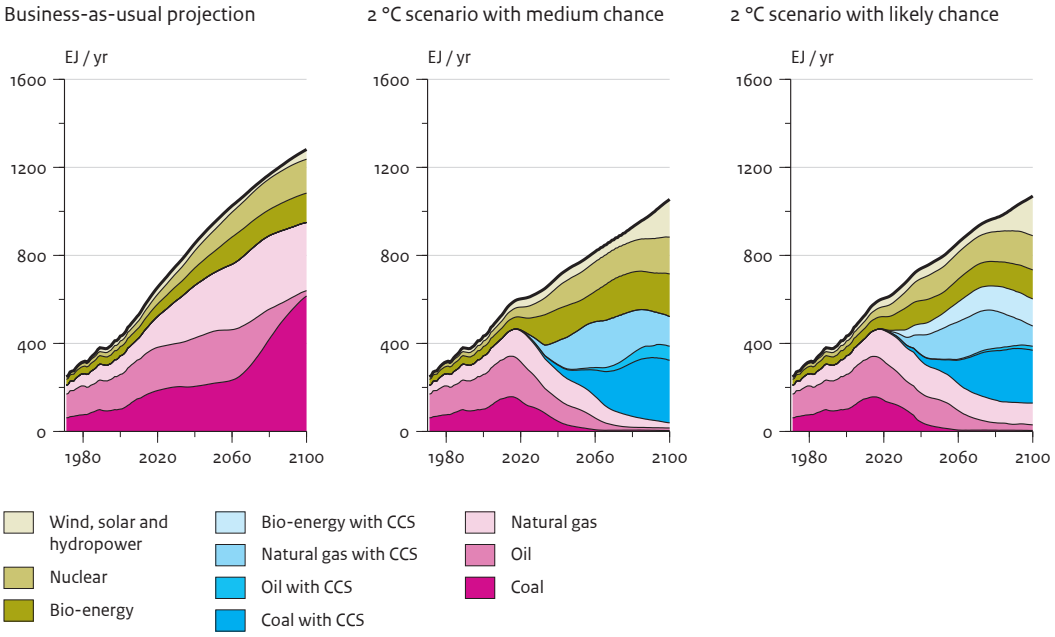
Source: Van Vuuren et al. (2007)
Forestry options here only include afforestation and reforestation (and not reducing deforestation).

contribution of various options changes over time. Early employment of measures regarding energy efficiency, reduction in non-CO_2 greenhouse gases, fuel switch, and forestry options are attractive, based on their relatively low costs. In the longer run, however, most reductions come from changes in energy supply.

Limiting global warming to 2 °C requires a completely different energy system.
An important implication of reaching the 2 °C objective is that the energy system will need to change completely. A 2050 energy system that would be consistent with achieving the 2 °C objective would look very different from today's system as well as from that under the business-as-usual projection (Figure 7.3). The use of coal, oil and natural gas will need to be replaced by fossil-fuel use in combination with CCS, bio-energy, nuclear power and renewable energy. The exact contribution of different options depends largely on technological development and societal choices. Therefore, this figure should be mainly regarded as an illustration. A similar pattern can be observed in most regions – although there are some noticeable regional characteristics that depend on the local availability of different forms of energy.

Some options, such as bio-energy combined with carbon capture and storage, are more critical than others to limit global warming to 2 °C.
Excluding emission reduction options may lead to additional costs or even to the inability to limit global warming to 2 °C. Combining bio-energy with carbon capture and storage (BECCS), for instance, is of critical importance for drastic emission reductions.

Figure 7.3
Global energy consumption per energy carrier



Source: Van Vuuren et al. (2010)

The shown energy shares are indicative examples. In the '2 °C scenario with likely chance' it is assumed that bio-energy combined with CCS is available, while this is not the case in the '2 °C scenario with medium chance'.

Some other technologies are less critical for achieving the reduction targets. In the power sector, for instance, different emission reduction techniques are projected to be available at lower costs than in many other sectors. As a result, certain technologies that are not available can be substituted, with limited financial consequences.

A closer look at important reduction options

Saving energy is an important reduction measure in the short term, with many other advantages.
Saving energy is an important element in all climate policy strategies. This includes technical measures, such as improving energy efficiency in buildings (better insulation, more efficient heating and cooling systems, more efficient appliances), industrial measures (e.g. more efficient production processes for steel and cement), as well as many so-called 'good housekeeping' measures that prevent energy waste. Increasing

the improvement rate of energy efficiency to potentially twice the historical rate would achieve substantial emission reductions over the next century, especially in the short term. Saving energy is an attractive option, because it has many other advantages; it reduces dependency on energy imports and sensitivity to energy price variations, and it helps to improve the competitiveness of companies or whole sectors.

