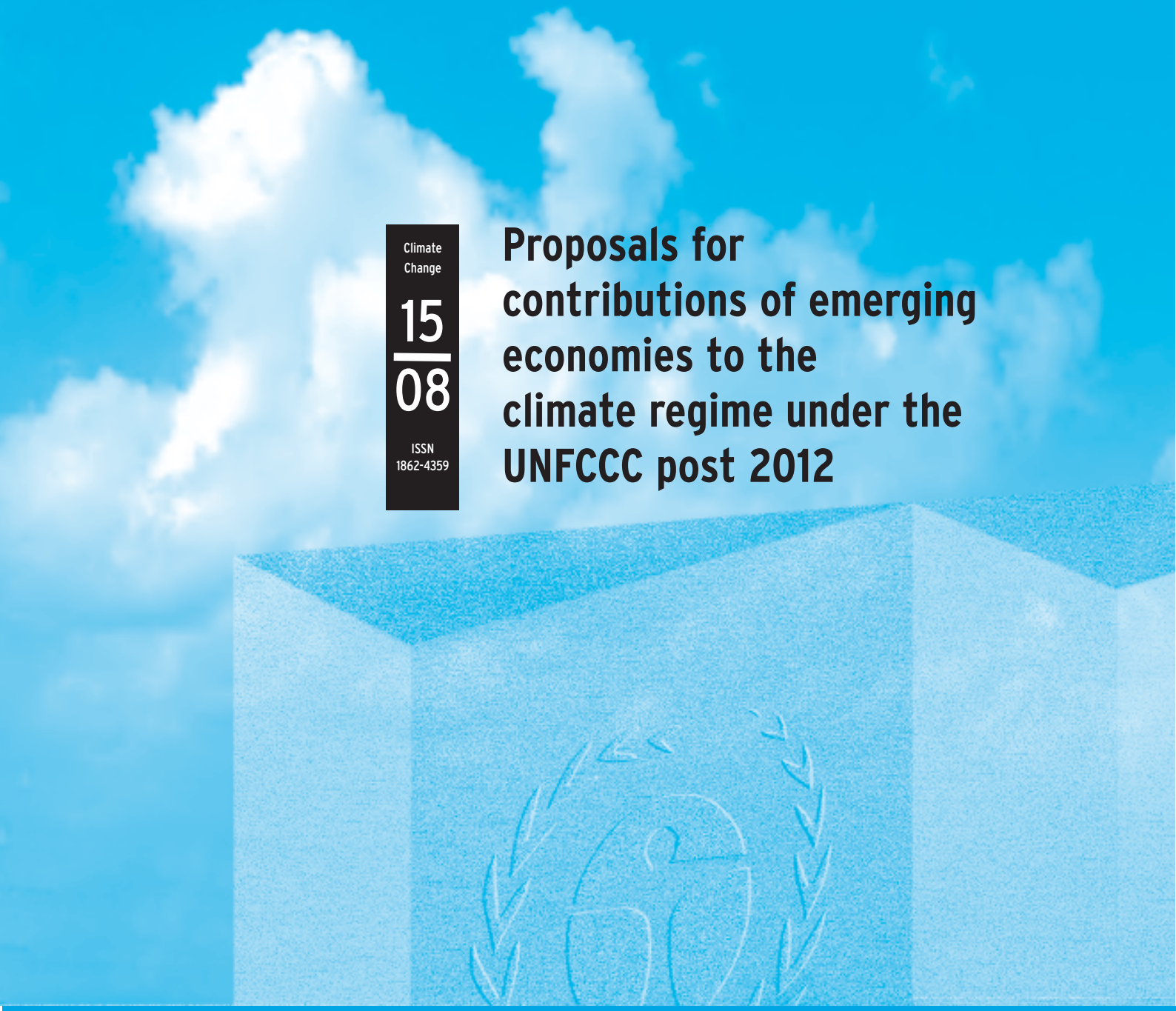
Climate Change

Climate Change
15/08
ISSN 1862-4359

Proposals for contributions of emerging economies to the climate regime under the UNFCCC post 2012



Umwelt Bundes Amt
Für Mensch und Umwelt

ENVIRONMENTAL RESEARCH OF THE
FEDERAL MINISTRY OF THE ENVIRONMENT,
NATURE CONSERVATION AND NUCLEAR SAFETY

Research Report 364 01 003
UBA-FB 001200

Climate Change
15/08
ISSN 1862-4359

Proposals for contributions of emerging economies to the climate regime under the UNFCCC post 2012

by

Niklas Höhne[1]
Christian Michelsen[2]
Sara Moltmann[1]
Hermann E. Ott[2]
Wolfgang Sterk[2]
Stefan Thomas[2]
Rie Watanabe[2]

with contributions from

Stefan Lechtenböhmer[2]
Karl Otto Schallaböck[2]

[1] Ecofys, Germany
[2] Wuppertal Institute, Germany

On behalf of the Federal Environment Agency

This Publication is only available as Download under
http://www.umweltbundesamt.de

Publisher: Federal Environmental Agency (Umweltbundesamt)
P.O.B. 14 06
06813 Dessau-Roßlau
Tel.: +49-340-2103-0
Telefax: +49-340-2103 2285
Internet: http://www.umweltbundesamt.de

Edited by: Section I 2.1
Guido Knoche
Anna Schreyögg

Dessau-Roßlau, Oktober 2008

Proposals for contributions of emerging economies to the climate regime under the UNFCCC post 2012

Niklas Höhne[1], Christian Michelsen[2], Sara Moltmann[1], Hermann E. Ott[2], Wolfgang Sterk[2], Stefan Thomas[2] and Rie Watanabe[2]

With contributions from Stefan Lechtenböhmer[2] and Karl Otto Schallaböck[2]

[1]: Ecofys, Germany

[2]: Wuppertal Institute, Germany

Final report

16 July 2008

For the Federal Environmental Agency (UBA), Germany

FKZ 364 01 003

PECSDE062376

ECOFYS GmbH, Eupener Straße 59, 50933 Cologne, Germany, Tel. +49 221 510907-0

Wuppertal Institut für Klima, Umwelt, Energie GmbH, Döppersberg 19, 42103 Wuppertal, Germany

Contents

Summary

1. Introduction

Under the principle of "common but differentiated responsibilities," (Article 3.1 of the UNFCCC) non-Annex I parties have so far been exempted from emission limitation or reduction commitments. However, the pressure is mounting on those countries, especially major emitting developing countries, to contribute actively to the mitigation of climate change. Participation by these developing countries in a future international climate regime is often called for, but it is usually unclear how and how much these countries should participate, what kind of support they need and in which sectors. This project aims to provide a more detailed view on six countries to understand how they could best make a contribution to the regime and how they could best be supported in limiting their greenhouse gas emissions.

In this project "Proposals for contributions of emerging economies to the climate regime under the UNFCCC post 2012" for the German Environment Agency, Ecofys and the Wuppertal Institute analyse in detail the situation of the major emitting developing countries Brazil, China, India, Mexico, South Africa and South Korea. It includes an overview of emissions and economic development, provides estimates of the emission reduction potential up to 2020 in a consistent manner, examines already existing policies and measures to effectively limit greenhouse gas emissions, suggests how they could be complemented by further measures and, finally, makes recommendations on how efforts by these countries could be integrated into the international climate change agreement under the UNFCCC and the Kyoto Protocol.

2. Methodology

Elements of the work were reviewed by country experts of all six countries and were subsequently refined.

Estimating reference emissions and mitigation potential

The project included the development of a bottom-up spreadsheet calculation model to describe possible future emission trends and reduction options until 2020 consistently for Brazil, China, India, Mexico, South Africa and South Korea. We calculated four scenarios in a consistent manner for all countries:

Business-as-usual: The business-as-usual (BAU) scenario follows production, energy consumption and energy efficiency trends that are based on moderate assumptions. Where available, these assumptions or related growth rates were taken from national studies. This was possible for Brazil, China and India (Centro Clima et al. 2006; Chen et al. 2006; TERI 2006). For those countries or sectors where no detailed studies were available, patterns and growth rate trends were usually assumed to be similar to previous years. This scenario can be considered to lead to relatively high levels of emissions.

No-regret: Pathways under the no-regret scenarios include GHG emission reduction options that can be achieved at negative or no direct costs. These would include, e.g. energy efficiency measures, where the economic gains from reduced energy use outweigh the investment costs for more efficient technology. Some would call this scenario also "economic potential at costs below 0€/tCO_2eq". We did not make a precise economic analysis of the costs of each measure but applied generic assumptions. Given the economic net benefit achievable, it should be in the interest of each country to realise this potential with its own resources. The international community could, however, support implementation both by technical contributions and by seed funding for, e.g. national revolving funds and for implementing policies and measures to overcome non-market barriers.

Co-benefit: Pathways under the co-benefit scenario consider reduction options that are reasonable due to political aims other than greenhouse gas emission reduction. This includes also reductions at some costs. A typical measure would be the increased use of

renewable energy sources to increase energy security and to decrease dependency on import of fossil fuels or switching from diesel to gas in passenger transport for air quality reasons. It should be in the interest of each country to realise this potential with its own resources. However, the fact that it may entail some extra cost means that not only technical but also financial contributions from the international community would be helpful to achieve this scenario.

Ambitious: The ambitious scenario includes reduction options, which can be implemented but at extra net costs, while maintaining the same service level. This scenario includes reduction options that are technically feasible and would accelerate the capital stock turnover, but they would not lead to stranded investments. We did not undertake a precise economic analysis but used the level of 100 USD/tCO_2eq as a rough guide for the maximum extra net costs of options to include. However, depending on discount rates as well as other developments, costs can lie below this level. This potential can be realised if both the non-market barriers are removed and financial incentives are provided to cover the extra net costs. It could be achieved with additional contributions from the country itself or from the international community.

The general methodology in the spreadsheet is a bottom-up approach. The tool, however, is limited to the availability of useful input data. With this tool, one is capable to compare emission reduction options across these developing countries in a comparable manner. This is a novelty since currently consistent studies are available only for broad global regions, which usually do not include these countries separately. Studies on individual countries are also available but these are not comparable between countries. The tool we developed allows this comparison.

Analysis of national climate policies

We developed a sourcebook for good practice climate policy instruments as a basis for the implementation of climate policies (see Appendix C). The sourcebook, assessments of country experts, and the circumstances of the respective country served as a basis for our suggestions on how to improve the existing mix of climate policies and measures. This study, however, merely provides a general framework. The concrete tailoring of policy packages including their evaluation and, if necessary, adaptation is a further task of the respective countries. It should also be noted that difficulties in gathering detailed information on current climate policy instruments in the selected countries did not allow a thorough in-depth analysis.

For each of the sectors analysed, technology areas or subsectors with a significant potential for reduction of GHG emissions have been identified. For each of these areas and subsectors, a package of policies and measures was identified.

Link to the international climate regime

We also made suggestions for potential contributions to the climate regime by the six countries considered based on two main principles:

- Ecological adequacy (contribution to stabilisation of GHG concentration): any post-2012 regime should aim for containing global temperature increase at below 2°C above pre-industrial levels. Meeting the 2°C limit requires that almost the full ambitious mitigation potential of the six countries considered in this project is mobilised in addition to a domestic emission reduction of at least 30% below 1990 levels by Annex I countries.
- Differentiation according to national circumstances to implement the principle of common but differentiated responsibilities and respective capabilities: the analysis is bases on the three principles of responsibility, capability and potential.

As for the provision of international support, we proceed from the assumption that the no-regret potential as a rule does not require permanent financial support from the international community. The analysis furthermore proceeds from the assumption that the co-benefit potential needs some financial support because it may not be realised by non-Annex I parties

despite the benefits and that countries will profit from non-financial support. It will finally proceed from the assumption that utilising the options identified under the ambitious mitigation scenario would crucially depend on international financial support in order to remove economic and other barriers as well as on other support.

3. Current mechanisms to involve developing countries in the international regime

Non-Annex I countries are in many ways already involved in mitigation and limitation activities within the Convention and the Protocol. These are financial mechanisms, technology transfer, and the Clean Development Mechanism (CDM).

The post-2012 negotiations under the UNFCCC and the Kyoto Protocol

The negotiations in the context of the UNFCCC and the Kyoto Protocol are the main pillar of the global efforts to fight climate change. This regime provides not only the global framework for a host of other multi- and bilateral activities; it is furthermore the only forum that is all-inclusive.

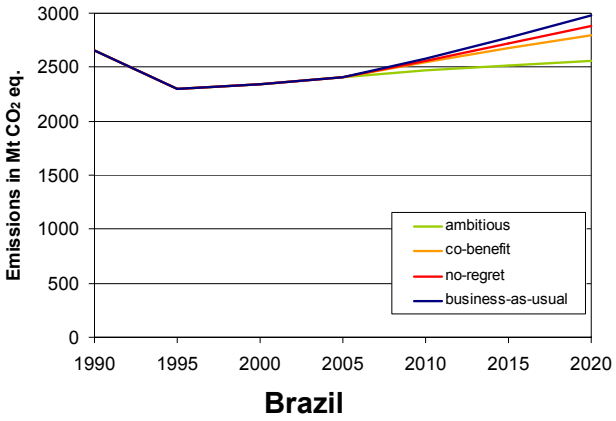
Of the many possible types of commitments of developing countries in a future framework, the following options/combinations appear to be most promising:

- Absolute emission targets
- Dual targets/no-lose targets
- Dynamic sectoral no-lose targets
- Registry of sustainable development policies and measures

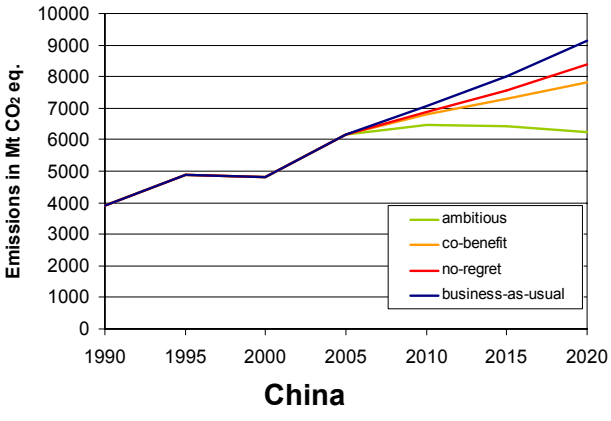
4. Overview of scenarios

Figure 1 gives an overview of the business-as-usual and the reduction scenarios for greenhouse gas emissions in Brazil, China, India, Mexico, South Africa and South Korea between 1990 and 2020.

For the ambitious scenario the reduction potential is considerable and amounts to about 30% below BAU for all considered countries as a whole. This is made up of a potential of 14% below BAU for Brazil, 32% below BAU for China, 38% below BAU for India, 39% below BAU for Mexico, 35% below BAU for South Africa and 42% below BAU for South Korea. The following sections provide more detailed information and results per country.



Brazil



China

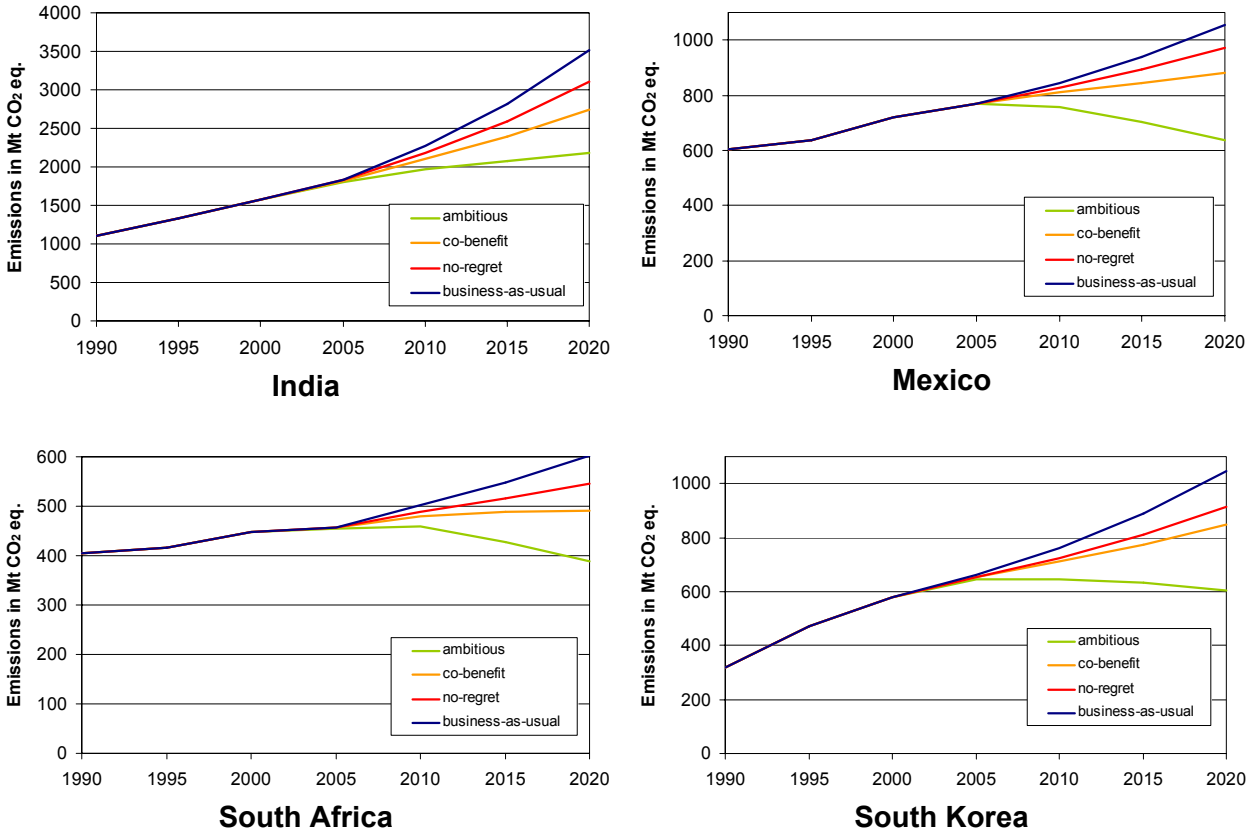


Figure 1. Scenarios for greenhouse gas emissions in Brazil, China, India, Mexico, South Africa and South Korea between 1990 and 2020.

5. Brazil

Overall, the strong position of renewable sources in Brazil's energy mix leads to comparatively low emission intensity in electricity generation. Due to Brazil's level of development and its fuel mix, per capita emissions are low compared to industrialised countries but high compared to other Latin American countries. Brazil's emissions are likely to increase in the future due to development and a related increase of transport and energy demand per capita.

Reference emissions and mitigation potential

As illustrated in Figure 1, the reduction potential for Brazil is 3% (no-regret), 6% (co-benefit) and 14% (ambitious potential) below BAU. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the transportation, power and industrial sector. The ambitious mitigation potential in the transportation sector is estimated at 164 $MtCO_2eq$ in 2020. In the power sector, there exists an ambitious potential of 120 $MtCO_2eq$. The ambitious potential in the industrial sector is estimated at 59 $MtCO_2eq$ in 2020. The total ambitious mitigation potential in Brazil is estimated at 429 $MtCO_2eq$ in the year 2020. A detailed overview of the potential per sector and scenario can be found in Appendix B.

Existing and possible further national climate policies

Already today, Brazil has implemented and planned a number of climate change policies and measures. Further policies and measures could be e.g.:

- **Transport sector**: energy taxation of fossil fuels, road fees, and congestion charges

- **Power sector**: renewable energy targets for heat and cold supply, an ecological finance reform and financial support for the installation of renewable energy sources (RES)
- **Industry sector**: gradual phase-out of energy subsidies backed by financial and technical support for energy efficiency and RES, enhanced financial support for the optimisation and installation of energy-efficient technologies linked to energy audits and management systems and minimum energy efficiency standards (for energy using equipment as well as included in building permits for new industrial production facilities).

Options for a stronger involvement of Brazil in the international regime

Responsibility: Brazil's responsibility for climate change due to its emissions excluding land use, land-use change and forestry (LULUCF) is below world average but above non-Annex I average. With LULUCF emissions it is likely to be higher, but sound historical estimates of emissions from the LULCUF sector are not available.