Decarbonising the power system represents an important element of ambitious climate policy.
In general, it seems to be less costly to decarbonise the central power system than to do so in some other sectors. This is partly because of the availability of various options: large-scale renewable power production (e.g. wind power, hydropower, concentrated solar power), bio-energy, nuclear power and/or fossil-fuel fired plants in combination with carbon capture and storage. This makes it attractive to stimulate the transformation to an energy system with a higher share of electricity use, with electricity being produced – at least partly – in centralised units and distributed through a well-developed grid. Part of such a strategy would also be stimulating electric or hydrogen-based transport systems. The use of renewable energy requires the development of systems that are able to deal with intermittent supply options.

Bio-energy is relatively easy to implement compared to other options, but important concerns exists with respect to impacts on biodiversity, food security and water scarcity.
Bio-energy – energy produced from organic materials – could be an important option in climate policy, because of its ease of implementation. Moreover, depending on the oil price, it can also be a relatively low-cost reduction measure. An important advantage of bio-energy is that it may help to reduce emissions in sectors where relatively few alternative options for emission reduction are available, such as in aviation and shipping. Moreover, bio-energy combined with carbon capture and storage, in the electricity sector, creates net negative CO_2 emissions, as CO_2 is absorbed during crop growth and subsequently stored. However, there are also major risks associated with bio-energy use, especially with regard to biodiversity, food security and water scarcity. Therefore, a careful introduction of bio-energy is important, must be based on strict criteria, and impacts must be closely monitored. The development of bio-energy production schemes that are less in competition with food crops may reduce negative impacts to a certain degree (e.g. use of more marginal lands and residues).

Lifestyle changes could also contribute substantially to a reduction in emissions.
The impact of lifestyle changes is often overlooked, but can be considerable. Changes in lifestyle may contribute substantially to emission reductions. Examples of such adjustments are changes in transport modes and a more efficient use of energy. One clear example of how lifestyle changes may contribute to achieving multiple sustainability targets is that of reduced meat consumption. Stehfest et al. (2009), for instance, showed that adoption of low-meat diets could theoretically achieve as much as 20% to 30% of the emission reductions required to achieve the 2 °C objective. Financial stimuli (e.g. a meat tax) could help to achieve such lifestyle changes, but societal acceptance is important for implementing such a tax.

Implementing reduction technologies will require about a doubling of investments in the energy system during the 2010–2050 period.
Investments need to be scaled up – and above all, steered in a different direction. Investments in the energy system over the next 50 years will be considerable, with or without climate policy. Even in the absence of climate policy, the world would need to spend the cumulative figure of around USD 60,000 billion on energy supply, during the 2010–2050 period, to meet global energy demand, which is about 1.5% of cumulative global GDP over this period. Expenditures on the demand side are more difficult to determine but are estimated to be at least of the same order of magnitude.
Implementing climate policy measures would require a shift in existing investments, as well as considerable additional investments. PBL calculations estimate the additional costs to be around USD 50,000 billion over the 2010–2050 period, which would imply almost a doubling of investments on global energy supply compared to a scenario without climate policy. Estimates in other studies, all assuming global participation in climate policy, range from USD 20,000 to 100,000 billion. Costs will be higher if not all countries participate in reducing emissions. However, most of these studies have not accounted for all options, such as those relating to lifestyle changes.

Putting climate policy in a wider context

So far, it has proven difficult to reach an agreement on ambitious long-term climate policy, not only on an international level but also within countries. Important reasons for this include the fact that transitions affect the (vested) interests of a large group of actors, uncertainty in costs and benefits, expectations that future emission reduction technologies will be less expensive, disagreement on preferred actions, and the fact that benefits often occur elsewhere and far into the future. Below, some elements of successful policies that could potentially induce such required transition are discussed.

Use adaptive policies that include long-term targets.
Energy systems can only be changed slowly, over decades. Many energy technologies, such as power plants, have lifetimes of several decades. This implies that decisions today will influence the future for a long time. For climate change, this is an even more prominent issue, as many greenhouse gases will continue to stay in the atmosphere for more than a century. Therefore, it is important to have long-term targets. At the same time, in view of uncertainty and short-term priorities, policies also need to be adaptive and based on 'learning by doing'.

An integrated policy towards the energy system may yield co-benefits.
Replacing conventional energy technologies with alternative ones may have positive impacts (co-benefits), such as improving air quality and enhancing energy security. However, certain options, such as biomass and nuclear energy, bring new risks of adverse impacts. Climate policy is expected to lead to lower oil use, causing a reduction in oil imports and, thus, improved energy security for net energy importing regions,

such as the United States, the EU, India and China. In contrast, climate policy may cause an increase in global natural gas trade, in the short term, as it is a relatively clean alternative to coal. Dependency on bio-energy imports may also increase, although bio-energy production is likely to be less concentrated.

Greenhouse gas emissions and emissions of air pollutants, such as sulphur dioxide, and nitrous oxides, largely originate from the same activities. This implies that there are important links between climate policies and air quality policies. To achieve air pollution targets alone, end-of-pipe technology is often cheaper than the structural changes in the energy system associated with climate policy. However, such structural measures become more attractive when both climate and air pollution targets are pursued. Along the same lines, such a joint strategy might also have consequences for priorities in reducing emissions; for instance, reducing black carbon and ozone precursor emissions lead to benefits for both issues. In contrast, reducing sulphur emissions reduces air pollution but worsens climate change. Because of the difference in the timing of benefits, reducing air pollution often has a more favourable cost–benefit ratio than climate policy. The indirect benefits of climate policy – improved air quality – could therefore be an additional incentive for countries to more actively participate in climate policy (Chapter 9).

EIGHT

Implications for developing countries of long-term reduction targets

This chapter is based on Den Elzen et al. (2011).

Background

The EU and the G8 have advocated an emission reduction target for developed countries of 80% to 95% below the 1990 level, by 2050, and a global reduction target of 50%. Developing countries have resisted the inclusion of these targets in both the Copenhagen Accord and the Cancún Agreements. This raises the question of what these targets would imply for these developing countries by 2050. The projected per-capita income levels for these countries are much higher than they are today – implying that, by 2050, most of them no longer will be developing countries.

The Copenhagen Accord and Cancún Agreements: 2050 reduction targets and the 2oC objective.
In 2009, the EU called for an agreement to reduce global emissions by at least 50% below 1990 levels, by 2050, in order to have a likely chance of achieving the 2 oC climate objective. In addition, the EU stated that developed countries as a group, within this context, should reduce their emissions by 80% to 95%, by 2050, compared to their 1990 emission levels. This range was adopted from the IPCC, which already mentioned the same reduction targets for developed countries in its Fourth Assessment Report. During the 1990 G8 summit, this 50% global reduction target was reaffirmed and the emission reduction target for developed countries was slightly reformulated to '80% or more by 2050 compared to 1990 or more recent years'. During the 2009 international climate negotiations in Copenhagen, many developing countries agreed that substantial cuts in global emissions were required to avoid a rise in global temperature beyond 2 °C above pre-industrial levels. In Cancún, no long-term global emission target was agreed. However, it was decided to work towards identifying a global target for a substantial

Table 8.1
Implications of a 50% global reduction target, combined with a target for developed countries as a whole, for targets of developing countries as a whole

Reduction target developed countries	Reduction target developing countries		Per-capita emission targets		
			Developed countries	Developing countries	World
% 1990 level	% business-as-usual level	% 2005 level	tCO_2 eq	tCO_2 eq	tCO_2 eq
80	70	41	3.0	1.9	2.0
85	68	37	2.2	2.0	2.0
90	66	34	1.5	2.1	2.0
95	64	30	0.7	2.2	2.0

Source: Den Elzen et al. (2011)