Capability: Brazil's per capita income is about world average. However, the regional and social income distribution is still very unequal. Its human development index is far above world average. It has in place many initiatives, laws and standards to reduce the emission intensity of electricity, transport and industry. But some institutional difficulties exist in terms of implementing policies.

Potential: Despite the high share of renewable sources in electricity production, Brazil has a substantial mitigation potential. According to the figures from Phase II of the project, the no-regret potential to reduce 2020 emissions below BAU levels amounts to 104 Mt, the co-benefit potential to 187 Mt and the ambitious mitigation potential to 429 $MtCO_2eq$. These would be equal to a 3%, 6% or 14% reduction compared to BAU levels respectively and a 20%, 16% or 6% increase compared to 2005 emissions levels.

Given the amount of global emission reductions required to keep temperature change below 2°C and based on the above analysis, we suggest that it would be equitable and feasible for Brazil to commit to an absolute country-wide no-lose emission target.

The target could either be set at a stringent level correlated to the ambitious potential as analysed in this project, but implementation be made contingent on the provision of financial and technical support from Annex I countries. The target would in this case amount to about 2,555 $MtCO_2eq$ annual emissions in 2020, 14% below the BAU level. Alternatively, the target could be set at a less stringent level, for instance correlated to the co-benefit mitigation potential. This target would amount to about 2,796 $MtCO_2eq$, 16% above 2005 levels. Brazil could then nevertheless implement ambitious policies and measures to overachieve the target and sell the resulting surplus on the carbon market. This alternative would require less direct financial and technical support from Annex I countries but more support through the carbon market and hence emission reduction targets for Annex I countries of 45% compared to 1990, as opposed to the -30% target as assumed in the option above.

6. China

Overall, China is classified as country with a medium human development. Its per capita income is on a developing country average level. The dominance of coal in China's energy mix and the comparatively low energy efficiency leads to high emission intensity in electricity generation. The overall per capita emissions are still low. Nevertheless, its national emissions are high, also due to substantial exports. Although China's energy intensity declined considerably during the last decades, its absolute energy demand strongly increased. This trend makes China a very important party in the future global climate regime.

Reference emissions and mitigation potential

As illustrated in Figure 1, the reduction potential for China is 8% (no-regret), 15% (co-benefit) and 32% (ambitious potential) below BAU. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the power,

industrial and transportation sector. In the power sector, there exists an ambitious mitigation potential of 1322 $MtCO_2eq$ in 2020. The ambitious potential in the industry sector is estimated at 770 $MtCO_2eq$. In the transportation sector, there is an ambitious potential of about 395 $MtCO_2eq$. The total ambitious mitigation potential in China is estimated at 2930 $MtCO_2eq$ in the year 2020. A detailed overview of the potential per sector and scenario can be found in Appendix B.

Existing and possible further national climate policies

Climate policy in China is mainly implemented and enforced at the regional level. The central government imposes standards that often have the form of directives and leaves their implementation and enforcement to the local governments. However, China implemented and is planning a number of climate change policies and measures. Further policies and measures could be e.g.:

- **Power sector**: specific renewable energy targets for electricity, heat and cold supply, ecological finance reform and a gradual phase-out of energy subsidies backed by financial and technical support for energy efficiency and RES
- **Industry sector**: gradual phase-out of energy subsidies backed by financial and technical support for energy-efficiency and RES, financial support for the optimisation and installation of energy efficient technologies linked to energy audits and management systems and the extension of the existing minimum energy efficiency standards
- **Transport sector**: targets/quotas for biofuels, tax exemptions for sustainable biofuels and road fees

Options for a stronger involvement of China in the international regime

Responsibility: China's responsibility for climate change due to its emissions excluding LULUCF is at about non-Annex I average compared on a per capita basis. Its current per capita emissions are above non-Annex I average. In absolute terms considering all gases and sources, China's emissions are almost equal or even higher than those of the USA, the formally largest emitter in the world, and emissions are rapidly increasing.

Capability: Per capita income is slightly above developing country average and the human development index score is medium. Income is very unequally distributed amongst the population.

Potential: The mitigation potential is very high. According to the figures from Phase II of the project, the no-regret potential to reduce 2020 emissions below BAU levels amounts to 777 Mt, the co-benefit potential to 1,342 Mt and the ambitious mitigation potential to 2,930 $MtCO_2eq$. These would be equal to an 8%, 15% or 32% reduction compared to BAU levels respectively and a 36%, 27% or 1% increase compared to 2005 emissions levels.

Given the amount of global emission reductions required to keep temperature change below 2°C and based on the above analysis, we suggest that it would be equitable and feasible for China to commit to no-lose sectoral targets for the power production, iron/steel and cement sectors, where relatively good data are available.

The target could either be set at a stringent level correlated to the ambitious mitigation potential but the implementation would be made contingent on the provision of financial and technical support from Annex I countries. The total target for the covered sectors would in this case amount to annual emissions of about 2,754 $MtCO_2eq$ in 2020, about 39% below the BAU level. Alternatively, the targets could be set at a lower level, for instance at the level indicated by the co-benefit mitigation potential. In this case the total target for all covered sectors would amount to 3,678 $MtCO_2eq$, about 19% below BAU levels. China could then nevertheless implement ambitious policies and measures to overachieve the target and sell the resulting surplus on the carbon market. This alternative would require less direct financial and non-financial support from Annex I countries but more support through the carbon market and hence more stringent emission reduction targets for Annex I countries of 45% compared to 1990 as opposed to -30% as assumed for the option above.

In addition, China could commit to implementing a set of SD PAMs for the sectors not covered by the sectoral no-lose targets. The total package of sectoral no-lose targets and SD PAMs should aim at mobilising the full ambitious mitigation potential. However, the implementation of these policies and measures would be conditional on additional international funding to cover the higher costs compared to business-as-usual development. Due to missing capacity in these sectors, the emission reductions achieved through PAMs could probably only be roughly estimated. Therefore, no direct link is assumed between policies and the international carbon markets.

7. India

Overall, India is in a medium development state. GDP/cap and HDI are below development countries' average and close to the average of low income countries (UNDP 2004). Its emissions are strongly increasing. The emissions per unit of GDP are comparatively high, the emissions per capita are low, also because still about half of the population is without reliable electricity access (World Bank 2006). Although India has a high share of carbon free energy sources, low conversion efficiency and an intensive use of coal lead to comparatively high specific emissions in energy production. However, India's energy and carbon intensities declined after 1995 (Chandler et al. 2002). Similar to Brazil, the share of biomass for residential use is high but decreasing.

Reference emissions and mitigation potential

As illustrated in Figure 1, the reduction potential for India is 12% (no-regret), 22% (co-benefit) and 38% (mitigation potential) below BAU. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious mitigation potential) are the power, industrial and transport sector. In the power sector, there exists an ambitious potential of 647 $MtCO_2eq$. For the industrial sector, the ambitious potential is estimated at 245 $MtCO_2eq$. The ambitious potential in the transport sector is estimated at 231 $MtCO_2eq$. The total ambitious mitigation potential in India is estimated at 1,336 $MtCO_2eq$. A detailed overview of the potential per sector and scenario can be found in Appendix B.

Existing and possible further national climate policies

In addition to already existing policies and measures in India further options could be e.g.:

- **Power sector**: renewable energy targets for heat and cold supply, gradual phase-out of energy subsidies backed by financial and technical support for energy-efficiency and RES and a domestic emission trading scheme
- **Industry sector**: gradual phase-out of energy subsidies backed by financial and technical support for energy-efficiency and RES, financial support for the optimisation and installation of energy efficient technologies linked to energy audits and management systems and the extension of the energy efficiency accord
- **Transport sector**: targets/quotas for sustainable biofuels, tax exemptions for sustainable biofuels and road fees

Options for a stronger involvement of India in the international regime

Responsibility: India's responsibility for climate change due to its emissions excluding LULUCF is below non-Annex I average compared on a per capita basis. Its current per capita emissions are well below non-Annex I average. In absolute terms, India's emissions are substantial and increasing rapidly.

Capability: Per capita income and the human development index score are below non-Annex I average. Income is very unequally distributed amongst the population. Policy implementation may be difficult.

Potential: The mitigation potential is high due to low efficiency and strongly increasing emissions in absolute and relative terms. According to the figures from Phase II of the

project, the no-regret potential to reduce 2020 emissions below BAU levels amounts to 416 Mt, the co-benefit potential to 775 Mt and the ambitious mitigation potential to 1,336 $MtCO_2eq$. These would be equal to a 12%, 22% or 38% reduction compared to BAU levels respectively and a 69%, 49% or 19% increase compared to 2005 emissions levels.

Based on the above analysis, we suggest that it would be feasible and equitable for India to implement a set of SD PAMs. India would quantify the effect of the package of SD PAMs in advance. The total package should aim at mobilising the full ambitious mitigation potential. However, the implementation of these policies and measures would be conditional on additional international funding to cover the higher costs compared to business-as-usual development. Due to the lack of technical capacity, the emission reductions achieved through policies implemented in India can probably only be roughly estimated. Therefore, no direct link is assumed between policies and the international carbon markets.

8. Mexico

Overall, Mexico is classified as a country with a high human development index. Its GDP lies well above world average and middle income countries average. After the establishment of the UNFCCC it became member of the OECD and is therefore, similar to South Korea, non-Annex I but OECD country. The dominance of oil in Mexico's energy mix leads to comparatively high emissions. Mexico's per capita emissions in 2002 were considerable and even slightly higher than those of some low-emission Annex I countries, namely Lithuania, Turkey and Latvia. Over the last years Mexico's emissions have been increasing.

Reference emissions and mitigation potential

As illustrated in Figure 1, the reduction potential for Mexico is 8% (no-regret), 16% (co-benefit) and 39% (ambitious potential) below BAU. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the power, transport and industrial sector. In the power sector, there exists an ambitious potential of 186 $MtCO_2eq$. For the transport sector, the ambitious potential is estimated at 111 $MtCO_2eq$. The ambitious potential in the industrial sector is estimated at 41 $MtCO_2eq$. The total ambitious mitigation potential in Mexico is estimated at 417 $MtCO_2eq$. A detailed overview of the potential per sector and scenario can be found in Appendix B.

Existing and possible further national climate policies

Already today, Mexico has implemented and planned a number of climate change policies and measures. Further policies and measures could be e.g.:

- **Power sector**: renewable energy targets for electricity, heat and cold supply, gradual phase-out of energy subsidies backed by financial and technical support for energy-efficiency and RES and feed-in tariffs or electricity quotas (green certificates) for RES and CHP
- **Transport sector**: targets/quotas for sustainable biofuels, tax exemptions for sustainable biofuels and road fees
- **Industry sector**: gradual phase-out of energy subsidies backed by financial and technical support for energy-efficiency and RES, financial support for the optimisation and installation of energy efficient technologies linked to energy audits and management systems and minimum energy efficiency

Options for a stronger involvement of Mexico in the international regime

Responsibility: Mexico's responsibility for climate change due to its emissions excluding LULUCF is below world average but slightly above non-Annex I average.

Capability: Mexico's per capita income is slightly above world average. Its human development index is far above world average.

Potential: Mexico has a substantial mitigation potential. According to the figures from Phase II of the project, the no-regret potential to reduce 2020 emissions below BAU levels amounts to 82 Mt, the co-benefit potential to 173 Mt and the ambitious potential to 417 $MtCO_2eq$. These would be equal to a 8%, 16% or 39% reduction compared to BAU levels respectively, and a +26%, +14% or -17% change compared to 2005 emissions levels.

Given the amount of global emission reductions required to keep temperature change below 2°C and based on the above analysis, we suggest that it would be equitable and feasible for Mexico to commit to an absolute country-wide no-lose emission target.

The target could either be set at a stringent level correlated to the ambitious mitigation potential but implementation would have to be made contingent on the provision of financial and technical support from Annex I countries. The target would in this case amount to about 638 $MtCO_2eq$ annual emissions in 2020, 39% below the BAU level and 17% below 2005 emissions. Alternatively, the target could be set at a lower level, for instance at a level correlated to the co-benefit mitigation potential. This target would amount to 882 $MtCO_2eq$, 14% above 2005 levels. Mexico could then, nevertheless, implement ambitious policies and measures to overachieve the target and sell the resulting surplus on the carbon market. This alternative would require less direct financial and technical support from Annex I countries but more support through the carbon market and hence more stringent emission reduction targets for Annex I countries 45% compared to 1990 as opposed to 30% as assumed for the option above.

9. South Africa

Overall, the dominance of coal in South Africa's energy mix leads to high emission intensity in electricity generation. This and the energy intensive industry result in very high emissions per GDP. Per capita emissions are lower than those of most Annex I countries but they are high for developing countries. South Africa's emissions are likely to increase in the future due to development and a remaining high importance of coal as energy source.

Reference emissions and mitigation potential

As illustrated in Figure 1, the reduction potential South Africa is 9% (no-regret), 18% (co-benefit) and 35% (ambitious potential) below BAU. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the power, transport and industrial sector. In the power sector, there exists an ambitious potential of 67 $MtCO_2eq$. For the transport sector, the ambitious potential is estimated at 42 $MtCO_2eq$. The ambitious potential in the industrial sector is estimated at 41 $MtCO_2eq$. The total ambitious potential in South Africa is estimated at 212 $MtCO_2eq$. A detailed overview of the potential per sector and scenario can be found in Appendix B.

Existing and possible further national climate policies

Already today, South Africa has implemented and planned a number of climate change policies and measures. Further policies and measures could be e.g.:

- **Power sector**: renewable energy targets for heat and cold supply, gradual phase-out of energy subsidies backed by financial and technical support for energy efficiency and RES (e.g. backed by the ESKOM DSM scheme) and feed-in tariffs or electricity quotas (green certificates) for RES and CHP
- **Transport sector**: targets/quotas for sustainable biofuels, tax exemptions for sustainable biofuels and road fees
- **Industry sector:** gradual phase-out of energy subsidies backed by financial and technical support for energy efficiency and RES, financial support for the optimisation and installation of energy-efficient technologies linked to energy audits and management systems and the extension of the energy efficiency accord

Options for a stronger involvement of South Africa in the international regime

Responsibility: South Africa's responsibility for climate change due to its emissions excluding LULUCF is slightly above world average. LULUCF emissions do not play a major role.

Capability: South Africa's per capita income is above world average on a GDP PPP basis. But its human development index is just below average. This is an indication that the income is very unevenly distributed.

Potential: South Africa disposes of a substantial mitigation potential. According to the figures from Phase II of the project, the no-regret potential to reduce 2020 emissions below BAU levels amounts to 57 Mt, the co-benefit potential to 110 Mt and the ambitious mitigation potential to 212 $MtCO_2eq$. These would be equal to a 9%, 18% or 35% reduction compared to BAU levels respectively and a +19%, +7% or -15% change compared to 2005 emissions levels.

Given the amount of global emission reductions required to keep temperature change below 2°C and based on the above analysis, we suggest that it would be equitable and feasible for South Africa to commit to sectoral no-lose targets for the power production and industry sectors.

The target could either be set at a stringent level correlated to the ambitious mitigation potential but implementation would have to be made contingent on the provision of financial and non-financial support from Annex I countries. The total target for both sectors would in this case amount to about 191 $MtCO_2eq$ annual emissions in 2020, about 36% below the BAU level. Alternatively, the targets could be set at a lower level, for instance correlated to the co-benefit mitigation potential. The total target for both sectors would in this case amount to about 256 $MtCO_2eq$, about 14% below BAU levels. South Africa could then nevertheless implement ambitious policies and measures to overachieve the target and sell the resulting surplus on the carbon market. This alternative would require less direct financial and non-financial support from Annex I countries but more support through the carbon market and hence more stringent emission reduction targets for Annex I countries of 45% compared 1990 as opposed to 30% as assumed for the option above.

In addition, South Africa could commit to implementing a set of SD PAMs for the sectors not covered by the sectoral no-lose targets. The total package of sectoral no-lose targets and SD PAMs should aim at mobilising the full ambitious mitigation potential. However, the implementation of these policies and measures would be conditional on additional international funding to cover the higher costs compared to business-as-usual development. Due to missing capacity in these sectors, the emission reductions achieved through PAMs could probably only be roughly estimated. Therefore, no direct link is assumed between policies and the international carbon markets.

10. South Korea

Overall, South Korea is in its state of development very similar to some Annex I countries. Its population was almost stable in the last decade. Its electricity mix includes a large share of nuclear energy, resulting in low emissions per kWh. South Korea's industrial sector makes up a large share of its emissions, but it is one of the most efficient in the world. Transport and household emissions are high, agricultural emissions are not relevant.

Reference emissions and mitigation potential

As illustrated in Figure 1, the reduction potential South Korea is 13% (no-regret), 19% (co-benefit) and 42% (ambitious potential) below BAU. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the industrial, power and transport sector. In the industrial sector, there exists an ambitious potential of 212 $MtCO_2eq$ in the year 2020. The ambitious potential in the power sector is estimated at 112 $MtCO_2eq$. In the transport sector, there is an ambitious potential of about 80 $MtCO_2eq$. The

total ambitious potential in Korea is estimated at 443 $MtCO_2eq$ in the year 2020. A detailed overview of the potential per sector and scenario can be found in Appendix B.

Existing and possible further national climate policies

Already today, South Korea has implemented and planned a number of climate change policies and measures. Further policies and measures could be e.g.:

- **Industry sector**: gradual phase-out of energy subsidies backed by financial and technical support for energy-efficiency and RES, financial support for the optimisation and installation of energy efficient technologies linked to energy audits and management systems, minimum energy efficiency standards (for energy using equipment as well as building permits for new industrial production facilities) and energy management systems
- **Power sector**: renewable energy targets for heat and cold supply, ecological finance reform and feed-in tariffs or electricity quotas (green certificates) for RES and CHP
- **Transport sector**: targets/quotas for biofuels, tax exemptions for sustainable biofuels and road fees

Options for a stronger involvement of South Korea in the international regime

Responsibility: South Korea's responsibility for climate change due to its emissions excluding LULUCF is at world average.

Capability: South Korea's per capita income is well above world average and closer to Annex I average. Its human development index is at Annex I average.

Potential: Despite the high efficiency of the South Korean economy and the large share of nuclear power in electricity production, the mitigation potential is substantial. According to the figures from Phase II of the project, the no-regret potential to reduce 2020 emissions below BAU levels amounts to 133 Mt, the co-benefit potential to 200 Mt and the ambitious mitigation potential to 443 $MtCO_2eq$. These would be equal to a 13%, 19% or 42% reduction compared to BAU levels respectively, and a +38%, +28% or -9% change compared to 1990 emissions levels.

Given the need for mobilising almost the full ambitious mitigation potential and based on the above analysis, we suggest that it would be equitable and feasible for South Korea to join Annex I and commit to an absolute and binding national emission limitation target. South Korea's target could be set at about a level correlated to the ambitious emission reduction potential, i.e. at about 604 $MtCO_2eq$ annual emissions in 2020. This would be equal to a 42% reduction compared to 2020 BAU levels and a 9% decrease compared to 2005 levels.

11. Resulting overall framework

Table 1 includes a summary of the possible contributions from the countries covered above ordered by decreasing overall stringency. Based on their respectively high and low levels of economic development, we propose that it would be equitable for South Korea to join Annex I and for India to commit to implementing Sustainable Development Policies and Measures. We present two options for Mexico, Brazil, South Africa and China.

In option A, Mexico, Brazil, South Africa and China would commit to national or sectoral no-lose targets to be set at the "ambitious level" but subject to financial support by Annex I countries outside of the carbon market. They could be accompanied by a 30% reduction below 1990 levels by 2020 for Annex I countries.

An alternative framing (option B) could be envisaged that is equally stringent but is relying more on the carbon market as financing instrument and not on additional financial assistance. In this alternative framing Mexico, Brazil, South Africa and China would commit to no-lose targets in the same sectors at their co-benefit potential. To bring global emissions on a 2°C trajectory, the target for Annex I countries would then need to be 45% below 1990 in 2020, not 30%. Annex I countries would provide technical assistance to remove non-

market barriers, but not substantial additional resources outside of the carbon market to developing countries to directly reduce emissions.

Table 1. Summary of illustrative example contributions for 2020 ordered by decreasing overall stringency

Country	Type	Scope	Option A		Option B	
			Emission level	Financing	Emission level	Financing
South Korea	Absolute and binding national emission limitation target	All sectors	Well below BAU (e.g. 40%)	No additional financing	Well below BAU (e.g. 40%)	No additional financing
Mexico	Absolute no-lose emission target	All sectors	Well below BAU (e.g. 40%)	Conditional on financial support	Below BAU (co-benefit potential, e.g. 15%)	Technical assistance to reach co-benefit potential
Brazil	Absolute no-lose emission target	All sectors	Well below BAU (e.g. 15%)	Conditional on financial support	Below BAU (co-benefit potential, e.g. 6%)	Technical assistance to reach co-benefit potential
South Africa	Sectoral no-lose targets	Power production and industry sector	Well below BAU (e.g. 35%)	Conditional on financial support	Below BAU (co-benefit potential, e.g. 18%)	Technical assistance to reach co benefit potential
	Sustainable development policies and measures	Remaining sectors	Not quantified		Not quantified	
China	Sectoral no-lose targets	Power production, iron/steel and cement sectors	Well below BAU (e.g. 30%)	Conditional on financial support	Below BAU (co-benefit potential, e.g. 14%)	Technical assistance to reach co benefit potential
	Sustainable development policies and measures	Remaining sectors	Not quantified		Not quantified	
India	Sustainable development policies and measures	All sectors	Well below BAU	Conditional on financial support	Well below BAU	Conditional on financial support

We observe from the table a differentiation between the countries ranging from Annex I like commitments to moderate supported emission reductions. We also observe that the proposed reduction level varies between countries based on our analysis of mitigation potential.

12. Consistency with 2°C limit

Figure 2 below on the left hand side shows global greenhouse gas emissions up to 2020 under the business-as-usual scenario split into Annex I and non-Annex I countries. The reduction potential identified here as “non-Annex I” includes only the potential identified in this report for the six countries for the ambitious scenario. Further mitigation potential in non-Annex I countries other than the six analysed here would be available in addition. However, the six countries cover more than 50% of the emissions of non-Annex I countries in 2020. Annex I countries are assumed to reduce emissions 30% below the 1990 level. The right hand side of the picture shows possible post-2020 emission paths that aim at limiting global average temperature increase to 2°C.

Keeping in mind the uncertainties of the calculations, we still conclude from the figure the encouraging finding that global emission growth from 2010 to 2020 can be halted by

implementing the ambitious scenario in the six non-Annex I countries. But after 2020, substantial further global reductions are necessary to stay below the 2°C limit.

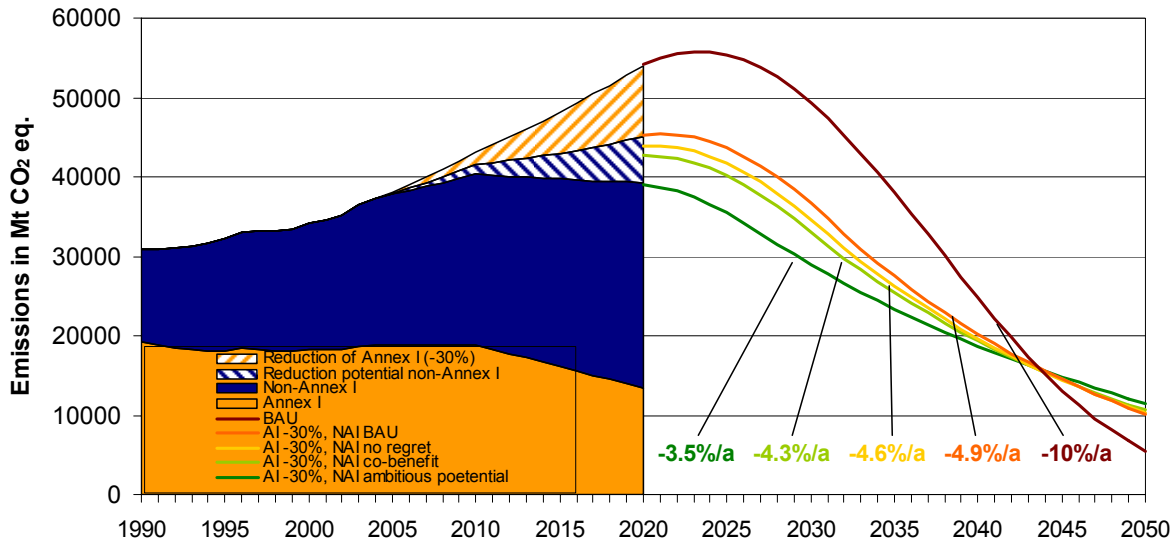


Figure 2. Global greenhouse gas emissions including reduction scenarios for Annex I (-30% domestic reductions compared to 1990 by 2020) and non-Annex I (ambitious potential reductions for Brazil, China, India, Mexico, South Africa and South Korea between 1990 and 2020). On the right hand side possible global reduction paths under all scenarios between 2020 and 2050 are provided to stay below the 2° limit in the long term.

13. Support for enhanced mitigation action

Financial support for a switch to low- and no-carbon technologies is a key element to enhance the participation of non-Annex I countries in the climate regime. We identify the following areas.

Policies and measures that require financial support (by country and by sector)

Based on Part II, Part III identified additional domestic policies and measures in the three sectors with the highest emissions reduction potential of each country. It also suggested that the following policies and measures could strengthen the existing policies and measures but require financial support for realisation (see Table 2). Providing adequate financial support for the policies and measures will greatly enhance the chances of participation by the six countries in a future mitigation regime.

Table 2. Additional policies and measures that require financial support for realisation

	Sector	Financial support
Brazil	Power	Phase-out of direct and indirect energy subsidies or energy price control backed by financial support for improving energy end-use efficiency Installation of RES technologies Investment support for improvements in the conversion efficiency of fossil fuel power plants
	Transportation	Switching from road-based to rail-or waterway based transportation in the transportation sector connected to an improved regulatory and financial framework which reduces risks and fosters investments
China	Power	Investment support for improvements in the conversion efficiency of fossil fuel power plants Installation of RES technologies
	Industry	Optimisation and installation of energy efficient technologies linked to energy audits and management systems

	Sector	Financial support
India	Power	Phase-out of direct and indirect energy subsidies or energy price control backed by financial support for improving energy end-use efficiency Installation of RES technologies Investment support for improvements in the conversion efficiency of fossil fuel power plants
	Industry	Optimisation and installation of energy efficiency technologies linked to energy audits and management systems
Mexico	Power	Phase-out of direct and indirect energy subsidies or energy price control backed by financial support for improving energy end-use efficiency Installation of RES technologies Investment support for improvements in the conversion efficiency of fossil fuel power plants
	Industry	Optimisation and installation of energy efficiency technologies linked to energy audits and management systems
South Africa	Power	Phase-out of direct and indirect energy subsidies or energy price control backed by financial support for improving energy end-use efficiency Installation of RES technologies Investment support for improvements in the conversion efficiency of fossil fuel power plants
	Industry	Optimisation and installation of energy efficiency technologies linked to energy audits and management systems
South Korea	Power	Installation of RES technologies
	Industry	Investment support for improvements in the conversion efficiency of fossil fuel power plants

Existing instruments in the international climate regime to provide financial support

Under the climate regime there are two main instruments, namely financial mechanisms and the CDM, to provide financial support for projects to reduce GHG emissions in developing countries. In order to examine the potential role of the two instruments for realising the potential identified in Part II and III, we compare the instruments in terms of the size of the funds, the donors, funded activities, requirements and procedure. This analysis illustrates the following points.

- Resources currently provided by the financial mechanisms are too small compared to the UNFCCC secretariat's estimate that additional investment and financial flows of 200-210 billion USD will be required in 2030 for mitigation (UNFCCC 2007, pp. 100-102). The CDM has potential to make up for the gap.
- The CDM also has other limits due to its tendency to focus on projects with large reduction potential. The financial mechanisms are thus more appropriate to address the needs of many non-Annex I Parties to provide financial resources for smaller projects.
- The financial mechanisms are perhaps better equipped to mobilise resources for realising the co-benefit potential.
- The implementation of non-financial support needs financial resources. Financial mechanisms may be utilised to provide financial resources for non-financial support measures.
- Both the CDM and the financial mechanisms have one deficiency: in principle they do not provide resources to projects that realise no-regret potential.

Based on the above analysis, we suggest to first restructure the financial mechanisms as explained below. Second, it is recommended to enhance bi-national, regional, and multi-national cooperation in order to provide more public funds for no-regret potential and for non-financial support and, third, to mobilise more private funds in order to realise no-regret and co-benefit potential.

Additional support options for enhanced mitigation action: non-financial support

Apart from financial support, non-Annex I countries could also benefit greatly from non-financial support. Exchange of knowledge and cooperation in research and development are potentially effective instruments of introducing and disseminating new technologies and political instruments. This form of technology cooperation has been employed outside of the climate regime. It has, however, not yet played an important role in the context of the FCCC and the Kyoto Protocol.

In general and for all countries, RD&D schemes are recommended for the accelerated development, technical improvement and market introduction of RES and CHP technologies for electricity, heat and cold, efficient fossil fuel power plants and in most countries for the analysis of CCS technologies. Other promising joint RD&D activities are schemes for energy efficient production technologies and methods and on sustainable transportation systems.

All six countries analysed in this report would furthermore benefit from cooperation in standard setting and the creation of technology mandates. This form of international technology cooperation comprises the agreement of energy efficiency standards, mandates for technologies like renewable energy or the introduction of economic incentives for the deployment of certain technologies (e.g. subsidies for RES or tax incentives). There is furthermore substantial benefit in sharing the experiences of the EU and Germany in the establishment of an ETS or an ecological finance reform.

A technology alliance with the emerging economies

The challenge and the opportunity for an enhanced participation of non-Annex I countries lies in developing an integrated system for the development and deployment of innovative technologies. This should combine high efficiency with the capacity to gradually develop and improve. It should be designed in such a way as to allow the progressive integration of non-Annex I countries in the mitigation effort in an international regime on climate change.

An offer of integrated technology cooperation in the context of a new climate alliance could present a first step. It can combine the interest of the EU in integrating the larger economies of the non-Annex I countries in the mitigation effort within an international regime on climate change with the interest of the emerging economies in new and cleaner technologies. Some of the ideas by the G77/China should thus be taken up and combined with other elements presented in this report to a coherent and effective technology alliance. Such an offer should comprise cooperation in the research, development and deployment (RD&D) of low- and no-carbon technologies, the elaboration of common standards and – as its core – a substantial commitment for financing the switch to low- and no-carbon technologies.

The switch to low- and no-carbon technologies will require much higher financial volumes – estimates of the finances required range from Euro 20-30 billion in the Stern Review (Stern 2006) to US$ 200-210 billion in 2030 according to the UNFCCC Secretariat (2007). In the short and medium term, such a fund will probably have to be financed with public money of Annex II countries. Taking part of the means generated by auctioning the emission rights under the EU ETS would already provide a considerable part of the means required. In addition to such a fund, the technology alliance could comprise an innovative feature employed by the Montreal Protocol in order to replace outdated technology – the Technology and Economic Assessment Panel (TEAP).

This new technology cooperation must be placed within the context of the carbon markets because these emerging markets are providing the background for all activities in the fight against climate change. In the North-South context the CDM is of particular importance. Certainly, the CDM cannot substitute the specialised means of cooperation in technology development and deployment and non-Annex I countries are emphasising that the CDM cannot be seen as an implementation of Article 4.5. It can, however, considerably improve the conditions for technological innovation and the deployment of innovative technologies in developing countries.

The offer of such a new technology alliance could provide a vital push for the post-2012 negotiations. Greatly enhanced cooperation in technology development and deployment could easily be expanded to include technologies for adaptation to the inevitable consequences of climate change. This would provide a positive incentive for the poorer developing countries (not considered otherwise in this report) that are not expected to undertake mitigation activities but are looking for ways to improve their resilience to climate impacts. Such an offer would be an expression of the openness for new and creative ways to counteract the climate crisis. This challenge requires giving up traditional forms of diplomacy that are based on narrow notions of national interest. A true partnership with emerging economies from non-Annex I countries must be part of this new approach.

14. Conclusions

This report provides a detailed overview of the national circumstances, emission levels, mitigation potential and policies and measures, for the major developing countries Brazil, China, India, Mexico, South Africa and South Korea. These countries are covering more than 50% of non-Annex I parties' emissions. The report further proposes enhanced mitigation activities for these countries and elements of international financial and non-financial support for realising these contributions.

We draw the following conclusions from this work:

- Climate change requires urgent action by developed countries to reduce their emissions and to support developing countries in slowing emissions growth and to eventually decrease their emissions.
- The tool developed in this project allows comparing mitigation potential across major developing countries in a comparable manner for individual sectors, which is currently not possible. As in any model, the results depend on the input assumptions. However, this tool allows using the same input assumptions for all countries to compare the results.
- The no-regret and co-benefit mitigation potential in the six developing countries is substantial according to our analysis. It is in the interest of these countries to achieve the reductions that are possible at no net costs (9% below reference) and reductions with a co-benefit other than climate (together 17% below reference). International support may be necessary to remove the barriers that currently prevent these reductions to occur.
- Additional reduction potential is available that allows to put these countries on a path that is consistent with 2°C. Most countries, except South Korea, would need financial assistance to realise this mitigation potential.
- Existing policy packages in the six countries can be individually supplemented by additional policies to realise the mitigation potential. The type and design of the policies largely depend on the current circumstances and emission profile of the country.

Financial and non-financial support mechanisms - in addition to the carbon market - need to be implemented to support the decarbonisation of the six countries considered in this study. These efforts would greatly benefit from an integrated strategy of promoting a technology alliance with non-Annex I parties.

Zusammenfassung

1. Einleitung

Nach dem Prinzip der “gemeinsamen aber differenzierten Verantwortung“ (Art. 3.1, UNFCCC) wurden Nicht-Annex-I-Parteien bisher von Zielen zur Emissionslimitierung oder -reduktion ausgeschlossen. Allerdings nimmt der Druck auf diese Länder, besonders auf schnell wachsende große Emittenten, zu, aktiv zur Minderung des Klimawandels beizutragen. Die Einbeziehung dieser Länder in ein zukünftiges Klimaregime wird besonders in Bezug auf Minderungsfragen stark gefordert, aber unklar ist, wie und welchen Anteil diese Länder dazu beitragen sollen und welche Unterstützung in welchen Sektoren notwendig ist.

Das Ziel dieses Projektes ist es, einen detaillierten Einblick in die Situation von sechs wirtschaftlich weiter fortgeschrittenen Entwicklungsländern zu bekommen, zu verstehen wie sie in Fragen der Emissionsminderung am besten zu einem Klimaregime beitragen können und welche Unterstützung sie zur Limitierung ihrer Treibhausgase benötigen.

In diesem Projekt „Proposals for contributions of emerging economies to the climate regime under the UNFCCC post 2012“ für das Umweltbundesamt (UBA) analysieren Ecofys und das Wuppertal Institut die Situation der Schwellenländer Brasilien, China, Indien, Mexiko, Südafrika und Südkorea. Der Bericht enthält einen Überblick über Treibhausgas-Emissionen und wirtschaftliche Entwicklung im Zeitraum zwischen 1990 und 2005, er stellt Abschätzungen für Emissionsminderungspotenziale bis zum Jahr 2020 in einer konsistenten Methode dar, er untersucht bereits existierende Politiken und Maßnahmen zur Limitierung von Treibhausgasemissionen, er enthält Anregungen mit welchen weiteren Maßnahmen diese ergänzt werden können und Vorschläge wie Bemühungen dieser Länder ins internationale Klimaregime unter den UNFCCC und dem Kyoto-Protokoll eingebunden werden können.

2. Methode

In diesen Bericht sind Elemente einer Überprüfung von Länderexperten aller sechs Länder eingegangen.

Abschätzung von Referenzemissionen und Reduktionspotenzialen

Das Projekt beinhaltet die Entwicklung eines „bottom-up“ Excel Modells um mögliche zukünftige Emissionstrends und Reduktionsoptionen bis zum Jahr 2020 für Brasilien, China, Indien, Mexiko, Südafrika und Südkorea darzustellen. Wir haben vier Szenarien mit einer konsistenten Methode für alle Länder berechnet:

Business-as-usual: Das „business-as-usual“ (BAU) Szenario folgt Produktions-, Energieverbrauchs- und Energieeffizienztrends, die auf moderaten Annahmen beruhen. Diese Annahmen oder die damit verbundenen Wachstumsraten wurden so weit wie möglich Länderstudien entnommen. Dies war für Brasilien, China und Indien möglich (Centro Clima et al. 2006; Chen et al. 2006; TERI 2006). Für die Länder oder Sektoren für die keine detaillierten Studien verfügbare waren, haben wir die Wachstumsraten der vergangenen Jahre gleichbleibend fortgeschrieben. Dieses Szenario führt zu einem vergleichsweise hohen Emissionsniveau im Jahr 2020.

No-regret: Das „no-regret“ Szenario beinhaltet Treibhausgasemissionsreduktionsoptionen die zu negativen oder keinen Kosten realisiert werden können. Diese beinhalten z.B. Energieeffizienzmaßnahmen bei denen die wirtschaftlichen Gewinne durch den reduzierten Energieverbrauch die Investitionskosten für eine effizientere Technologie ausgleichen. Dieses Szenario könnte auch als „ökonomisches Potenzial zu Kosten unter 0€/tCO_2äquiv” betrachtet werden. Wir haben keine detaillierte ökonomische Analyse der Kosten der einzelnen Maßnahmen durchgeführt sondern verwenden allgemeine Annahmen. Unter der Annahme eines wirtschaftlichen Nettogewinns sollte es im Interesse jedes Landes liegen, dieses Potenzial mit seinen eigenen Mitteln zu realisieren. Trotzdem könnte die

internationale Gemeinschaft die Umsetzung mit technologischer und anfänglicher finanzieller Hilfe, z.B. für nationale Fonds und die Umsetzung von Politiken und Maßnahmen um Umsetzungsbarrieren die nicht vom Markt beeinflusst werden können zu überwinden, unterstützen.

Co-benefit: Pfade unter dem „co-benefit" Szenario beinhalten Reduzierungsoptionen, die aus einer anderen politischen Zielsetzung als der Treibhausgasreduktion sinnvoll sind. Dies umfassen auch Reduktionen zu geringen Kosten. Eine typische Maßnahme wäre die erhöhte Nutzung erneuerbarer Energien, um die Versorgungssicherheit zu gewährleisten und die Abhängigkeit vom Import fossiler Energieträger zu verringern. Eine andere Maßnahme wäre ein Treibstoffwechsel von Diesel zu Gas im öffentlichen Personenverkehr aus Gründen der verbesserten Luftqualität. Es sollte im Interesse jedes Landes liegen dieses Potenzial mit seinen eigenen Mitteln zu umzusetzen. Allerdings können einige Maßnahmen mit zusätzlichen Kosten verbunden sein. Daher wäre sowohl technologische als auch finanzielle Unterstützung hilfreich, um dieses Szenario zu realisieren.

Ambitious: Das „ambitious" Szenario beinhaltet Emissionsreduktionsoptionen, deren Umsetzung mit zusätzlichen Kosten verbunden ist um das gleiche Versorgungsniveau (z.B. bezogen auf die Energieversorgung) beizubehalten. Das Szenario berücksichtigt Reduktionsoptionen, die technisch machbar sind und den Umsatz des Kapitalstocks beschleunigen aber nicht zu überflüssigen Investitionen führen würden. Wir haben keine detaillierte ökonomische Analyse der Kosten der einzelnen Maßnahmen durchgeführt sondern nehmen eine obere Grenze von ca. 100 USD/tCO_2äquiv, für Nettokosten die durch die berücksichtigten Maßnahmen zusätzlich anfallen, an. Da die Kosten von Annahmen zu Diskontierungsraten und anderen Entwicklungen abhängen, können die Kosten auch unterhalb dieses Betrages liegen. Das Potenzial kann realisiert werden, wenn die Umsetzungsbarrieren, die nicht vom Markt beeinflusst werden können beseitigt werden und finanzielle Anreize zur Deckung der zusätzlichen Kosten zur Verfügung stehen. Dies könnte mit zusätzlichen eigenen Beiträgen des jeweiligen Landes oder der internationale Gemeinschaft erreicht werden.