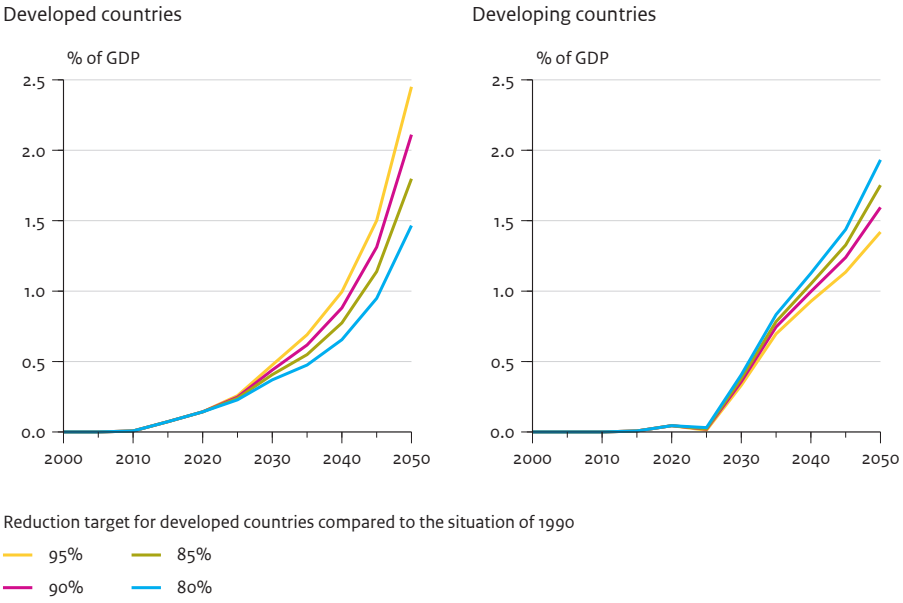
global emission reduction by 2050, and to discuss this at the COP17 meeting in Durban in 2011.

Developing countries resisted an 80% to 95% reduction target for developed countries, combined with a 50% global target, by 2050.
The developing countries resisted the inclusion of the above emission reduction targets for 2050, first in the Copenhagen Accord and later also in the Cancún Agreements. A global target combined with a target for developed countries naturally would delimit the emission space for developing countries, as well. A global emission target for 2050 of 50% below 1990 levels, combined with a reduction target for developed countries of 80% to 95%, would leave developing countries with only 15 to 17 Gt CO_2 eq emission space. This chapter shows the implications of such an emission space for the reduction targets, reduction costs, and energy transition of developing countries.

Implications for developing countries of a reduction target related to developed countries and the world

An 85% to 90% reduction target for developed countries and a 50% global target would result in similar per-capita emissions for developed and developing countries.
Table 8.1 shows that an 80% to 95% reduction target for developed countries would result in a reduction target for developing countries of between 30% and 40% below 2005 levels. A reduction target of 80% below 1990 levels for developed countries, combined with a 50% global target by 2050, implies that per-capita emission targets for developed countries would remain significantly higher than those for developing countries (Table 8.1). However, a 95% reduction target for developed countries with the same global target would result in per-capita emission targets for developed countries

Figure 8.1
Greenhouse gas emission reduction costs



Source: Den Elzen et al. (2011)

Transfer of public funds may change cost distribution. Global emissions are assumed to be reduced by 50% from 1990 levels.

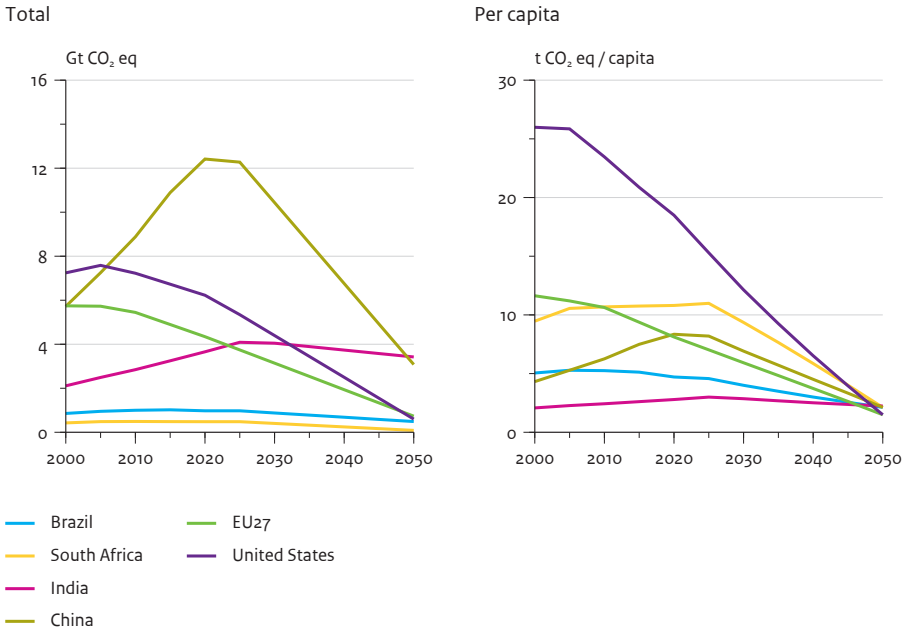
that are only one third of those for developing countries. In order to have similar per-capita targets for developed and developing countries, the reduction target for developed countries should be between 85% and 90% below 1990 levels.