Das entwickelte Excelmodell basiert auf einem „bottom-up" Ansatz. Es wird daher durch die Verfügbarkeit brauchbarer Eingangsdaten begrenzt. Das Modell vergleicht Emissionsreduktionsoptionen der betrachteten sechs Länder mithilfe einer einheitlichen Methode. Dies ist ein neuer Beitrag zur derzeitigen Diskussion, da bestehende Studien mit einem ähnlichen Ansatz sich nur auf Weltregionen beziehen und diese Länder nicht individuell berücksichtigen. Länderstudien sind vielfach verfügbar, lassen sich aber untereinander oft nicht vergleichen. Das von uns entwickelte Excelmodell erlaubt einen solchen Vergleich.

Analyse der nationalen Klimaschutzmaßnahmen

Wir haben eine Sammlung aller sinnvollen Politikinstrumente („sourcebook for good practice") als Basis für die Umsetzung der Klimaschutzmaßnahmen zusammengestellt (siehe Appendix C). Diese Sammlung, Einschätzungen der Länderexperten und die besonderen Umstände des jeweiligen Landes dienten als Grundlage für unsere Vorschläge, wie die jeweils bestehenden Politiken und Maßnahmen weiterentwickelt und verbessert werden könnten. Dennoch bietet diese Studie nur einen allgemeinen Rahmen. Daraus eine konkrete Maßanfertigung eines Pakets von Politikinstrumenten zu entwickeln, die eine Evaluation und wenn nötig eine Anpassung beinhaltet, ist eine Aufgabe, die am Besten vom jeweiligen Land selbst erfüllt werden kann. Als Nebenbemerkung ist zu erwähnen, dass Schwierigkeiten detaillierte Informationen über bereits bestehende Klimapolitikinstrumente in einzelnen Ländern zu erhalten eine gründliche Analyse teilweise verhindert haben.

Für jeden der betrachteten Sektoren wurden Technologiefelder oder Untersektoren mit einem signifikanten Emissionsreduktionspotenzial ermittelt. Für jedes dieser Felder oder jeden Untersektor wurde eine Paket von Politiken und Maßnahmen identifiziert.

Verknüpfung mit dem internationalen Klimaregime

Die Vorschläge für mögliche Beiträge der betrachteten sechs Länder zu einem Klimaregime basieren auf zwei Hauptprinzipien:

- Ökologische Angemessenheit (Beitrag zur Stabilisierung der Treibhausgaskonzentration): Ein Klimaschutzregime nach dem Jahr 2012[1] sollte zum Ziel haben den globalen Temperaturanstieg unter 2°C im Vergleich zum vorindustriellen Niveau zu halten. Um die 2° Grenze einzuhalten, muss für die betrachteten sechs Länder, zusätzlich zu einer 30-prozentigen Reduktion der Annex-I-Staaten im Vergleich zum Emissionsniveau im Jahr 1990, nahezu das gesamt Reduktionspotenzial unter dem „ambitious" Szenario umgesetzt werden.
- Differenzierung entsprechend nationaler Umstände, um den Grundsatz der gemeinsamen aber differenzierten Verantwortung und die Berücksichtigung der jeweiligen Fähigkeiten umzusetzen: die Analyse basiert auf den drei Prinzipien Verantwortung, Möglichkeiten und Potenzial.

Wir nehmen an, dass die Umsetzung des Reduktionspotenzials unter dem „no-regret" Szenario grundsätzlich keiner permanenten finanziellen Unterstützung der internationalen Gemeinschaft bedarf. Darüber hinaus gehen wir davon aus, dass Nicht-Annex-I-Staaten das „co-benefit" Potenzial trotz des damit verbundenen Nutzens nicht ohne zumindest teilweise finanzielle Unterstützung umsetzen können. Zudem profitieren diese Länder von nicht-finanzieller Unterstützung. Die Nutzung der Reduktionsoptionen die im „ambitious" Szenario berücksichtigt werden hängt dagegen ganz entscheidend von zusätzlicher internationaler finanzieller Unterstützung zur Beseitigung ökonomischer und andere Barrieren, sowie anderen Formen der Unterstützung ab.

3. Bestehende Mechanismen zur Einbeziehung von Entwicklungsländern in das internationale Regime

Nicht-Annex-I-Staaten sind in vielerlei Hinsicht bereits in Emissionsbegrenzungs- und Reduktionsaktivitäten innerhalb der Klimarahmenkonvention und dem Kyoto-Protokoll eingebunden. Diese sind vor allem Finanzmechanismen, Technologietransfer und der „Clean Development Mechanism" (CDM).

Die Post-2012[2] Verhandlungen unter der Klimarahmenkonvention und dem Kyoto-Protokoll

Die Verhandlungen im Rahmen der UNFCCC und dem Kyoto-Protokoll sind die Grundlage globaler Bemühungen zum Kampf gegen den Klimawandel. Dieses Regime bildet nicht nur den globalen Rahmen für andere multi- und bilaterale Aktivitäten, es ist darüber hinaus auch das einzige Forum das alle wichtigen Bereiche umfasst.

Von den vielen verschiedenen Arten von Verpflichtungen für Entwicklungsländer in einem zukünftigen Klimaregime scheinen die folgenden Optionen und Kombinationen die vielversprechendsten zu sein:

- absolute Emissionsreduktionsziele,
- duale Ziele/„no-lose" Ziele,
- dynamische sektorale „no-lose" Ziele,
- Registrierung von Politiken und Maßnahmen zur nachhaltigen Entwicklung (SD PAMs).

[1] Im Folgenden als Post-2012-Klimaregime bezeichnet.

[2] Gemeint sind die Verhandlung zum Post-2012-Klimaregime.

4. Szenarienüberblick

Abbildung 1 zeigt einen Überblick über das „business-as-usual“- und die Reduktionsszenarien für Treibhausgasemissionen in Brasilien, China, Indien, Mexiko, Südafrika und Südkorea zwischen den Jahren 1990 und 2020.

Unter dem „ambitious“ Szenario ist das Reduktionspotenzial beträchtlich und beläuft sich für alle betrachteten Länder zusammen auf ungefähr 30% unterhalb der BAU-Entwicklung. Dies setzt sich aus Reduktionspotenzialen von 14% unter BAU für Brasilien, 32% unter BAU für China, 38% unter BAU für Indien, 39% unter BAU für Mexiko, 35% unter BAU für Südafrika und 42% unter BAU für Südkorea zusammen. Die folgenden Abschnitte liefern detaillierte Informationen und länderspezifische Ergebnisse.

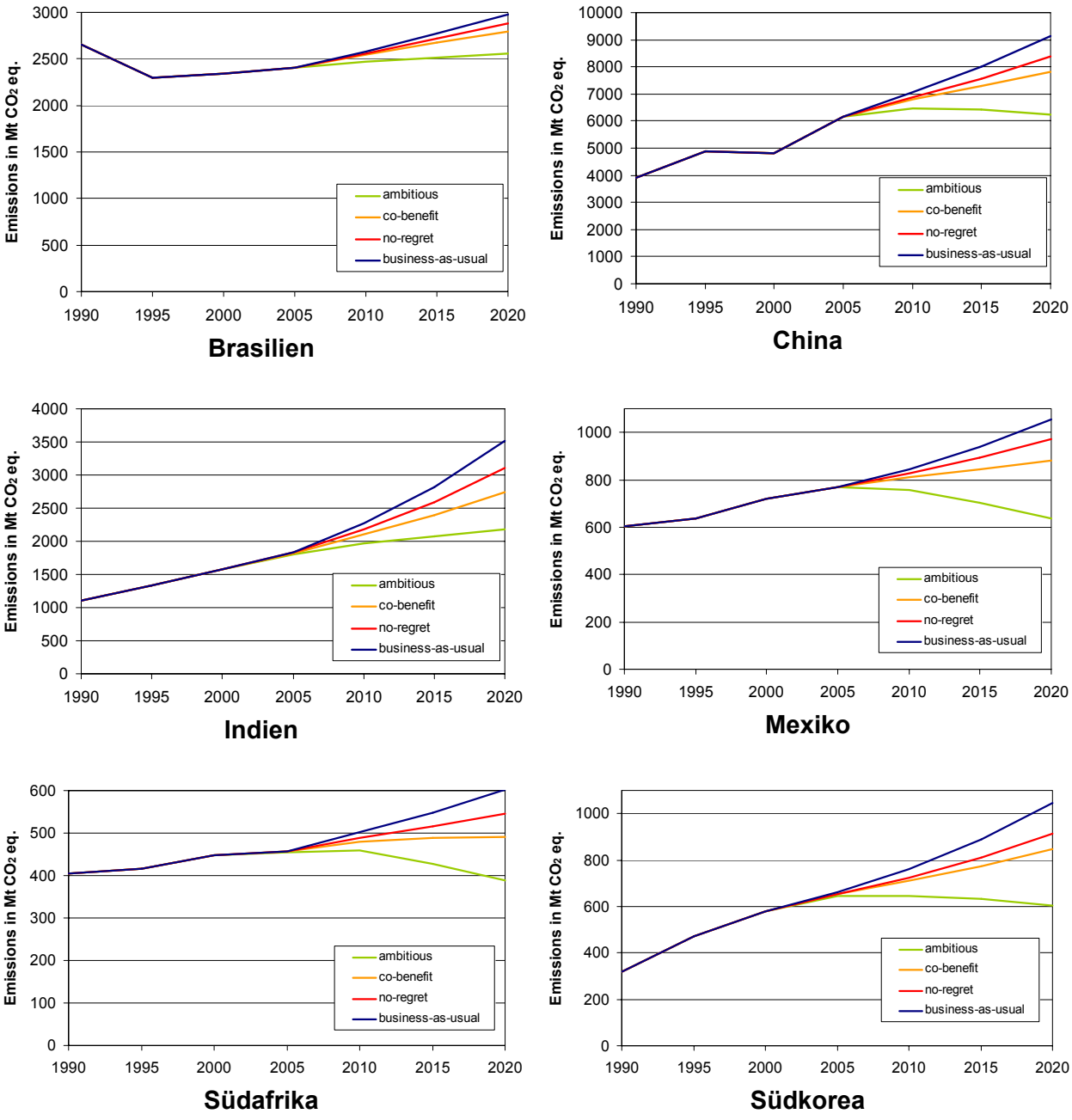


Abbildung 1. Szenarien zu Treibhausgasemissionen in Brasilien, China, Indien, Mexiko, Südafrika und Südkorea im Zeitraum zwischen 1990 und 2020.

5. Brasilien

Insgesamt führt die starke Position von erneuerbaren Energien in Brasiliens Energiemix zu vergleichsweise niedrigen Emissionsintensitäten in der Stromproduktion. Durch Entwicklungsstand und Energiemix sind die Pro-Kopf-Emissionen im Vergleich zu Industrieländern niedrig, aber hoch im Vergleich zu anderen lateinamerikanischen Ländern. Durch die weitere Entwicklung und ein damit verbundenes Wachstum des Transportaufkommens und der Pro-Kopf-Energienachfrage werden Brasiliens Emissionen in Zukunft wahrscheinlich zunehmen.

Referenzemissionen und Reduktionspotenzial

Wie in Abbildung 1 dargestellt beträgt Brasiliens Minderungspotenzial 3% („no-regret"), 6% („co-benefit") und 14% („ambitious") unterhalb der BAU-Entwicklung. Die drei Sektoren mit den höchsten THG-Minderungspotenzialen zwischen den Jahren 2005 und 2020 („ambitious") sind Transport, Energieproduktion und Industrie. Das Minderungspotenzial („ambitious") wird im Transportsektor auf 164 Mio. tCO_2äquiv für das Jahr 2020 geschätzt. Im Energiesektor ist ein Potenzial („ambitious") von 120 Mio. tCO_2äquiv vorhanden. Im Industriesektor wird für das Jahr 2020 ein Potenzial („ambitious") von 59 Mio. tCO_2äquiv angenommen. Das gesamte Minderungspotenzial („ambitious") in Brasilien wird auf 429 Mio. tCO_2äquiv für das Jahr 2020 geschätzt. Ein detaillierter Überblick über die Potenziale je Sektor und Szenario ist in Appendix B enthalten.

Bestehende und mögliche zukünftig nationale Klimaschutzmaßnahmen

Bis heute hat Brasilien bereits eine Reihe von Klimaschutzmaßnahmen geplant und umgesetzt. Weitere Maßnahmen könnten z.B. sein:

- **Transportsektor**: Energiebesteuerung fossiler Treibstoffe, Straßengebühren und City-Maut
- **Energiesektor**: Erneuerbare Energien-Ziele für Wärme- und Kälteversorgung, eine ökologische Finanzreform und finanzielle Unterstützung bei der Installation von erneuerbaren Energiequellen (RES)
- **Industriesektor**: allmähliche Rücknahme von Energiesubventionen unterstützt durch finanzielle und technische Hilfen für Energieeffizienz und RES, verbesserte finanzielle Unterstützung zur Optimierung und Anwendung von energieeffizienten Technologien in Verbindung mit Energieaudits und -Managementsystemen sowie Mindest-Energieeffizienzstandards (für energieverbrauchende Anlagen und integriert in Baugenehmigungen für neue Produktionsstätten)

Optionen für eine stärkere Einbeziehung von Brasilien in das internationale Regime

Verantwortung: Brasiliens Verantwortung für den Klimawandel gemessen an seinen Emissionen ohne Landnutzung, Landnutzungsänderung und Forstwirtschaft (LULUCF) liegt unter dem weltweiten Durchschnitt, allerdings über dem Durchschnitt für Nicht-Annex-I-Länder. Unter Berücksichtigung von LULUCF-Emissionen liegt sie wahrscheinlich höher, zuverlässige historische Schätzungen für den LULUCF-Sektor sind allerdings nicht verfügbar.

Möglichkeiten: Brasiliens Pro-Kopf-Einkommen liegt in etwa im weltweiten Durchschnitt. Allerdings ist die regionale und soziale Einkommensverteilung immer noch sehr ungleich. Brasiliens „human development index" (HDI) liegt weit über dem weltweiten Durchschnitt. Es gibt viele Initiativen, Gesetze und Standards zur Reduzierung der Emissionsintensität der Energieproduktion, des Transports und der Industrie. Allerdings gibt es einige institutionelle Schwierigkeiten bei der Umsetzung der Maßnahmen.

Potenzial: Trotz des hohen Anteils erneuerbarer Energien an der Stromproduktion besitzt Brasilien ein nennenswertes Minderungspotenzial. Nach Zahlen aus der Phase II des Projekts beträgt das „no-regret" Potenzial zur Reduktion der Emissionen im Jahr 2020 unter das BAU-Szenario 104 Mio. t, das „co-benefit" Potenzial beträgt 187 Mio. t und das

„ambitious“ Potenzial beträgt 429 Mio. tCO_2äquiv. Diese entsprächen einer Reduzierung von 3%, 6% bzw. 14% im Vergleich zum BAU-Szenario und einem Anstieg von 20%, 16% bzw. 6% verglichen mit Emissionen im Jahr 2005.

Angesichts der notwendigen Menge weltweiter Emissionsminderungen zur Einhaltung des 2°C-Limits und der oben erfolgten Analyse erachten wir es für Brasilien als angemessen und vertretbar, sich zu einem absoluten, landesweiten „no-lose“ Emissionsziel zu verpflichten.

Das Ziel könnte auf einem ambitionierten Niveau gemäß dem „ambitious“ Potenzial, wie in diesem Projekt analysiert, formuliert, aber in seiner Umsetzung abhängig von finanzieller und technischer Unterstützung der Annex-I-Staaten gemacht werden. Das Ziel würde sich in diesem Fall auf ca. 2.555 Mio. tCO_2äquiv jährlicher Emissionen im Jahr 2020 belaufen, 14% unterhalb des BAU-Niveaus. Alternativ könnte das Ziel auch auf einem weniger ehrgeizigen Niveau angesetzt werden, z.B. entsprechend dem „co-benefit“ Minderungspotenzial. Dieses Ziel würde sich auf 2.796 Mio. tCO_2äquiv belaufen, 16% über den Emissionen im Jahr 2005. Brasilien könnte dann trotzdem ehrgeizige Maßnahmen zur Übererfüllung des Ziels umsetzen und den resultierenden Überschuss auf dem Emissionshandelsmarkt verkaufen. Diese Alternative würde geringere finanzielle und technische Leistungen aus Annex-I-Staaten erfordern, jedoch eine höhere Unterstützung durch den Emissionshandelsmarkt und damit Emissionsminderungsziele von 45% im Vergleich zum Jahr 1990 für Annex-I-Staaten, im Gegensatz zu dem in der obigen Option angenommenen -30%-Ziel.

6. China

China wird als ein Land mit einem durchschnittlichen „human development index“ (HDI) eingestuft. Das Pro-Kopf-Einkommen befindet sich auf durchschnittlichem Entwicklungslandniveau. Die Dominanz von Kohle in Chinas Energiemix und die vergleichsweise geringe Energieeffizienz führen zu einer hohen Emissionsintensität in der Stromerzeugung. Die Pro-Kopf-Emissionen sind noch gering. Dennoch sind Chinas nationale Emissionen hoch, unter anderem auf Grund von beträchtlichen Exporten. Während Chinas Energieintensität in den letzten Jahrzehnten gesunken ist, hat die Energienachfrage stark zugenommen. Dieser Trend hat zur Folge, dass Chinas Teilnahme an einem zukünftigen Klimaregime von hoher Bedeutung ist.

Referenzemissionen und Reduktionspotenzial

Wie in Abbildung 1 dargestellt, liegt Chinas THG-Minderungspotenzial bei 8% („no-regret“), 15% („co-benefit“) and 32% („ambitious“) unterhalb des BAU Szenarios. Die Top-drei Sektoren mit dem höchsten THG-Minderungspotenzial zwischen den Jahren 2005 und 2020 („ambitious“) sind der Energie-, Industrie- und Transportsektor. Für das „ambitious“ Szenario liegt das Minderungspotenzial bei 1.322 Mio. tCO_2äquiv im Jahr 2020 im Kraftwerkssektor, bei 770 Mio. tCO_2äquiv im Industriesektor und bei 295 Mio. tCO_2äquiv im Transportsektor. Das gesamte Minderungspotenzial („ambitious“) wird auf 2.930 Mio. tCO_2äquiv geschätzt. Ein detaillierter Überblick über die Potenziale je Sektor und Szenario ist in Appendix B enthalten.

Bestehende und mögliche zukünftig nationale Klimaschutzmaßnahmen

Klimapolitik in China wird hauptsächlich auf regionaler Ebene entwickelt und umgesetzt. Von der zentralen Regierung werden Standards, oft in Form von Richtlinien, gesetzt. Die Implementierung und Durchführung ist den lokalen Regierungen überlassen. Jedoch hat China eine Anzahl von Klimapolitiken und -maßnahmen implementiert und plant weitere. Weitere Politiken könnten z.B. die folgenden umfassen:

- **Energiesektor**: Ziele für den Ausbau erneuerbarer Energien, erneuerbare Energien-Ziele für Wärme- und Kälteversorgung, ökologische Steuerreform, allmähliche Rücknahme von Energiesubventionen unterstützt durch finanzielle und technische Hilfen für Energieeffizienz und RES

- **Industriesektor**: allmähliche Rücknahme von Energiesubventionen unterstützt durch finanzielle und technische Hilfen für Energieeffizienz und RES, verbesserte finanzielle Unterstützung zur Optimierung und Anwendung von energieeffizienten Technologien in Verbindung mit Energieaudits und -Managementsystemen sowie Mindest-Energieeffizienzstandards
- **Transportsektor**: Zielvorgaben/Quoten für Biokraftstoffe, Steuerbefreiung für nachhaltige Biokraftstoffe und Straßengebühren

Optionen für eine stärkere Einbeziehung von China in das internationale Regime

Verantwortung: Auf einer Pro-Kopf-Basis liegt Chinas Verantwortung für den Klimawandel aufgrund seiner Emissionen (ohne LULUCF) im Mittelfeld der Nicht-Annex-I-Staaten. Die gegenwärtigen Pro-Kopf-Emissionen sind oberhalb des Nicht-Annex-I Staaten Durchschnitts. Die absoluten Emissionen aller Gase und Quellen Chinas sind ungefähr genau so hoch oder höher wie die Emissionen der USA, dem vormals weltweit größten Emittenten, und wachsen rasant.

Möglichkeiten: Das Pro-Kopf-Einkommen befindet sich knapp oberhalb des Durchschnitts der Entwicklungsländer. China besitzt einen durchschnittlichen „human development index". Jedoch ist das Einkommen innerhalb der Bevölkerung ungleich verteilt.

Potenzial: Das THG-Minderungspotenzial ist sehr groß. Ausgehend von den Berechnungen der zweiten Phase dieses Projekts, beläuft sich das „no-regret" Minderungspotenzial gegenüber dem BAU- Szenario auf 777 Mio. t, das „co-benefit" Minderungspotenzial auf 1.342 Mio. tCO_2äquiv und das „ambitious" Minderungspotenzial auf 2.930 Mio. tCO_2äquiv. Dies würde einer Emissionsreduktion gegenüber dem BAU-Szenario von 8%,15% bzw. 32% und einer Erhöhung des Emissionsniveaus gegenüber 2005 von 36%, 27% bzw. 1% entsprechen.

Angesichts der benötigten globalen Emissionsreduktionen um die Temperaturänderung unterhalb von 2°C zu halten und basierend auf der oben beschriebenen Analyse, halten wir es für angemessen und vertretbar, wenn China sich zu sektoralen „no-lose" Zielen im Energiesektor, im Eisen- und Stahlsektor und im Zementsektor verpflichten würde. In diesen Sektoren ist die notwendige Datenlage recht gut.

Das Ziel könnte auf einem ambitionierten Niveau gemäß dem „ambitious" Potenzial, wie in diesem Projekt analysiert, formuliert, aber in seiner Umsetzung abhängig von finanzieller und technischer Unterstützung der Annex-I-Staaten gemacht werden. Das Ziel für die oben genannten Sektoren wäre in diesem Fall absolute jährliche Emissionen von 2.754 Mio. tCO_2 im Jahr 2020, was einer Reduktion um ungefähr 39% unterhalb der BAU-Entwicklung entspricht. Alternativ könnte das Ziel niedriger ausgestaltet werden, z.B. auf einem durch das „co-benefit„ Szenario" angedeuteten Niveau. In diesem Fall würde sich das absolute Ziel für das Jahr 2020 für alle abgedeckten Sektoren auf 3.678 Mio. tCO_2 belaufen, ungefähr 19% unterhalb der BAU-Entwicklung. China könnte dann trotzdem ehrgeizige Klimaschutzmaßnahmen umsetzen, die das Ziel übererfüllen, und den resultierenden Überschuss auf dem Emissionshandelsmarkt verkaufen. Diese Alternative würde weniger direkte finanzielle und nicht-finanzielle Unterstützung seitens der Annex-I-Staaten beanspruchen, dafür aber mehr Unterstützung seitens des Emissionshandelsmarktes und somit ehrgeizigere CO_2 Emissionsziele für die Annex-I-Staaten erfordern. Die Emissionsziele der Annex-I-Staaten müssten sich daher in diesem Fall von -30% im Vergleich zum Jahr 1990 auf -45% erhöhen.

Außerdem könnte China sich dazu verpflichten eine Reihe von SD PAMs für Sektoren umzusetzen die nicht von dem oben genannten sektoralen „no-lose" Ziel abgedeckt werden. Das Paket aus sektoralen „no-lose" Zielen und SD PAMs sollte darauf abzielen, das gesamte „ambitious" Minderungspotenzial zu mobilisieren. Indessen wäre die Durchführung dieser SD PAMs abhängig von zusätzlicher internationaler Unterstützung um die höheren Kosten, die im Vergleich zur BAU-Entwicklung entstehen, decken zu können. Aufgrund fehlender (institutioneller) Kapazitäten in den von SD PAMs abzudeckenden Sektoren, können die dort

erreichten Emissionsminderungen nur grob abgeschätzt werden. Daher wird keine direkte Verknüpfung zwischen diesen Politiken und dem internationalen Emissionshandelsmarkt angenommen.

7. Indien

Indien befindet sich auf einem durchschnittlichen Entwicklungsstand. Das Pro-Kopf-BIP und der HDI liegen unterhalb des Durchschnitts der Entwicklungsländer und in der Nähe vom Durchschnitt der einkommensschwachen Länder (UNDP 2004). Indiens Emissionen steigen stark an. Die Emissionen pro BIP-Einheit sind vergleichsweise hoch. Die Emissionen pro Kopf sind niedrig, unter anderem weil ungefähr die Hälfte der Bevölkerung noch keine zuverlässigen Elektrizitätsversorgung hat (World Bank 2006). Obwohl Indien einen großen Anteil an CO_2-freien Energiequellen besitzt, führen geringe Umwandlungseffizienzen und eine intensive Nutzen von Kohle zu hohen spezifischen Emissionen in der Energieproduktion (Chandler et al. 2002). Ähnlich wie in Brasilien ist der Anteil an Biomasse am Energieverbrauch des Haushaltssektors hoch aber abnehmend.

Referenzemissionen und Reduktionspotenzial

Wie in Abbildung 1 dargestellt liegt Indiens Minderungspotenzial 12% („no-regret"), 22% („co-benefit") und 38% („ambitious") unterhalb der BAU-Entwicklung. Die drei Sektoren mit dem größten THG-Minderungspotenzial zwischen den Jahren 2005 und 2020 („ambitious") sind der Energie-, Industrie- und Transportsektor. Im Energiesektor liegt das „ambitious" Minderungspotenzial bei ca. 245 Mio. tCO_2äquiv, im Industriesektor bei 245 Mio. tCO_2äquiv und im Transportsektor bei 231 Mio. tCO_2äquiv. Das gesamte Minderungspotenzial („ambitious") beläuft sich auf ca. 1.336 Mio. tCO_2äquiv. Ein detaillierter Überblick über die Potenziale je Sektor und Szenario ist in Appendix B enthalten.

Bestehende und mögliche zukünftig nationale Klimaschutzmaßnahmen

Bereits heute hat Indien eine Reihe von Klimaschutzmaßnahmen geplant und umgesetzt. Weitere Maßnahmen könnten z.B. sein:

- **Energiesektor**: Erneuerbare Energien Ziel für die Wärme- und Kältebereitstellung, stufenweise Abschaffung von Energiesubventionen gefördert durch finanzielle und technische Unterstützung für Energieeffizienz und erneuerbare Energien, innerstaatliches Emissionshandelsystem
- **Industriesektor:** stufenweise Abschaffung von Energiesubventionen unterstützt durch finanzielle und technische Unterstützung für Energieeffizienz und erneuerbare Energien**,** finanzielle Unterstützung für die Optimierung und Installation von energieeffizienten Technologien verbunden mit Energieaudits und -Managementsystemen sowie die Erweiterung des Energieeffizienzabkommen
- **Transportsektor:** Zielvorgaben/Quoten für nachhaltige Biotreibstoffe, Steuerbefreiungen für nachhaltige Biotreibstoffe und Straßengebühren

Optionen für eine stärkere Einbeziehung von Indien in das internationale Regime

Verantwortung: Indiens Verantwortung für den Klimawandel aufgrund seiner historischen Pro-Kopf-Emissionen (ohne LULUCF) ist geringer als die des Durchschnitts der Nicht-Annex-I-Staaten. Indiens gegenwärtigen Pro-Kopf-Emissionen liegen ebenfalls unterhalb des Durchschnitts der Nicht-Annex-I-Länder. Die absoluten Emissionen Indiens sind aber beachtlich und wachsen rasant.

Möglichkeiten: Das Pro-Kopf-Einkommen und der HDI liegen unter dem Nicht-Annex-I-Durchschnitt. Das Einkommen ist innerhalb der Bevölkerung ungleich verteilt. Die tatsächliche Umsetzung von Politikmaßnahmen könnte sich schwierig gestalten.

Potenzial: Das Minderungspotenzial ist aufgrund der geringen Energieeffizienz und den stark ansteigenden absoluten und relativen Emissionen hoch. Gemäß den Zahlen aus der Phase

II dieses Projektes liegt das „no-regret“ Potenzial für die Reduktion von Emissionen im Jahr 2020 bei 416 Mio. t, das „co-benefit“ Potenzial bei 775 Mio. t und das „ambitious“ Potenzial bei 1.336 Mio. tCO_2äquiv. Dies würde einer Reduktion gegenüber der BAU-Entwicklung von 12%, 22% bzw. 38% und eine Erhöhung der Emissionen gegenüber dem Niveau des Jahres 2005 von 69%, 49% bzw. 19% entsprechen.

Basierend auf der oben beschriebenen Analyse halten wir es für angemessen und möglich, dass Indien eine Reihe von SD PAMs implementiert. Indien würde die Effekte von solchen SD PAMs im Voraus quantifizieren. Das komplette Paket sollte auf die Mobilisierung des gesamten „ambitious“ Potenzials abzielen. Allerdings wäre die Durchführung dieser Politiken und Maßnahmen abhängig von zusätzlicher internationaler Unterstützung, um die hohen Kosten, die im Vergleich zur BAU-Entwicklung entstehen, decken zu können. Aufgrund fehlender technischer Kapazitäten können die in Indien durch implementierte SD PAMs erreichten Emissionsreduktionen nur ungefähr abgeschätzt werden. Daher wird keine direkte Verknüpfung zwischen den Politiken und dem internationalen Emissionshandelsmarkt angenommen.

8. Mexiko

Insgesamt ist Mexiko ein Land mit einem hohen HDI. Das BIP liegt deutlich über dem weltweiten Durchschnitt und dem Durchschnitt von Ländern mittleren Einkommens. Es wurde erst nach Gründung der UNFCCC Mitglied der OECD und ist deshalb, ähnlich wie Südkorea, ein Nicht-Annex-I- aber dennoch OECD-Staat. Die Dominanz des Öls in Mexikos Energiemix führt zu vergleichsweise hohen Emissionen. Mexikos Pro-Kopf-Emissionen im Jahr 2002 waren erheblich und sogar geringfügig höher als jene einiger Annex-I-Staaten mit niedrigen Emissionen, z.B. Litauen, der Türkei oder Lettland. Im Laufe der letzten Jahre haben Mexikos Emissionen weiter zugenommen.

Referenzemissionen und Reduktionspotenzial

Wie in Abbildung 1 dargestellt beträgt das Reduktionspotenzial Mexikos 8% („no-regret“), 16% („co-benefit“) und 39% („ambitious“) im Vergleich zur BAU-Entwicklung. Die drei Sektoren mit den höchsten THG-Minderungspotenzialen zwischen den Jahren 2005 und 2020 („ambitious“) sind Transport, Energie und Industrie. Im Energiesektor existiert ein Potenzial („ambitious“) von 186 Mio. tCO_2äquiv. Für den Transportsektor wird das Potenzial („ambitious“) auf 111 Mio. tCO_2äquiv geschätzt. Für das Potenzial („ambitious“) im Industriesektor werden 41 Mio. tCO_2äquiv angenommen. Das gesamte Minderungspotenzial („ambitious“) Mexikos wird auf 417 Mio. tCO_2äquiv geschätzt. Ein detaillierter Überblick über die Potenziale je Sektor und Szenario ist in Appendix B enthalten.

Bestehende und mögliche zukünftig nationale Klimaschutzmaßnahmen

Bereits heute hat Mexiko eine Reihe von Klimaschutzmaßnahmen geplant und umgesetzt. Weitere Maßnahmen könnten z.B. sein:

- **Energiesektor**: Erneuerbare Energien-Ziele für Strom-, Wärme- und Kälteversorgung, allmähliche Rücknahme von Energiesubventionen unterstützt durch finanzielle und technische Hilfen für Energieeffizienz und RES sowie Einspeisevergütungen oder Stromquoten (Grüne Zertifikate) für RES und KWK
- **Transportsektor**: Ziele/Quoten für nachhaltige Biotreibstoffe, Steuererleichterungen für nachhaltige Biotreibstoffe sowie Straßengebühren
- **Industriesektor**: allmähliche Rücknahme von Energiesubventionen unterstützt durch finanzielle und technische Hilfen für Energieeffizienz und RES, verbesserte finanzielle Unterstützung zur Optimierung und Anwendung von energieeffizienten Technologien in Verbindung mit Energieaudits und -Managementsystemen sowie Mindest-Energieeffizienzstandards

Optionen für eine stärkere Einbeziehung von Mexiko in das internationale Regime

Verantwortung: Mexikos Verantwortung für den Klimawandel liegt gemessen an seinen Emissionen ohne LULUCF unter dem weltweiten Durchschnitt, allerdings geringfügig über dem Durchschnitt für Nicht-Annex-I-Staaten.

Möglichkeiten: Mexikos Pro-Kopf-Einkommen liegt geringfügig über dem weltweiten Durchschnitt. Sein HDI liegt weit über dem weltweiten Durchschnitt.

Potenzial: Mexiko besitzt ein nennenswertes Minderungspotenzial. Nach Zahlen aus Phase II des Projekts beträgt das „no-regret" Potenzial zur Reduktion der Emissionen im Jahr 2020 unter das BAU-Szenario 82 Mio. t, das „co-benefit" Potenzial beträgt 173 Mio. t und das „ambitious" Potenzial beträgt 417 Mio. tCO_2äquiv. Diese entsprächen einer Reduzierung von 8%,1 6% bzw. 39% im Vergleich zur BAU-Entwicklung und einer Veränderung von +26%, +14% bzw. -17% verglichen mit den Emissionen im Jahr 2005.

Angesichts der notwendigen Menge weltweiter Emissionsminderungen zur Einhaltung des 2°C-Limits und der oben erfolgten Analyse halten wir es für Mexiko angemessen vertretbar, sich zu einem absoluten, landesweiten „no-lose" Emissionsziel zu verpflichten.

Das Ziel könnte auf einem ambitionierten Niveau gemäß dem „ambitious" Potenzial formuliert, aber in seiner Umsetzung abhängig von finanzieller und technischer Unterstützung der Annex-I-Staaten gemacht werden. Das Ziel würde sich in diesem Fall auf ca. 638 Mio. tCO_2äquiv jährlicher Emissionen im Jahr 2020 belaufen, 39% unterhalb des BAU-Niveaus und 17% niedriger als die 2005er Emissionen. Alternativ könnte das Ziel auch auf einem weniger ehrgeizigen Niveau angesetzt werden, z.B. entsprechend dem „co-benefit" Minderungspotenzial. Dieses Ziel würde sich auf 882 Mio. tCO_2äquiv belaufen, 14% über den Emissionen im Jahr 2005. Mexiko könnte dann trotzdem ehrgeizige Maßnahmen zur Übererfüllung des Ziels umsetzen und den resultierenden Überschuss auf dem Emissionshandelsmarkt verkaufen. Diese Alternative würde geringere finanzielle und technische Leistungen aus Annex-I-Staaten benötigen, jedoch eine höhere Unterstützung durch den Emissionshandelsmarkt und damit Emissionsminderungsziele von 45% im Vergleich zum Jahr 1990 für Annex-I-Staaten, im Gegensatz zu dem in der obigen Option angenommenen -30%-Ziel.

9. Südafrika

Insgesamt führt die Dominanz von Kohle in Südafrikas Energiemix zu einer sehr hohen Emissionsintensität in der Stromproduktion. Dies und die energieintensive Industry führen zu sehr hohen Emissionen pro BIP-Einheit. Die Emissionen pro Kopf sind niedriger als die der meisten Annex-I-Staaten, verglichen mit anderen Entwicklungsländern sind sie allerdings hoch. Bedingt durch weitere Entwicklung und dem anhaltend hohen Stellenwert von Kohle als Energiequelle, werden Südafrikas Emissionen sehr wahrscheinlich in Zukunft weiter ansteigen.

Referenzemissionen und Reduktionspotenzial

Wie in Abbildung 1 dargestellt, beträgt das Minderungspotenzial von Südafrika 9% („no-regret"), 18% („co-benefit") und 35% („ambitious") unterhalb der BAU-Entwicklung. Die drei Sektoren mit den höchsten THG-Minderungspotenzialen zwischen den Jahren 2005 und 2020 („ambitious") sind der Energiesektor, der Transportsektor und der Industriesektor. Das Minderungspotenzial („ambitious") im Energiesektor wird auf 67 Mio. tCO_2äquiv für das Jahr 2020 geschätzt. Im Transportsektor ist ein Potenzial („ambitious") von 42 Mio. tCO_2äquiv vorhanden. Im Industriesektor wird für das Jahr 2020 ein Potenzial („ambitious") von 41 Mio. tCO_2äquiv angenommen. Das gesamte Minderungspotenzial unter dem „ambitious" Szenario wird in Südafrika auf 212 Mio. tCO_2äquiv für das Jahr 2020 geschätzt. Ein detaillierter Überblick über die Potenziale je Sektor und Szenario ist in Appendix B enthalten.

Bestehende und mögliche zukünftig nationale Klimaschutzmaßnahmen

Südafrika hat bereits heute eine beträchtliche Anzahl an Politiken und Maßnahmen im Klimabereich geplant und umgesetzt. Weitere Instrumente könnten z.B. folgende sein:

- **Energiesektor**: Erneuerbare Energien-Ziele für Wärme- und Kälteversorgung, schrittweise Ausstieg aus direkter und indirekter Subventionierung von Energie, unterstützt von finanzieller Hilfe zur Verbesserung der Energieeffizienz und RES (z.B. unterstütz durch das ESKOM System zur Steuerung der Nachfrage) und Einspeisevergütungen oder Elektrizitätsquoten (Grüne Zertifikate) für RES und KWK
- **Transportsektor**: Ziele/Quoten für nachhaltige Biotreibstoffe, Steuerbefreiung für nachhaltige Biotreibstoffe, Straßengebühren
- **Industriesektor**: allmähliche Rücknahme von Energiesubventionen unterstützt durch finanzielle und technische Hilfen für Energieeffizienz und RES, finanzielle Unterstützung zur Optimierung und Anwendung von energieeffizienten Technologien in Verbindung mit Energieaudits und -Managementsystemen sowie die Ausweitung der Energieeffizienzvereinbarung („energy efficiency accord“)

Optionen für eine stärkere Einbeziehung von Südafrika in das internationale Regime

Verantwortung: Aufgrund seiner Emissionen (ohne LULUCF) liegt Südafrikas Verantwortung am Klimawandel leicht über dem Weltdurchschnitt. LULUCF spielt in Südafrika keine große Rolle.

Möglichkeiten: Südafrikas kaufkraftbereinigtes Pro-Kopf-Einkommen liegt über dem weltweiten Durchschnitt. Allerdings liegt der HDI liegt leicht unter dem Durchschnitt. Dies ist ein Indikator dafür, dass die regionale und soziale Einkommensverteilung sehr ungleich ist.

Potenzial: Südafrika verfügt über eine beträchtliches Minderungspotenzial. Basierend auf den Daten aus Phase II des Projektes beträgt das „no-regret“ Potenzial zur Reduktion der Emissionen im Jahr 2020 unter die BAU-Entwicklung 57 Mio. t, das „co-benefit“ Potenzial beträgt 110 Mio. t und das „ambitious“ Potenzial beträgt 212 Mio. tCO_2äquiv. Diese Zahlen entsprächen einer Reduzierung von 9%, 18% bzw. 35% im Vergleich zum BAU-Szenario und einer Änderung von +19%, +7% bzw. -15%% verglichen mit Emissionen im Jahr 2005.

Angesichts der notwendigen Menge weltweiter Emissionsminderungen zur Erreichung des 2°C-Limits und der oben erfolgten Analyse erachten wir es für Südafrika als angemessen und vertretbar, sich zu einem sektoralen „no-lose“ Ziel für den Energie- und den Industriesektor zu verpflichten.

Das Ziel könnte auf einem ambitionierten Niveau gemäß dem „ambitious“ Potenzial, wie in diesem Projekt analysiert, formuliert, aber in seiner Umsetzung abhängig von finanzieller und technischer Unterstützung der Annex-I-Staaten gemacht werden. Das Ziel würde sich in diesem Fall für die beiden berücksichtigten Sektoren auf ca. 191 Mio. tCO_2äquiv jährlicher Emissionen im Jahr 2020 belaufen, 36% unterhalb der BAU-Entwicklung. Alternativ könnte das Ziel auch auf einem weniger ehrgeizigen Niveau angesetzt werden, z.B. entsprechend dem „co-benefit“ Minderungspotenzial. Dieses Ziel würde sich auf 256 Mio. tCO_2äquiv belaufen, 14% unter den Emissionen im Jahr 2005. Südafrika könnte dann trotzdem ehrgeizige Maßnahmen zur Übererfüllung seines Ziels umsetzen und den resultierenden Überschuss auf dem Emissionshandelsmarkt verkaufen. Diese Alternative würde geringere finanzielle und technische Leistungen aus Annex-I-Staaten erfordern, jedoch eine höhere Unterstützung durch den Emissionshandelsmarkt und damit Emissionsminderungsziele von 45% im Vergleich zum Jahr 1990 für Annex-I-Staaten, im Gegensatz zu dem in der obigen Option angenommenen -30%-Ziel.