Emission reduction costs for developed countries are projected to be of the order of 1.5% to 2.5% of their GDP, by 2050.

According to our model, equal per-capita emission targets for 2050, under a 50% global target, would lead to annual emission reduction costs as a percentage of GDP of about 1.5% to 2%, by 2050, for developed and developing regions as a whole (Figure 8.1) – assuming no transfer of funds for financing mitigation measures. Increasing the reduction target from 80% to 95% for developed countries would increase their costs from 1.5% to 2.5% of their GDP by 2050, whereas the costs for developing countries would decrease from 2% to less than 1.5%.

Figure 8.2

Greenhouse gas emission targets to achieve a 90% reduction for developed countries



Source: Den Elzen et al. (2011)

Global emissions are assumed to be reduced by 50% from 1990 levels.

Emission targets for Brazil, South Africa and China will peak around the 2020–2025 period, and for India five years later.

Politically speaking, the year by which emissions absolutely will have to decline is an important issue. This emission peak year marks the year in which the rate of decoupling of economic growth from emissions growth exceeds the economic growth rate, resulting in absolute emission reductions. Apart from the 2050 targets, the peak year depends on the height of emission targets of the various countries. Here, we have assumed a differentiated per-capita convergence rule. This implies that per-capita emissions in all countries will reach the same level, but differentiated over time. Developed countries will start their convergence trajectory after 2020 at emission levels resulting from their high pledges, and developing countries will start five years later. Under these assumptions and a target for developed countries of 90%, emission levels for China, South Africa and Brazil would be allowed to peak around the 2020–2025 period, and for India this would be five years later (Figure 8.2).

Alternative routes for international climate policies

This chapter is based on Slingerland et al. (2011).

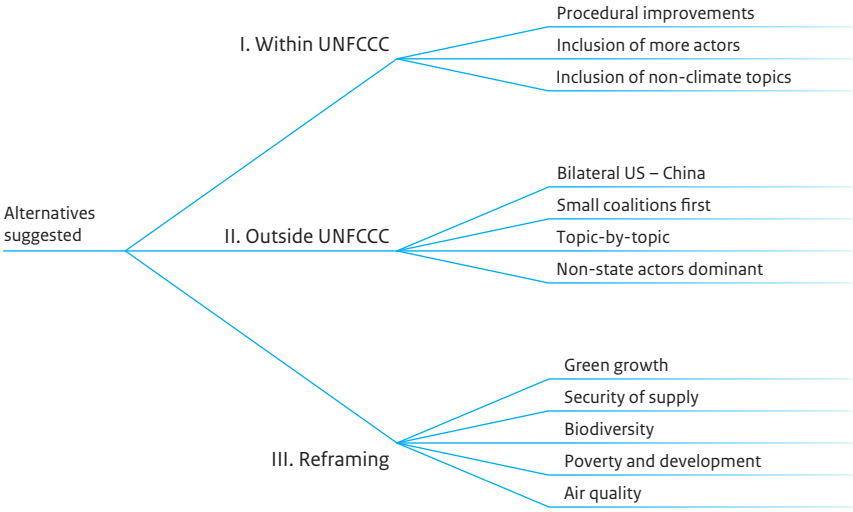
Apart from the technical complexities of issues in the climate negotiations, as addressed in the previous chapters, there are also many uncertainties about the effectiveness of the UNFCCC climate negotiations themselves. Overall, the UNFCCC process, so far, has led to fewer results (in actual emission reductions and current policies) than has often been claimed by policymakers, scientists and NGOs. Moreover, after the perceived failure of the Copenhagen summit in 2009, the process was close to losing its credibility altogether. In recent years, this has led to a large number of changes being proposed. This chapter provides a short inventory and discussion on these proposals.

Proposed alternative routes

Alternative routes may occur within the UNFCCC, outside the UNFCCC, or involve a complete reframing of the objective.

What are the possible changes or alternative routes in international climate policies? A review of articles published in scientific journals, web searches and interviews provided a first indication. These routes were found on three different levels. One set of proposals for reform believes that the UNFCCC is the right place for future international climate policies, but that a reform of this institution is needed. These types of routes were labelled '*Institutional routes within the UNFCCC*'. Another broad set of proposals considers institutional reform within the UNFCCC to be insufficient and focuses on other institutions that might be more effective in reaching international agreements regarding emission reductions. These routes were named '*Institutional routes outside the UNFCCC*'. A third main group of proposals, finally, does not focus on greenhouse gas emission

Figure 9.1
A taxonomy of suggested alternative routes for international climate policies



Source: Slingerland et al. (2011)

reductions, but indicates that attention should be focused on other international policy objectives, such as poverty or air quality, and greenhouse gas emissions should be aimed for as a co-benefit of these objectives. These routes were named '*Reframing routes*' (Figure 9.1).

Proposed reforms within the UNFCCC consist of procedural improvements, inclusion of more actors as well as non-climate topics.

The proposals within the 'Institutional routes within the UNFCCC' consist of a variety of proposed procedural reforms, varying from very small to very ambitious. Minor proposed reforms include capacity building by delegates, increased transparency of informal meetings, a more formal status for legal representation in small negotiation groups involved in drafting negotiation texts (e.g. 'friends of the chair') or a better institutional relation between the conference of the parties and the expert groups. Sometimes, proposals indicated the inclusion of civil society or businesses in the climate negotiations. Former UNFCCC Secretary, Yvo de Boer, for instance, stated that 'if private sector finance is a significant part of the solution, then it should also have a significant say in how that solution is designed' (De Boer, 2011). In some cases, proposals called for more inclusive negotiations in terms of topics. Or, as formulated by Noreena Hertz (2011): 'Widening the scope of the next round of negotiations so that much more can be

used as bargaining chips would make the job of the negotiators considerably harder. But it would give them also considerably more to work with.'

Proposed reforms outside the UNFCCC mainly focus on smaller coalitions or fewer topics.
Institutional routes outside the UNFCCC are found to be generally based on 'partial approaches' – that is to say, on the assumption that starting with smaller coalitions or fewer topics could create momentum and, at a later stage, could form a stepping stone towards a more comprehensive approach. Four main sub-routes are identified within this category:

1 Partial coalitions, starting with a limited number of countries to include more countries at a later stage. The most noteworthy examples within this group are the activities of the G8 and G20, which aim to push forward the climate policy agenda by involving only the main emitters and the most important economies. Another example is the 'Cartagena Group', a group of countries seeking to promote more ambitious climate policies.
2 Topic-by-topic approaches single out one or a few topics to be promoted in detail. Proposals include an 'Orchestra of Treaties' (Sugiyama and Sinton, 2005), a 'Building Blocks Approach' (Falkner et al., 2010) and discussions about separate technology treaties (De Coninck, 2009). Examples that build on this approach, which have developed in actual practice, are the REDD+ partnership, the Carbon Sequestration Leadership Forum and the Methane to Markets partnership.
3 Initiatives by non-state actors, such as cities, businesses or NGOs. Examples of such initiatives that have emerged are the C40 climate leadership group, in which large cities worldwide with ambitious climate targets are involved, or the activities of the World Business Council on Sustainable Development.
4 Bilateral activities by the main emitters the United States and China could also be put in this category, although this is mostly meant to support other processes. In this context, Lewis (2010) can be quoted: 'Although bilateral cooperation between the United States and China alone cannot solve the global climate challenge, it is essential to working out key differences, facilitating dialogue among business and policy leaders, and implementing workable solutions to climate change in incremental but concrete steps.'

Reframing routes hope to achieve greenhouse gas emission reductions as a co-benefit.
Reframing routes see reducing greenhouse gas emissions as a by-product or co-benefit of other policies that are supposed to find more support within societies, worldwide. Prins et al. (2010) formulate this as follows: '...It is now plain that it is not possible to have a 'climate policy' that has emissions reductions as the all-encompassing goal. However, there are many other reasons why the decarbonisation of the global economy is highly desirable'. Although it is debatable whether this statement is correct, there is a large array of potential reframing routes that can be grouped into five main policy themes: Green Growth; Security of Supply; Biodiversity; Poverty and Development; and Air Quality and Ozone Layer Protection. Currently, these five themes, for various reasons, are also on the agendas of policymakers worldwide.