Darüber hinaus könnte Südafrika sich zur Umsetzung einer Reihe von SD PAMs für Sektoren die nicht von dem oben genannten sektoralen „no-lose“ Ziel abgedeckt werden verpflichten. Das Paket aus sektoralen „no-lose“ Zielen und SD PAMs sollte darauf abzielen, das gesamte „ambitious“ Minderungspotenzial zu mobilisieren. Die Durchführung dieser SD

PAMs wäre abhängig von zusätzlicher internationaler Unterstützung um die höheren Kosten, die im Vergleich zur BAU-Entwicklung entstehen, decken zu können. Aufgrund fehlender Kapazitäten in den von SD PAMs abzudeckenden Sektoren können die dort erreichten Emissionsreduktionen nur grob abgeschätzt werden. Daher wird keine direkte Verknüpfung zwischen diesen Politiken und dem internationalen Emissionshandelsmarkt angenommen.

10. Südkorea

Insgesamt ist der Entwicklungsstand von Südkorea dem einiger Annex-I-Staaten sehr ähnlich. Seine Bevölkerungszahlen waren in den letzten Jahrzehnten nahezu stabil. Ein großer Anteil von Atomenergie im Strommix führt zu niedrigen Emissionen pro kWh. Südkoreas Industriesektor ist verantwortlich für einen großen Anteil der nationalen Emissionen, allerdings ist er im internationalen Vergleich bereits sehr effizient. Emissionen aus Transport und Haushalten sind hoch, während Emissionen aus dem Agrarsektor nicht relevant sind.

Referenzemissionen und Reduktionspotenzial

Wie in Abbildung 1 dargestellt, liegt Südkoreas THG-Minderungspotenzial bei 9% („no-regret“), 15% („co-benefit“) and 31% („ambitious“) unterhalb der BAU-Entwicklung. Die drei Sektoren mit dem höchsten THG-Minderungspotenzial zwischen den Jahren 2005 und 2020 („ambitious“) sind der Industrie-, Energie- und Transportsektor. Für das „ambitious“ Szenario liegt das Minderungspotenzial im Industriesektor bei 212 Mio. tCO_2äquiv im Jahr 2020, im Energiesektor bei 112 Mio. tCO_2äquiv und im Transportsektor bei 80 Mio. tCO_2äquiv. Das absolute Minderungspotenzial wird auf 443 Mio. tCO_2äquiv geschätzt. Ein detaillierter Überblick über die Potenziale je Sektor und Szenario ist in Appendix B enthalten.

Bestehende und mögliche zukünftig nationale Klimaschutzmaßnahmen

- **Industriesektor**: schrittweise Rücknahme von Energiesubventionen unterstützt durch finanzielle und technische Hilfen für Energieeffizienz und RES, verbesserte finanzielle Unterstützung zur Optimierung und Anwendung von energieeffizienten Technologien in Verbindung mit Energieaudits und -Managementsystemen sowie Mindest-Energieeffizienzstandards (für energieverbrauchende Anlagen und integriert in Baugenehmigungen für neue Produktionsstätten)
- **Energiesektor**: Erneuerbare Energien-Ziele für Wärme- und Kälteversorgung, eine ökologische Finanzreform sowie Einspeisetarife oder Elektrizitätsquoten (Grüne Zertifikate) für RES und KWK
- **Transportsektor**: Ziele/Quoten für nachhaltige Biotreibstoffe, Steuerbefreiungen für nachhaltigen Biotreibstoffe und Straßengebühren

Optionen für eine stärkere Einbeziehung von Südkorea in das internationale Regime

Verantwortung: Aufgrund seiner Emissionen (ohne LULUCF) liegt Südkoreas Verantwortung für den Klimawandel beim Weltdurchschnitt.

Möglichkeiten: Südkoreas Einkommen pro Kopf liegt weit über dem Weltdurchschnitt und ist nahe am Annex-I-Durchschnitt. Sein HDI liegt beim Annex-I-Durchschnitt.

Potenzial: Trotz der hohen Effizient der südkoreanischen Wirtschaft und einem hohen Anteil an Atomenergie in der Stromproduktion ist das Emissionsreduktionspotenzial beträchtlich. Ausgehend von den Berechnungen der zweiten Phase diese Projektes beträgt das „no-regret“ Potenzial zur Reduktion der Emissionen im Jahr 2020 unter der BAU-Entwicklung 133 Mio. t, das „co-benefit“ Potenzial beträgt 200 Mio. t und das „ambitious“ Potenzial beträgt 443 Mio. tCO_2äquiv. Diese entsprächen einer Reduzierung von 13%, 19% bzw. 42% im Vergleich zum BAU-Szenario und einer Veränderung von +38%, +28% bzw. -9% verglichen mit Emissionen im Jahr 2005.

Angesichts der nötigen globalen Emissionsreduktionen und basierend auf der oben beschriebenen Analyse erachten wir es als gerecht und vertretbar, wenn Südkorea dem Annex I der Klimarahmenkonvention beitreten würde. Im Rahmen dessen könnte es sich zu einem absoluten und bindenden nationalen Ziel zur Begrenzung seiner Emissionen verpflichten. Südkoreas Ziel könnte gemäß dem „ambitious“ Potenzial, wie in diesem Projekt analysiert, formuliert werden. Dies würde einem absoluten Emissionsziel von 604 Mio. tCO_2äquiv in 2020 entsprechen. Das wäre gleichbedeutend mit einer Reduktion um 42% unter der BAU-Entwicklung im Jahr 2020 bzw. einer Reduktion um 9% im Vergleich zu den 2005er Emissionen.

11. Resultierendes umfassendes Rahmenwerk

Tabelle 1 beinhaltet eine Zusammenfassung der möglichen Beiträge der sechs in diesem Bericht betrachteten Länder. Die Tabelle ist nach der Art der Ziele geordnet, die in der Tabelle nach unten hin weniger ehrgeizig werden. Basierend auf ihrem hohen bzw. niedrigen Niveau wirtschaftlicher Entwicklung erachten wir es für Südkorea als angemessen, dem Annex I der UNFCCC beizutreten. Aus unserer Sicht ist für Indien die Verpflichtung zur Umsetzung von SD PAMs ein angemessener Beitrag. Für Mexiko, Brasilien, Südafrika und China schlagen wir je zwei Optionen vor.

Unter Option A würden sich Mexiko, Brasilien, Südafrika und China dazu verpflichten nationale oder sektorale „no-lose“ Ziele in Höhe des „ambitious“ Emissionsminderungspotenzials anzunehmen. Die Erreichung dieser Emissionsreduktionen wäre allerdings an finanzielle Unterstützung der Annex-I-Staaten außerhalb des Emissionshandelsmarktes gebunden. Sie könnte von einer Reduktion der Emissionen in Annex-I-Staaten um 30% bis zum Jahr 2020 im Vergleich zum Emissionsniveau im Jahr 1990 begleitet werden.

Die Option B führt zu vergleichbaren globalen Emissionsreduktionen, würde aber stärker auf den Emissionshandelsmarkt als Finanzierungsinstrument und weniger auf zusätzliche direkte Finanzierung aus Annex-I-Staaten vertrauen. Diese Option sieht vor, dass Mexiko, Brasilien, Südafrika und China sich in den oben genannten Sektoren zu „no-lose“ Zielen in der Höhe ihres „co-benefit“ Potenzials verpflichten. Um die globalen Emissionen auf einem Pfad zu halten der das 2°C Limit nicht überschreitet müssten sich Annex-I-Staaten statt zu einem 30% Ziel zu einer Reduktion um 45% im Vergleich zum 1990 Emissionsniveau bis 2020 verpflichten. Annex-I-Staaten würden technische Unterstützung zur Beseitigung von Umsetzungsbarrieren die nicht vom Markt gesteuert werden können, aber keine umfangreichen zusätzlichen Ressourcen außerhalb des Emissionshandelsmarktes bereitstellen, um die Entwicklungsländer bei der Umsetzung ihrer Beiträge zu unterstützen.

Tabelle 1. Zusammenfassung der vorgeschlagenen Beitrage für das Jahr 2020, sortiert nach Art der Ziele

Land	Art	Umfang	Option A		Option B	
			Emissions-niveau	Finanzierung	Emissions-niveau	Finanzierung
Südkorea	Absolutes und bindendes nationales Emissions-minderungsziel	Alle Sektoren	Weit unter BAU (z.B. 40%)	Keine zusätzliche Finanzierung	Weit unter BAU (z.B. 40%)	Keine zusätzliche Finanzierung
Mexiko	Absolutes “no-lose” Emissionsziel	Alle Sektoren	Weit unter BAU (z.B. 40%)	Abhängig von finanzieller Unterstützung	Unter BAU („co-benefit“ Potenzial, z. B. 15%)	Technische Unterstützung zur Erreichung des „co-benefit“ Potenzials

Land	Art	Umfang	Option A		Option B	
			Emissions-niveau	Finanzierung	Emissions-niveau	Finanzierung
B rasilien	Absolutes “no-lose” Emissionsziel	Alle Sektoren	Weit unter BAU (z.B. 40%)	Abhängig von finanzieller Unterstützung	Unter BAU („co-benefit“ Potenzial, z. B. 6%)	Technische Unterstützung zur Erreichung des „co-benefit“ Potenzials
Südafrika	Sektorales “no-lose” Emissionsziel	Energiesektor, Industriesektor	Weit unter BAU (z.B. 35%)	Abhängig von finanzieller Unterstützung	Unter BAU („co-benefit“ Potenzial, z. B 18%)	Technische Unterstützung zur Erreichung des „co-benefit“ Potenzials
	Politiken und Maßnahmen zur nachhaltigen Entwicklung	Übrige Sektoren	Nicht quantifiziert		Nicht quantifiziert	
China	Sektorales “no-lose” Emissionsziel	Energiesektor, Eisen und Stahl- sowie Zementsektor	Weit unter BAU (z.B. 30%)	Abhängig von finanzieller Unterstützung	Unter BAU („co-benefit“ Potenzial, z. B 14%)	Technische Unterstützung zur Erreichung des „co-benefit“ Potenzials
	Politiken und Maßnahmen zur nachhaltigen Entwicklung	Übrige Sektoren	Nicht quantifiziert		Nicht quantifiziert	
Indien	Politiken und Maßnahmen zur nachhaltigen Entwicklung	Alle Sektoren	Weit unter BAU	Abhängig von finanzieller Unterstützung	Weit unter BAU	Abhängig von finanzieller Unterstützung

Aus dieser Tabelle ist zu entnehmen, dass die Differenzierung der Länder von Zielen die mit Annex-I-Zielen vergleichbar sind bis hin zu moderaten und unterstützten Emissionsreduktionen reicht. Es ist ebenfalls erkennbar, dass vorgeschlagenen Reduzierungsniveaus zwischen den Ländern, basierend auf unserer Analyse der Reduktionspotenziale, variieren.

12. Konsistenz mit dem 2°C Limit

Die linke Seite in Abbildung 2 zeigt die globalen THG Emissionen unter dem BAU-Szenario bis zum Jahr 2020, aufgeteilt auf Annex-I- und Nicht-Annex-I-Staaten. Das identifizierte Reduktionspotenzial für die Nicht-Annex-I Staaten („non-Annex I“) enthält nur das in diesem Bericht analysierte „ambitious“ Potenzial für die sechs betrachteten Länder. Reduktionspotenziale in anderen Nicht-Annex-I-Staaten wären zusätzlich verfügbar. Allerdings sind nach unseren Abschätzungen die hier betrachteten sechs Länder schon für mehr als die Hälfte der Nicht-Annex-I THG Emissionen in 2020 verantwortlich. Wir nehmen an, dass Annex-I-Staaten ihre Emissionen bis zum Jahr 2020 auf 30% unter das Niveau des Jahres 1990 reduzieren. Die rechte Seite der Abbildung 2 zeigt mögliche Emissionspfade über das Jahr 2020 hinaus, die die Einhaltung des globalen 2°C Limits zum Ziel haben.

Unter Berücksichtigung der Unsicherheiten der Berechnungen können wir daraus dennoch schließen, dass der globale Emissionsanstieg im Zeitraum von 2010 bis 2020 trotzdem gestoppt werden kann, wenn das gesamte „ambitious“ Reduktionspotenzial in den betrachteten sechs Ländern erschlossen wird. Ab dem Jahr 2020 sind darüber hinaus aber weitere umfangreiche Emissionsreduktionen notwendig um unter dem 2°C Limit zu bleiben.

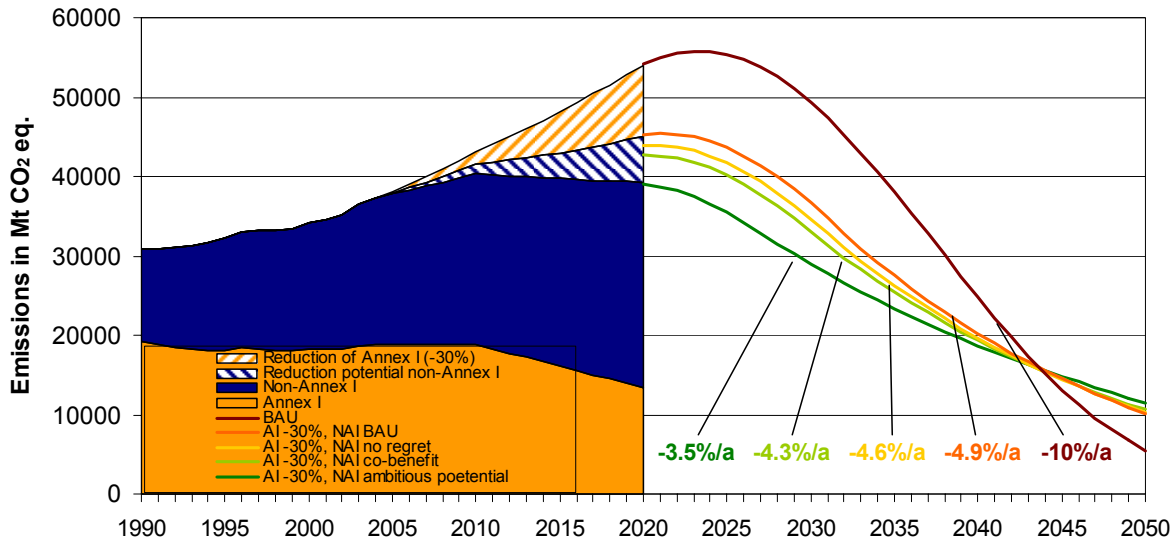


Abbildung 2. Globale THG Emissionen die Reduktionsszenarien für Annex I (-30% innerstaatliche Reduktionen bis zum Jahr 2020 im Vergleich zu den 1990er Emissionen) und Nicht-Annex-I („non-Annex I“ Reduktionen in Höhe des „ambitous“ Potenzials für Brasilien, China, Indien, Mexiko, Südafrika und Südkorea im Zeitraum von 1990 bis 2020). Auf der rechten Seite sind mögliche globale Reduktionspfade für die Einhaltung des 2°C Limits im Zeitraum von 2020 bis 2050 für alle hier betrachteten Szenarien aufgetragen.

13. Unterstützung für verbesserte Emissionsminderung

Finanzielle Unterstützung für eine Umstellung auf kohlenstoffarme und –freie Technologien ist ein Schlüsselelement für die erweiterte Teilnahme der Nicht-Annex-I-Staaten am Klimaregime. In diesem Zusammenhang haben wir die folgenden Felder als wichtig identifiziert.

Politikinstrumente (je Land und Sektor) die finanzieller Unterstützung bedürfen

Basierend auf Teil II haben wir in Teil III des Projektes für jedes der sechs Länder zusätzliche nationale Politikinstrumente jeweils für die drei Sektoren mit den höchsten Reduktionspotenzialen identifiziert. Darüber hinaus schließen wir aus unserer Analyse, dass die folgenden Politikinstrumente die bereits bestehenden Politiken und Maßnahmen unterstützen können, aber für ihre Umsetzung auf finanzielle Hilfe angewiesen sind (siehe Tabelle 2). Die Bereitstellung adäquater finanzieller Unterstützung wird die Chancen für die aktive Beteiligung der sechs untersuchten Länder an einem zukünftigen Klimaregime erheblich erhöhen.

Tabelle 2. Zusätzliche Politikinstrumente die für ihre Umsetzung finanzielle Unterstützung benötigen

	Sektor	Finanzielle Unterstützung
Brasilien	Energie	Ausstieg aus direkter und indirekter Subventionierung von Energie oder Energiepreiskontrollen, unterstützt von finanzieller Hilfe zur Verbesserung der Energieeffizienz in der Endnutzung Installation von RES Technologien Unterstützung für Investitionen in die Verbesserung der Umwandlungseffizienz fossiler Kraftwerke
	Transport	Umstellung vom Transport auf der Straße zu Schienen- oder Schiffstransport, verknüpft mit einer Verbesserung des rechtlichen und finanziellen Rahmens um Risiken zu reduzieren und Investitionen zu fördern

	Sektor	Finanzielle Unterstützung
China	Energie	Unterstützung für Investitionen in die Verbesserung der Umwandlungseffizienz fossiler Kraftwerke Installation von RES Technologien
	Industrie	Optimierung und Installation von energieeffizienten Technologien, verbunden mit Energieaudits und -Managementsystemen
Indien	Energie	Ausstieg aus direkter und indirekter Subventionierung von Energie oder Energiepreiskontrollen, unterstützt von finanzieller Hilfe zur Verbesserung der Energieeffizienz in der Endnutzung Installation von RES Technologien Unterstützung für Investitionen in die Verbesserung der Umwandlungseffizienz fossiler Kraftwerke
	Industrie	Optimierung und Installation von energieeffizienten Technologien, verbunden mit Energieaudits und -Managementsystemen
Mexiko	Energie	Ausstieg aus direkter und indirekter Subventionierung von Energie oder Energiepreiskontrollen, unterstützt von finanzieller Hilfe zur Verbesserung der Energieeffizienz in der Endnutzung Installation von RES Technologien Unterstützung für Investitionen in die Verbesserung der Umwandlungseffizienz fossiler Kraftwerke
	Industrie	Optimierung und Installation von energieeffizienten Technologien, verbunden mit Energieaudits und -Managementsystemen
Südafrika	Energie	Ausstieg aus direkter und indirekter Subventionierung von Energie oder Energiepreiskontrollen, unterstützt von finanzieller Hilfe zur Verbesserung der Energieeffizienz in der Endnutzung Unterstützung für Investitionen in die Verbesserung der Umwandlungseffizienz fossiler Kraftwerke
	Industrie	Optimierung und Installation von energieeffizienten Technologien, verbunden mit Energieaudits und -Managementsystemen
Südkorea	Energie	Installation von RES Technologien
	Industrie	Unterstützung für Investitionen in die Verbesserung der Umwandlungseffizienz fossiler Kraftwerke

Bestehende Instrumente zur finanziellen Unterstützung im internationalen Klimaschutzregime

Innerhalb des Klimaschutzregimes existieren zwei Hauptinstrumente zur finanziellen Unterstützung für THG Reduktionsprojekte in Entwicklungsländern: die Finanzmechanismen und der CDM. Um die mögliche Rolle dieser beiden Instrumente bei der Realisierung der in Teil II und III identifizierten Potenziale zu untersuchen vergleichen wir sie bezüglich ihrer Finanzkraft, der Art der Finanzgeber, der finanzierten Aktivitäten sowie ihrer Anforderungen und Verfahren. Diese Analyse veranschaulicht die folgenden Punkte:

- Die bislang durch die Finanzmechanismen mobilisierten Ressourcen sind im Vergleich zu der Schätzung des UNFCCC Sekretariats, dass im Jahr 2030 zusätzliche Investitionen und Finanzflüsse in Höhe von 200-210 Mrd. USD für Emissionsminderungsmaßnahmen gebraucht werden (UNFCCC 2007, S. 100-102), zu klein. Das Potenzial des CDM ist ausreichend um diese Lücke zu füllen.
- Andere Beschränkungen zeigen sich beim CDM wegen der Tendenz hauptsächlich Projekte mit großem THG Reduktionspotenzial zu realisieren. Die Finanzmechanismen sind daher eher geeignet die Bedürfnisse vieler Nicht-Annex-I-Staaten zu decken, die finanzielle Ressourcen für kleinere Projekte benötigen.
- Die Finanzmechanismen sind möglicherweise besser dafür geeignet Ressourcen bereitzustellen, die um Reduktionsoptionen des „co-benefit“ Potenzials zu realisieren.
- Nichtmonetäre Unterstützungsmaßnahmen benötigen finanzielle Ressourcen. Finanzmechanismen können genutzt werden um diese bereitzustellen.

- Sowohl der CDM als auch die Finanzmechanismen weisen Defizite bei der Erschließung von „no-regret“ Potenzialen auf.

Aufgrund dieser Analysen schlagen wir vor, zunächst die Finanzmechanismen, wie im Folgenden, beschrieben umzustrukturieren. Weiterhin sollte die internationale, zwischenstaatliche und regionale Kooperation gestärkt werden um mehr öffentliche Mittel für „no-regret“ Projekte und nichtmonetäre Unterstützung bereitzustellen. Darüber hinaus sollte die Rolle von privatem Kapital bei der Realisierung von „no-regret“ und „co-benefit“ Potenzialen gestärkt werden.

Zusätzlicher Hilfe für verbesserte Aktivitäten in der Treibhausgasminderung: nichtmonetäre Unterstützung

Abgesehen von finanzieller Hilfe könnten Nicht-Annex-I-Länder auch sehr von nichtmonetärer Unterstützung profitieren. Wissensaustausch und Zusammenarbeit in Forschung und Entwicklung sind möglicherweise wirkungsvolle Instrumente um neue Technologien und politische Instrumente einzuführen und zu verbreiten. Diese Art von technologischer Zusammenarbeit wird außerhalb des Klimaschutzregimes vielfach praktiziert, hat aber bisher im Zusammenhang mit dem UNFCCC und dem Kyoto-Protokoll noch keine wichtige Rolle gespielt.

Grundsätzlich sollten Fördermaßnahmen im Bereich von Forschung und Entwicklung für die beschleunigte Entwicklung, technische Verbesserung und Markteinführung erneuerbarer Energien und Kraft-Wärme-Kopplung für Elektrizität, Heizung und Kühlung, effizienter Kraftwerke mit fossilen Brennstoffen und in den meisten Ländern zur Erforschung von CCS-Technologie eingesetzt werden. Andere vielversprechende Möglichkeiten der Zusammenarbeit in Forschung und Entwicklung sind Maßnahmen für energieeffiziente Produktionstechnologien und -methoden und nachhaltige Transportsysteme.

Die im vorliegenden Bericht untersuchten sechs Länder können von Zusammenarbeit in der Entwicklung von Standards und technischen Vorschriften profitieren. Diese Art internationaler Technologieallianz umfasst Beschlüsse über Standards in der Energieeffizienz, technische Vorschriften für erneuerbare Energiequellen und wirtschaftliche Anreize für den Einsatz bestimmter Technologien (z.B. Subventionen oder steuerliche Vorteile für erneuerbare Energiequellen). Weiterhin gäbe es große Vorteile die Erfahrungen Deutschlands und der EU im Aufbau eines Emissionshandelssystems oder ökologischer Finanzreformen zu nutzen.

Eine Technologieallianz mit Schwellenländern

In der Schaffung eines integrierten Systems für die Entwicklung und den Einsatz innovativer Technologien liegen die Herausforderung und die Chance einer verstärkten Teilnahme von Nicht-Annex-I-Ländern am internationalen Klimaregime. Dies sollte eine hohe Effizienz mit der Möglichkeit verbinden, sich Schritt für Schritt zu entwickeln, um die zukünftige Integration von Nicht-Annex-I-Ländern bei der Eindämmung und Vermeidung von Treibhausgasemissionen in einem künftigen Klimaregime zu ermöglichen.

Das Angebot über eine integrierte Technologieallianz im Rahmen einer neuen Klimaallianz könnte einen ersten Schritt in diese Richtung darstellen. Dadurch würde das Interesse der EU an der Einbindung der wirtschaftlich großen Nicht-Annex-I-Länder bei der Eindämmung und Vermeidung von Treibhausgasemissionen mit den Interessen der aufstrebenden Wirtschaftsnationen an neuen und sauberen Technologien in Einklang gebracht werden. Einige der Ideen der G77/China sollten daher in die Diskussion aufgenommen und mit anderen in diesem Bericht vorgestellten Elementen zu einem schlüssigen und effektiven Technologiebündnis zusammengebracht werden. Ein solches Angebot sollte Zusammenarbeit in der Forschung, Entwicklung und dem Einsatz von kohlenstoffarmen oder -freien Technologien, Erarbeitung gleicher Standards und – als zentrales Feld – eine in ihrer Höhe bedeutende Verpflichtung zur Finanzierung der Umstellung auf kohlenstoffarme und -freie Technologien enthalten.

Eine solche Umstellung wird einen deutlich höheren Kapitaleinsatz erfordern – Schätzungen gehen von 20-30 Mrd. USD im Stern Review (Stern 2006) bis zu 200-210 Mrd. USD im Jahr 2030 gemäß UNFCCC Sekretariat (2007). Kurz- und mittelfristig muss solch ein Fonds wahrscheinlich mit öffentlichen Geldern der Annex-II-Länder ausgestattet werden. Einnahmen aus der Versteigerung der Emissionsrechte im EU Emissionshandelssystem könnten schon einen Teil des benötigten Kapitals ausmachen. Abgesehen von einem solchen Fonds sollte das Technologiebündnis einen innovativen Bestandteil des Montreal-Protokolls enthalten – den „Technology and Economic Assessment Panel" (TEAP) zur Ersetzung veralteter Technologien.

Diese Technologieallianz muss im Zusammenhang mit dem Emissionsrechtehandel gesehen werden, da dieser Markt das Fundament für alle Aktivitäten im Kampf gegen den Klimawandel bildet. Im Nord-Süd-Kontext ist der CDM von besonderer Bedeutung. Natürlich kann der CDM nicht die besonderen Maßnahmen der Zusammenarbeit bei der Entwicklung und dem Einsatz von Technologien in Nicht-Annex-I-Ländern ersetzen. Diese Länder betonen auch, dass der CDM nicht als Weg der Implementierung von Artikel 4.5 FCCC gesehen werden kann. Allerdings können die Bedingungen für technologische Innovation und den Einsatz von innovativen Technologien durch den CDM deutlich verbessert werden.

Solch ein Technologiebündnis anzubieten könnte die Verhandlungen für ein Post 2012-Klimaregime entscheidend voranbringen. Deutlich verstärkte Zusammenarbeit bei der Entwicklung und dem Einsatz von Technologien kann auf einfache Weise so angepasst werden, dass auch Technologien für die Anpassung an die unvermeidbaren Folgen des Klimawandels enthalten wären. Dies wäre ein Anreiz für die schwächeren, in diesem Bericht nicht betrachteten Entwicklungsländer, ihre Anpassungsfähigkeiten gegenüber den Einflüssen des Klimawandels zu stärken, obwohl von ihnen keine Treibhausgasminderungsaktivitäten erwartet werden. Ein Angebot dieser Art wäre ein Ausdruck der Offenheit für neue und kreative Antworten auf die Klimakrise. Für diese Herausforderung ist es nötig, traditionelle Ansätze der Diplomatie, die auf eng definierte nationale Interessen ausgerichtet sind, aufzugeben. Eine echte Partnerschaft mit den neuen Akteuren unter den Nicht-Annex-I-Ländern muss ein Teil dieses Ansatzes sein.

Schlussfolgerungen

Dieser Bericht enthält einen detaillierten Überblick über nationale Umstände, Emissionstrends, Reduktionspotenziale und Politikinstrumente für die großen Emittenten unter den Entwicklungsländern: Brasilien, China, Indien, Mexiko, Südafrika und Südkorea. Auf diese Länder entfallen ca. 50% der Treibhausgasemissionen der Nicht-Annex-I-Länder. Darüber hinaus enthält dieser Bericht Vorschläge zur verstärkten Einbeziehung dieser Länder in eine zukünftiges Klimaregime sowie Elemente internationaler finanzieller und nichtmonetärer Unterstützung für diese Länder.

Wir ziehen die folgenden Schlussfolgerungen aus dieser Arbeit

- Der Klimawandel erfordert schnelles Handeln der Industriestaaten, um ihre THG Emissionen zu reduzieren und Entwicklungsländer zu unterstützen, ihr THG-Emissionswachstum zu bremsen oder ihre Emissionen sogar zu reduzieren.
- Das im Rahmen dieses Projektes entwickelte Excel Modell ermöglicht es, die Emissionsminderungspotenziale auf Sektorbasis zwischen den Ländern mit einer einheitlichen Methode zu vergleichen. Dies war bisher nicht möglich. Wie in jedem Modell werden die Ergebnisse maßgeblich von den Eingangsdaten beeinflusst. Dieses Modell ermöglicht es vergleichbare Eingangsannahmen für alle Länder zu treffen, um vergleichbare Ergebnisse zu erhalten.
- Das „no-regret" und „co-benefit" Reduktionspotenzial in den betrachteten sechs Entwicklungsländern ist nach unseren Analysen beträchtlich. Es ist im Interesse dieser Länder solche Reduktionspotenziale, die keine zusätzlichen Nettokosten verursachen (9% „no-regret" Reduktion unter BAU) oder die mit positiven Nebeneffekten außerhalb des Klimaschutzes zusammenhängen (insgesamt 17% „co-benefit" Reduktion unter

BAU), umzusetzen. Internationale Unterstützung ist notwendig, um Hindernisse zu beseitigen, die derzeit dazu führen, dass diese Potenziale nicht ausgeschöpft werden.

- In den untersuchten sechs Ländern ist ein zusätzliches Reduktionspotenzial verfügbar, das einen ausschlaggebenden Einfluss auf die Einhaltung des globalen 2°C Limits hat. Allerdings sind außer Südkorea alle der betrachteten Länder auf finanzielle Unterstützung angewiesen, um das jeweilige Potenzial auszuschöpfen.
- Bestehende Politikinstrumente in den betrachteten Ländern können individuell durch weitere Politiken und Maßnahmen ergänzt werden um das Reduktionspotenzial zu realisieren. Die Art und die Ausgestaltung der Politiken und Maßnahmen sind stark von den derzeitigen landesspezifischen Umständen und Emissionsprofilen abhängig.

In Ergänzung zum Emissionshandelsmarkt werden finanzielle und nichtmonetäre Unterstützungsmechanismen benötigt, um die Kohlenstoffintensität der hier betrachteten Länder zu reduzieren. Diese Anstrengungen würden sehr von einer integrierten Strategie zum Vorantreiben eines Technologiebündnisses zwischen Annex-I- und Nicht-Annex-I-Staaten profitieren.

List of figures

List of tables

List of Boxes

1. Introduction

Further action is needed that goes far beyond what has been agreed so far under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol to "prevent dangerous anthropogenic interference with the climate system", the ultimate objective of the UNFCCC. It is out of question that developed countries (Annex I countries) will have to take a leading role. They will have to commit to substantial emission reductions and financing commitments due to their historical responsibility and their financial capability. However, the stabilisation of the climate system will require global emissions to peak within the next decade and decline well below current levels by the middle of the century. It is hence a global issue and, thus, depends on the participation of as many countries as possible.

Several countries, including the European Community, and many environmental NGOs have agreed that global average temperature increase should be limited to 2°C above pre-industrial levels to avoid such dangerous interference. The risk that a stable greenhouse gas concentration of e.g. 450 ppmv CO_2eq would result in global average temperature above 2°C in the long term is around 50%. At 400 ppmv CO_2eq, the risk is 30% (Meinshausen 2005). Consequently, global emissions have to peak in the next 15 years and decline well below the 1990 level in 2050 and further thereafter.

Under the principle of "common but differentiated responsibilities," one of the guiding principles stipulated in Article 3.1 of the United Nations Framework Convention on Climate Change (UNFCCC), non-Annex I parties have so far been exempted from emission limitation or reduction commitments. Not least since the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC-AR4), however, the pressure is mounting on these countries to contribute actively to the mitigation of climate change. This conflict between non-Annex I and Annex I parties has become more intense since the initiation of the post 2012 negotiations in 2005 in Montreal. While Annex I parties argued that strengthened action by the major developing countries is a precondition for taking on any new commitments under Article 3.9 of the Kyoto Protocol (KP), non-Annex I parties insisted that Annex I parties take the lead by determining their further commitments in the Ad-hoc working group under the Kyoto Protocol and to transfer technology and financial resources necessary for controlling their GHGs (Sterk et al. 2007b). Therefore, innovative ideas are needed for the next phase of the negotiations in order to break the deadlock and enhance the participation of the emerging economies in the climate regime.

Developing countries have a lower historical responsibility for climate change but are already or will become important emitters. A less carbon intensive development will have positive effects on these countries' sustainable development and on the global climate system. On the one hand, climate change action will contribute directly to achieving sustainable development objectives, such as energy security, sustainable economic development, technology innovation, job creation, local environmental protection and enhancement of capacity to adapt to climate change impacts. On the other hand, especially developing countries will benefit from a more stable global climate because they are the most vulnerable to climate change effects.

In this project "Proposals for contributions of emerging economies to the climate regime under the UNFCCC post 2012" for the German Environment Agency, Ecofys and the Wuppertal Institute analyse in detail the situation of the major emitting developing countries Brazil, China, India, Mexico, South Africa and South Korea. It includes an overview of emissions and economic development, provides estimates of emission reduction potential in a consistent manner, lists policies and measures to effectively limit greenhouse gas emissions, suggests how these measures could be complemented and finally, makes recommendations on how efforts by these countries could be integrated into the international climate change agreement under the UNFCCC and the Kyoto Protocol.

We first describe the methodology of the project (Chapter 2), then our findings per country (Chapters 3 to 9). After the country analyses we provide an overview of a possible future overall framework (Chapter 10) and test the consistency with a 2°C limit (Chapter 11). We close with an overview of support options for enhanced mitigation of developing countries (Chapter 12) as well as a synthesis and general conclusions from this work (Chapter 13).

2. Methodology

2.1 Project setup

The project was implemented by Ecofys and the Wuppertal Institute. Elements of the work were reviewed by country experts and were subsequently refined. Experts that had agreed to provide input included:

- Dr. Vivek Kumar (India) – The Energy and Resources Institute, Teri
- Prof Emilio Lèbre La Rovere (Brazil) – Universidade Federal Do Rio de Janeiro
- Prof Jiahua Pan (China) – Chinese Academy of Social Science
- Stanford Mwakasonda (South Africa) – Energy Research Centre, University of Cape Town
- Odón de Buen (Mexico) – Energía, Tecnología y Educación SC, Mexico D.F.;
- Prof. Dr. Sung-Jin Leem (South Korea) – Director of Environmental and Energy Institute, Jeonju University (no feedback has been received from Prof. Dr. Sung-Jin Leem).

The project was completed in 4 phases. In the first phase, we provided a literature review of the issues at hand: An overview of which types of commitments have been proposed for emerging developing countries in the literature, a first overview of policies implemented by Brazil, China, India, Mexico, South Africa and South Korea that have an effect on greenhouse gas emissions, and an overview of the literature that calculates emission reduction potential and reduction costs.

In a second phase, we developed a bottom-up spreadsheet calculation model to describe past and possible future emission trends and reduction options in a consistent format for Brazil, China, India, Mexico, South Africa and South Korea (see section 2.2).

In the third phase, we outlined and analysed the existing mix of climate policy instruments and measures (based on phase I and a review by experts from the different countries) in the sectors with the highest GHG emission reduction potential of the respective country (based on the findings from phase II) (see section 2.3).

In the fourth phase, we transferred the findings of phases II and III into the international arena. To this end, we suggested potential contributions to the mitigation of climate change by the six countries and outlined financial and non-financial support necessary to enhance the efforts of the emerging economies in limiting and reducing greenhouse gas emissions, based on the options and potential identified in phase II and the measures identified in phase III. The analysis concentrates on support in the context of the UNFCCC and the Kyoto Protocol (see section 2.4).

2.2 Estimating reference emissions and mitigation potential

Phase II of the project includes the development of a bottom-up spreadsheet calculation model to describe possible future emission trends and reduction options consistently for Brazil, China, India, Mexico, South Africa and South Korea until 2020. The aim of the tool is to describe the future emission trends and emission reduction options in a consistent manner

for all six countries. This is a novelty since currently consistent studies are available only for broad global regions, which usually do not include these countries separately. Studies on individual countries are also available but these are not comparable between countries. The developed tool allows this comparison. This section describes the methodology used.

2.2.1 Scenario descriptions

We calculated four scenarios in a consistent manner for all countries:

Business-as-usual

The business-as-usual (BAU) scenario follows production, energy consumption and energy efficiency trends that are based on moderate assumptions. Where available, these assumptions or related growth rates were taken from national studies. This was possible for Brazil, China and India (Centro Clima et al. 2006; Chen et al. 2006; TERI 2006). These studies include recent national policies up to the year 2000/2001. Later polices are not considered because often their level of implementation and the resulting impacts are still unclear. For those countries or sectors where no detailed studies were available, patterns and growth rate trends were usually assumed to be similar to previous years. These do not include special additional policies. Consequently this scenario can be considered to lead to relatively high levels of emissions.

No-regret

Pathways under the no-regret scenarios include GHG emission reduction options that can be achieved at negative or no direct costs. These would include, e.g. energy efficiency measures, where the economic gains from reduced energy use outweigh the investment costs for more efficient technology. Some would call this scenario also "economic potential at costs below 0€/tCO_2eq". We did not make a precise economic analysis of the costs of each measure but applied generic assumptions. Given the economic net benefit achievable, it should be in the interest of each country to realise this potential with its own resources. The international community could, however, support implementation both by technical contributions and by seed funding for, e.g. national revolving funds and for implementing policies and measures to overcome non-market barriers.

Co-benefit

Pathways under the co-benefit scenarios consider reduction options that are reasonable due to political aims other than greenhouse gas emission reduction. This includes also reductions at some costs. A typical measure would be the increased use of renewable energy sources to increase energy security and to decrease dependency on import of fossil fuels or switching from diesel to gas in passenger transport for air quality reasons. Recent policies agreed in the countries such as energy efficiency or renewable targets are included in this scenario assuming that they are fully implemented. But the scenario also includes further measures that could be implemented. It should be in the interest of each country to realise this potential with its own resources. However, the fact that it may entail some extra cost means that not only technical but also financial contributions from the international community would be helpful to achieve this scenario.

Ambitious

The ambitious scenario includes reduction options, which can be implemented but at extra net costs, while maintaining the same service level. This scenario includes reduction options that are technically feasible and would accelerate the capital stock turnover, but they would not lead to stranded investments. We did not undertake a precise economic analysis but used the level of 100 USD/tCO_2eq as a rough guide for the maximum extra net costs of options to include. However, depending on discount rates as well as other developments, costs can lie below this level. This potential can be realised if both the non-market barriers are removed and financial incentives are provided to cover the extra net costs. It could be

achieved with additional contributions from the country itself or from the international community.

2.2.2 Calculation of scenarios

The aim of the modelling under this project is to show the emission development and the reduction potential of the major developing countries in a consistent and comparable manner.

The general methodology is a bottom-up approach: For each sector, production and performance parameters are collected (e.g. tonnes of cement produced and energy efficiency of cement production). From these figures, energy demand as well as energy and process related emissions are calculated (see Figure 3).