Main advantages and disadvantages of alternative routes

Small procedural reforms probably are easy to implement, but will not fundamentally change the course of negotiations. Fundamental reforms are much more difficult to agree on.
Regarding proposed routes within the UNFCCC, it can be said that smaller procedural reforms, such as those aiming at capacity building, are likely to facilitate the negotiations and may be relatively easy to implement, but will not fundamentally change the course of the negotiations or lead to new breakthroughs. More fundamental procedural reforms however, such as the introduction of majority voting or even an organisational redistribution of functions within the negotiations, are considered very difficult to agree on – as such decisions would meet with the same conflicting interest between countries that exist within the current negotiations.

Including businesses and NGOs in UNFCCC deliberations has the disadvantage of further complicating negotiations.
Formal inclusion of actors such as businesses and NGOs, would lead to a better representation of those groups of actors responsible for an important part of implementing future actions and providing financing that are required for emission reductions. Nevertheless, their inclusion in the negotiations would further increase the number of views and interests that have to be taken into account for any decisions to be taken. It should be noted that businesses may have differing views, due to differences in interests. In the end, as businesses and NGOs are not a Party to the UNFCCC, it will remain up to countries to agree on a political regime that creates the legal certainty that particularly businesses require to take investment decisions; while governments also remain politically accountable to their constituencies.

Including other topics in the UNFCCC is not likely at this moment due to increasing complexity.
Many feel that the climate negotiations already have become far too complex (partly because many policy initiatives are linked - and a deadlock on one issue can derail the whole process). The advantage of adding other topics (allowing more 'horse-trading') is therefore likely to be outweighed by the risk of further increasing the complexity and bureaucracy of the negotiations.

Starting with smaller coalitions can mobilise aspirations, but it remains to be seen whether this can result in many countries joining at a later stage.
The general merit of institutional routes outside the UNFCCC would be that an agreement of all parties on all topics is no longer needed. Rather, some of these alternative routes could be followed independently of other routes. The main hypothesis related to these routes is that leading examples may later be followed by others and that individual pieces of the puzzle can be merged into one complete picture in the future. However, although starting with smaller coalitions appears promising in that they could mobilise existing energies and aspirations within societies worldwide, there is as yet little evidence of the 'leader inspires follower' principle in international

climate policies. Additional potential disadvantages are: a possibly reduced ambition level, in the long run, as a result of quickly negotiated agreements between small numbers of participants; implications to international competitiveness and trade regimes if one coalition opts for stringent measures and others do not; an environmental 'race to the bottom' caused by pick-and-choose behaviour by actors between the various routes available; and, finally, concerns about equity, as more powerful countries would be able to create mechanisms that best serve their own interests, whereas less powerful countries might not be able to do so.

vReframing climate policies could make use of the support for other policy topics, but serious contributions to emission reductions are uncertain.

Potential advantages of reframing routes are found particularly in the additional drivers that the climate discussion could make use of. Rather than being a main international policy topic, climate change in these alternative routes could (also) be attached to other policy topics that have greenhouse gas emission reductions as a co-benefit. In this way, climate policies could use other policies to achieve results. Some of these options could have more benefits at a local level and in the short term than climate policy, such as air pollution control and security of energy supply.

Disadvantages are considered to lie in particular in the conceptual vagueness of some reframing routes, such as 'green growth' and 'security of supply'. Without clear and internationally agreed definitions and indicators, 'greenwashing' in these routes is hard to distinguish from serious contributions to emission reductions and other environmental targets. Another possible disadvantage of reframing routes is found in doubts about the relative drive of these alternative routes as public mobilising concepts, compared to climate change (e.g. is there more progress in international policy-making on biodiversity?). It is far from certain that differences of interest between countries that exist in the climate discussion are not also encountered within the reframing routes (e.g. does putting poverty first resolve the North–South conflicts in the climate discussion?). Finally, for many of these options solutions exist that do not have climate benefits: air pollution can be reduced by end-of-pipe measures, energy security can be improved by using coal. Co-benefits will be much larger when climate change effects are explicitly accounted for in policy design.

Glossary

Allowances (or 'credits')
The allowed amount of greenhouse gas emissions for achieving the targets from the first Kyoto commitment period (2008-2012) or subsequent commitment periods.

BECCS
Bio-energy combined with carbon capture and storage. A greenhouse gas emission reduction technology which leads to negative net CO_2 emissions by combining biomass use with carbon capture and storage in geological reservoirs. The technology is usually applied in power generation plants.

Bio-energy
Energy generated from materials derived from biological sources (biomass). This includes wood, agricultural crops such as sugar cane and maize, straw, and agricultural and forest residues.

Business as usual
Refers to a future without new climate policies. Business-as-usual future emission projections are therefore projected emissions assuming no new climate policies are implemented.

Carbon price
Marginal price at which emission credits for greenhouse gases (in CO_2 eq) are sold on the market. In the model framework used in this report, emission reduction measures were implemented in response to a carbon price resulting from a carbon tax. Due to the carbon price, low greenhouse gas technologies become relatively attractive compared

to greenhouse gas intensive technologies. The potential for greenhouse gas emission reduction increases with increasing carbon prices.

Carbon tax
A tax on greenhouse gas emissions. A carbon tax is one of the possible policy measures that put a price on greenhouse gas emissions (carbon price).

CCS
Carbon capture and storage. Similar to BECCS, but applied in fossil-fuel combustion instead of biomass. Therefore, CCS does not generate negative emissions.

Clean Development Mechanism (CDM)
One of the three flexibility mechanisms under the Kyoto Protocol. CDM allows developed countries to invest in emission reduction projects in developing countries. Developed countries investing in CDM projects receive certified emission rights (credits) for reductions achieved in developing countries. These credits subsequently may be used to offset domestic emissions. In this way, CDM may help developed countries reach their emission reduction target.

CO_2 eq
The concept of CO_2 eq emissions is used for expressing various greenhouse gas emissions that influence climate, in a single number. This is generally done by weighing the emissions of different gases, over a 100-year period, using Global Warming Potentials (GWPs). These GWPs represent a relative measure of how much heat a greenhouse gas traps in the atmosphere over a certain period of time.

Commitment period
Period within which countries have committed to reducing their CO_2 eq emissions below certain levels. The first commitment period is from 2008 to 2012; the second period is still under consideration.

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 credits between countries. This may also apply to trade in emission credits between businesses, such as within the EU ETS. A precondition for emission trading is a capping of the allowable emissions for each country or business joining the cap-and-trade system. If actual emissions are below the allowance level, the excess allowances can be sold to countries/businesses that have difficulties in reaching their target.

GDP
Gross Domestic Product. The market value of all final goods and services produced in a country within a given period. It does not include international financial transfers.

Gt
Gigatonne = 10^{12} kg.

High pledges
Refers to a scenario in which countries implement their most ambitious conditional emission reduction pledge for 2020.

Joint Implementation (JI)
One of the three flexibility mechanisms under the Kyoto Protocol. Similar to CDM, except for the fact that, under JI, emission reduction projects take place in another developed country, rather than in a developing country.

Likely chance
Used to convey the probability of meeting temperature limits with a likelihood of over 66%.

Low pledges
In this report, the term 'Low pledges' refers to a scenario in which all countries with only one (conditional) emission reduction pledge for 2020 implement their pledges and all countries with both an unconditional and conditional pledge implement their least ambitious (unconditional) pledges.

Medium chance
Used to convey the probability of meeting temperature limits with a likelihood of between 50% and 60%.

Pledge
For the purpose of this report, pledges include targets for Annex I (developed) countries and non-Annex I (developing) countries, as included in the Copenhagen Accord's Appendices I and II, respectively.

Surplus allowances
Following the first commitment period of the Kyoto Protocol (2008-2012), countries still holding allowances that are not required for compliance with their commitments, are able to carry them over for future use or sale. There is also the possibility that new surplus allowances will be created in the second commitment period, when targets are set above business-as-usual expectations.

UNFCCC
The United Nations Framework Convention on Climate Change. 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
US dollars (US$). We have used the dollar value of 2005 throughout this report.

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In the coming years, decisions have to be made on several important, yet unresolved issues within the UNFCCC climate negotiations. This report provides analytical insights into a number of these issues, including: the emission reduction levels needed by 2020 to meet the 2°C objective; the adequacy of the current emission reduction pledges made by countries; the effect of different rules to address the Kyoto surpluses on the 2020 reduction efforts; the contribution from reducing deforestation to emission reduction and generating funds for supporting climate policies in developing countries. The report also addresses some issues related to long-term strategies, such as the feasibility of a transition to a low greenhouse gas economy, and the impacts of long-term emission targets on developing countries. Finally, this report discusses the potential for 'alternative policy routes' as support for the activities within the UNFCCC. Model calculations show that achieving the 2°C objective will be difficult, assuming the 2020 level expected from all pledges, as these would lead to higher long-term costs and depend heavily on future technological developments.

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