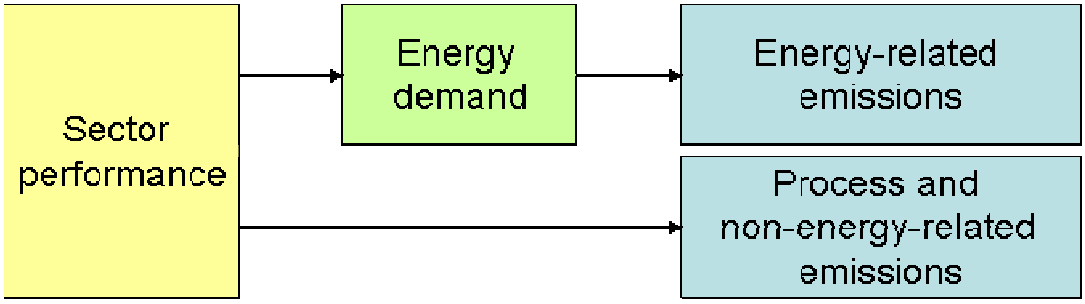


Figure 3. Simplified methodology to develop future emission pathways.

The model distinguishes among five main sectors. For each sector several parameters are used as inputs. Table 3 provides a rough overview of the most important input parameters that we considered per sector. The following sections explain the methodology per sector in more detail.

The approach works well for the energy and industry sectors, due to relatively good data availability, to a certain extent also for agriculture and waste. For households and services, only limited performance data are available. Except for South Korea, the data availability for transport is weak as well. For Land-use change and forestry (LUCF), we used only historical emission data and assumed constant emissions into the future.

Table 3. Different sectors and the related sector performance input parameters.

Sector	Subsectors (*sector performance input parameters*)				
General	For all sectors: *GDP* *Population* *Emission factors*	overview of primary energy consumption	overview of emissions on sector basis	overview of all scenarios	
Power production sector	Electricity, CHP, heat generation	Other energy industry	Distribution losses	Production, net imports, international marine bunkers, stock changes	
	Demand in other sectors + Distribution losses	*Demand in other sectors*	*Historic development related to actual power production*	*Demand in other sectors*	
Industry sector	Iron + steel	Cement	Pulp + paper	Rest of industry	
	Steel production *Iron production*	*Cement production* *Clinker production*	*Pulp production* *Paper production*	*GDP* *historic growth rate*	
Domestic sectors	Households	Commercial + services			
	Population growth *Number of households* *Households/ population connected to the electricity grid*	*Population growth* *Labour force*			
Agriculture + waste	Agriculture	Waste	Rest (fishing + non-specified other sectors)	Non-energy use	Land-use change and forestry
	Population growth *Use of fertiliser* *Increase in crop* *Manure management* *Methane enteric fermentation* *N2O Manure* *N2O soil fertiliser, soil livestock and soil crop related*	*Population growth* *Recovered methane* *% landfilled* *Waste generation per capita* *Methane conversion fraction*	*Population growth* *historic growth*	*increase due to average historic growth rate*	*constant emissions according to last available historic year*
Transport sector	Aviation	Road transport	Rail	Domestic navigation	
	development related to GDP growth	*development related to GDP growth*	*development related to GDP growth or constant*	*development related to GDP growth or constant*	

Table 4 below includes the most important historical and scenario parameters for all countries and sectors. The parameters chosen for future developments are based on national studies where available, e.g. Winkler et al. (2005a), Centro Clima et al. (2006), Chen et al. (2006), TERI (2006) and others. Due to poor data availability, the classification of the scenarios is not as clear for the transport sector as for the other sectors.

The table includes red figures. These are not consistent with what we would expect the data for these countries to look like (e.g. very low Energy Efficiency Index). Data shortcomings can be found especially in the transport sector. But also in the industry sector (e.g. South Africa: too low energy consumption values for pulp and paper production; South Korea: too low energy consumption values for iron and steel production) still some gaps exist that we had to fill with imperfect data. The reviews by country experts did not help to fill all data gaps.

Table 4. Selected historical and scenario parameters for all countries and sectors

Scenario parameters	Korea Historical	Korea BAU 2020	Korea No regret 2020	Korea Co-benefit 2020	Korea Ambitious mitigation 2020	South Africa Historical	South Africa BAU 2020	South Africa No regret 2020	South Africa Co-benefit 2020	South Africa Ambitious mitigation 2020	Mexico Historical	Mexico BAU 2020	Mexico No regret 2020	Mexico Co-benefit 2020	Mexico Ambitious mitigation 2020
Energy industries															
Elektricity and CHP output															
Annual growth in (non-CHP) electricity generation (2005 to 2020)	9%	4%	2%	2%	0%	3%	2%	0%	0%	-1%	5%	1%	0%	0%	0%
Share coal without CCS	39%	39%	39%	29%	19%	94%	94%	94%	84%	73%	14%	5%	5%	0%	0%
Share coal with CCS	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%
Share petroleum products	8%	8%	8%	8%	8%	0%	0%	0%	0%	0%	32%	17%	17%	12%	2%
Share gas	10%	10%	10%	10%	10%	0%	0%	0%	0%	0%	35%	61%	61%	61%	61%
Share nuclear	42%	42%	42%	42%	42%	6%	6%	6%	6%	6%	5%	4%	4%	4%	4%
Share hydro	2%	2%	2%	2%	2%	1%	1%	1%	1%	1%	9%	10%	10%	10%	10%
Share solar, wind, others	0%	0%	0%	5%	10%	0%	0%	0%	5%	10%	0%	0%	0%	5%	10%
Share combustable renewables and waste	0%	0%	0%	5%	10%	0%	0%	0%	5%	10%	1%	1%	1%	5%	10%
Annual growth in CHP production (2005 to 2020)	28%	-2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Share of CHP in total electricity generation	11%	5%	8%	8%	11%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Efficiency electricity gegeration															
Coal without CCS	40%	45%	45%	45%	45%	37%	43%	43%	43%	45%	40%	45%	45%	45%	45%
Coal with CCS															
Petroleum products	73%	79%	79%	79%	79%	34%	39%	39%	39%	52%	36%	42%	42%	42%	52%
Natural gas	63%	73%	73%	73%	73%	35%	41%	41%	41%	55%	37%	43%	46%	46%	55%
Distribution losses															
Electricity losses to production ratio	5%	5%	5%	5%	5%	9%	9%	9%	9%	9%	16%	16%	10%	10%	5%
Other energy industries (mainly coal transf. and refineries)															
Efficiency (output/input)	86%	86%	86%	86%	86%	57%	57%	57%	57%	57%	77%	77%	78%	78%	80%
Industry															
Iron and steel															
Annual production growth (steel, 2005 to 2020)	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%	1%	1%	1%	1%
Ratio iron over steel production	58%	57%	51%	51%	41%	80%	83%	77%	77%	70%	63%	62%	57%	57%	53%
Share coal	40%	30%	30%	30%	30%	66%	66%	56%	56%	56%	19%	19%	9%	9%	10%
Share petroleum products	7%	7%	7%	7%	7%	0%	0%	0%	0%	0%	9%	9%	9%	9%	9%
Share gas	9%	9%	9%	9%	9%	4%	4%	4%	4%	4%	56%	56%	56%	56%	56%
Share combustable renewables and waste	0%	10%	10%	10%	10%	0%	0%	10%	10%	10%	0%	0%	10%	10%	10%
Share electricity	44%	44%	44%	44%	44%	30%	30%	30%	30%	30%	16%	16%	16%	16%	16%
Annual change in energy consumption per primary steel (2005 to 2020)	2%	-0.2%	-0.2%	-0.2%	-0.3%	0%	-0.1%	-0.2%	-0.2%	-2.0%	-1.1%	-1.0%	-1.0%	-1.0%	-1.2%
Energy efficiency index	0.7	0.7	0.7	0.7	0.7	1.9	1.8	1.8	1.8	1.3	1.2	1.0	0.9	0.9	0.9
Cement															
Annual production growth (cement, 2005 to 2020)	4%	0%	0%	0%	0%	4%	5%	5%	5%	5%	3%	4%	4%	4%	4%
Clinker cement ration	89%	89%	65%	65%	65%	90%	90%	65%	65%	65%	86%	86%	65%	65%	65%
Share coal	86%	86%	56%	56%	56%	90%	90%	60%	60%	60%	7%	7%	0%	0%	0%
Share petroleum products	2%	2%	2%	2%	2%	0%	0%	0%	0%	0%	74%	74%	53%	53%	53%
Share gas	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%	4%	4%	4%	4%
Share combustable renewables and waste	0%	0%	30%	30%	30%	0%	0%	30%	30%	30%	3%	3%	30%	30%	30%
Annual change in energy consumption per clinker (2005 to 2020)	-0.4%	-0.4%	-0.4%	-0.4%	-0.5%	0.0%	0.0%	-0.2%	-0.2%	-1.0%	0.1%	-0.1%	-0.1%	-0.1%	-0.5%
Energy efficiency index	1.0	0.9	0.9	0.9	0.9	1.3	1.3	1.2	1.2	1.1	1.0	1.1	1.1	1.1	1.0
Pulp and Paper															
Annual production growth (pulp and paper, 2005 to 2020)	6%	1%	1%	1%	1%	2%	-7%	-7%	-7%	-7%	2%	3%	3%	3%	3%
Share coal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Share petroleum products	50%	50%	45%	45%	30%	0%	0%	0%	0%	0%	45%	45%	40%	40%	25%
Share gas	3%	3%	3%	3%	3%	35%	35%	30%	30%	30%	17%	17%	17%	17%	17%
Share combustable renewables and waste	0%	0%	5%	5%	20%	0%	0%	5%	5%	20%	0%	0%	5%	5%	20%
Share electricity	41%	41%	41%	41%	41%	65%	65%	65%	65%	65%	38%	38%	38%	38%	38%
Energy efficiency index	1.2	1.1	1.1	1.1	0.9	0.2	0.2	0.2	0.2	0.2	1.0	1.0	1.0	1.0	0.9
Other															
Annual growth in energy use (2005 to 2020)	9%	5%	4%	4%	3%	1%	1%	1%	1%	1%	-1%	-1%	-1%	-1%	-1%
Share coal	8%	8%	8%	8%	8%	45%	45%	45%	45%	35%	0%	0%	0%	0%	0%
Share petroleum products	64%	64%	59%	59%	44%	5%	5%	5%	5%	5%	35%	35%	34%	34%	19%
Share gas	5%	5%	5%	5%	5%	3%	3%	3%	3%	3%	28%	28%	28%	28%	28%
Share combustable renewables and waste	0%	0%	5%	5%	20%	10%	10%	10%	10%	20%	4%	4%	5%	5%	20%
N2O emissions (Mt CO2eq)	8	10	8	8	2	2	2	2	2	1	1	1	1	1	0
HFC emissions (Mt CO2eq)	20	43	43	43	5	7	17	17	17	2	8	14	14	14	2

	Scenario parameters	India					China					Brazil				
		Historical	BAU 2020	No regret 2020	Co-benefit 2020	Ambitious mitigation 2020	Historical	BAU 2020	No regret 2020	Co-benefit 2020	Ambitious mitigation 2020	Historical	BAU 2020	No regret 2020	Co-benefit 2020	Ambitious mitigation 2020
Power production	**Power production**															
	Elektricity and CHP output															
	Annual growth in (non-CHP) electricity generation (2005 to 2020)	6%	4%	2%	2%	1%	9%	4%	3%	3%	2%	4%	4%	4%	4%	3%
	Share coal without CCS	68%	68%	68%	59%	48%	79%	79%	79%	70%	59%	2%	2%	2%	2%	2%
	Share coal with CCS	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%
	Share petroleum products	5%	5%	5%	5%	5%	3%	3%	3%	3%	3%	3%	2%	2%	2%	2%
	Share gas	11%	11%	11%	11%	11%	0%	0%	0%	0%	0%	4%	42%	31%	31%	6%
	Share nuclear	3%	3%	3%	3%	3%	2%	2%	2%	2%	2%	4%	2%	2%	2%	2%
	Share hydro	12%	12%	12%	12%	12%	15%	15%	15%	15%	15%	84%	48%	48%	48%	48%
	Share solar, wind, others	1%	1%	1%	5%	10%	0%	0%	0%	5%	10%	0%	0%	5%	5%	10%
	Share combustable renewables and waste	0%	0%	0%	5%	10%	0%	0%	0%	5%	10%	4%	4%	10%	10%	30%
	Annual growth in CHP production (2005 to 2020)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Share of electricity in total CHP generation	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Efficiency															
	Coal without CCS	28%	30%	30%	38%	45%	38%	41%	41%	41%	45%	31%	36%	36%	36%	45%
	Coal with CCS					35%					35%					
	Petroleum products	34%	37%	37%	37%	52%	48%	52%	52%	52%	52%	36%	41%	41%	41%	52%
	Natural gas	51%	55%	55%	55%	55%	64%	69%	69%	69%	69%	46%	53%	53%	53%	53%
	Distribution losses															
	Electricity losses to production ratio	29%	29%	18%	18%	10%	8%	8%	8%	8%	8%	17%	17%	13%	13%	8%
		82%	81%	81%	81%	81%	56%	56%	56%	56%	56%	82%	82%	82%	82%	82%
Industry	**Industry**															
	Iron and steel															
	Annual production growth (steel, 2005 to 2020)	7%	9%	9%	9%	9%	11%	4%	4%	4%	4%	4%	4%	4%	4%	4%
	Percentage of primary steel	95%	96%	96%	96%	96%	92%	86%	77%	77%	77%	106%	99%	90%	90%	90%
	Share coal	80%	80%	70%	70%	70%	73%	73%	63%	63%	63%	33%	33%	33%	33%	33%
	Share petroleum products	2%	2%	2%	2%	2%	4%	4%	4%	4%	4%	5%	5%	5%	5%	5%
	Share gas	10%	10%	10%	10%	10%	0%	0%	0%	0%	0%	7%	7%	7%	7%	7%
	Share combustable renewables and waste	0%	0%	10%	10%	10%	0%	0%	10%	10%	10%	40%	40%	40%	40%	40%
	Share electricity	8%	8%	8%	8%	8%	18%	18%	18%	18%	18%	15%	15%	15%	15%	15%
	Annual energy efficiency improvement primary steel (2005 to 2020)	-1.6%	-0.1%	-0.5%	-0.5%	-1.0%	-4.6%	-1.1%	-1.1%	-1.1%	-1.5%	-1.5%	0.3%	0.0%	0.0%	-0.5%
	Energy efficiency index	1.8	1.6	1.5	1.5	1.4	1.0	0.8	0.8	0.8	0.7	1.1	1.1	1.0	1.0	1.0
	Cement															
	Annual production growth (cement, 2005 to 2020)	7%	9%	9%	9%	9%	12%	2%	2%	2%	2%	2%	4%	4%	4%	4%
	Clinker cement ration	86%	80%	65%	65%	65%	72%	72%	65%	65%	65%	73%	73%	65%	65%	65%
	Share coal	89%	90%	60%	60%	60%	92%	92%	62%	62%	62%	5%	5%	0%	0%	0%
	Share petroleum products	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	70%	70%	70%	70%	70%
	Share gas	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Share combustable renewables and waste	0%	0%	30%	30%	30%	0%	0%	30%	30%	30%	25%	25%	30%	30%	30%
	Annual energy efficiency improvement (2005 to 2020)	-2.6%	-0.7%	-0.7%	-0.7%	-0.7%	-0.5%	0.0%	-0.2%	-0.2%	-1.5%	0.1%	-0.2%	-0.2%	-0.2%	-1.0%
	Energy efficiency index	1.0	0.8	0.8	0.8	0.8	1.7	1.7	1.6	1.6	1.3	1.4	1.4	1.4	1.4	1.2
	Pulp and Paper															
	Annual production growth (pulp and paper, 2005 to 2020)	6%	8%	8%	8%	8%	6%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	Share coal	85%	85%	70%	70%	45%	52%	52%	37%	37%	12%	1%	1%	1%	1%	1%
	Share petroleum products	0%	0%	0%	0%	0%	7%	7%	7%	7%	7%	11%	11%	11%	11%	11%
	Share gas	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	6%	6%	6%	6%
	Share combustable renewables and waste	0%	0%	15%	15%	40%	0%	0%	15%	15%	40%	66%	66%	66%	66%	66%
	Share electricity	15%	15%	15%	15%	15%	26%	26%	26%	26%	26%	17%	17%	17%	17%	17%
	Energy efficiency index	1.7	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.8	1.5	1.5	1.5	0.9
	Other															
	Annual growth in energy use (2005 to 2020)	8%	3%	3%	3%	1%	0%	-1%	-1%	-1%	-1%	4%	4%	4%	4%	3%
	Share coal	9%	9%	9%	9%	9%	16%	16%	11%	11%	0%	2%	2%	2%	2%	2%
	Share petroleum products	38%	38%	38%	38%	38%	31%	31%	31%	31%	27%	34%	34%	34%	34%	34%
	Share gas	8%	14%	14%	14%	14%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
	Share combustable renewables and waste	28%	20%	20%	20%	20%	0%	0%	5%	5%	20%	33%	33%	33%	33%	33%
	N2O emissions (Mt CO2eq)	3	4	4	4	1	32	37	32	32	3	6	7	6	6	1
	HFC emissions (Mt CO2eq)	12	14	14	14	4	100	149	149	149	10	8	20	20	20	2

	Scenario parameters	Korea					South Africa					Mexico				
		Historical	BAU 2020	No regret 2020	Co-benefit 2020	Ambitious mitigation 2020	Historical	BAU 2020	No regret 2020	Co-benefit 2020	Ambitious mitigation 2020	Historical	BAU 2020	No regret 2020	Co-benefit 2020	Ambitious mitigation 2020
Domestic	**Domestic**															
	Households															
	People per household	3.2	2.9	2.9	2.9	2.9	3.7	3.4	3.4	3.4	3.4	4.3	4.0	4.0	4.0	4.0
	Share of households connected to electricity grid	86%	93%	93%	93%	93%	70%	89%	89%	89%	89%	96%	99%	99%	99%	99%
	Share of people with electricity access															
	Share coal	4%	4%	4%	4%	4%	22%	22%	22%	22%	22%	0%	0%	0%	0%	0%
	Share petroleum products	30%	30%	30%	30%	30%	6%	6%	6%	6%	6%	53%	53%	53%	53%	53%
	Share gas	66%	66%	66%	66%	66%	0%	0%	0%	0%	0%	5%	5%	5%	5%	5%
	Share solar, wind, others	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Share combustable renewables and waste	0%	0%	0%	0%	0%	71%	71%	71%	71%	71%	42%	42%	42%	42%	42%
	FE excl. electricity per household (toe/household)	0.85	0.92	0.92	0.92	0.92	0.93	1.01	1.01	1.01	1.01	0.65	0.70	0.70	0.70	0.70
	Electricity use/household connected to the grid (toe/cap)	0.27	0.42	0.42	0.42	0.28	0.35	0.41	0.41	0.41	0.41	0.15	0.18	0.18	0.18	0.18
	Electricity use/cap (toe/household)	0.07	0.13	0.13	0.13	0.09	0.07	0.11	0.11	0.11	0.11	0.03	0.04	0.04	0.04	0.04
	Commercial and services															
	Active labour force (people employed) (% of working age population)	62%	62%	62%	62%	62%	41%	43%	43%	43%	43%	59%	61%	61%	61%	61%
	Share coal	0%	0%	0%	0%	0%	65%	65%	65%	65%	65%	0%	0%	0%	0%	0%
	Share petroleum products	81%	81%	81%	81%	81%	35%	35%	35%	35%	35%	81%	81%	81%	81%	81%
	Share gas	19%	19%	19%	19%	19%	0%	0%	0%	0%	0%	14%	14%	14%	14%	14%
	Share solar, wind, others	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%	5%	5%	5%	5%
	Share combustable renewables and waste	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	FE excl. electricity per employee (ktoe/employee)	528	569	569	569	515	170	183	183	183	183	34	36	36	36	36
	Electricity use per employee (ktoe/employee)	274	295	295	295	267	160	173	173	173	173	40	43	43	43	43
Transport	**Transport**															
	Energy for aviation, annual growth rate	2.5%	5.0%	5.0%	4.8%	3.5%	6.2%	3.8%	3.3%	3.3%	1.7%	2.9%	4.0%	3.5%	3.5%	1.9%
	Energy for road transport, annual growth rate	4.8%	2.3%	0.3%	-2.1%	-3.9%	2.1%	2.8%	2.3%	1.4%	-0.2%	2.2%	3.0%	2.5%	1.6%	0.0%
	Energy for rail transport, annual growth rate	1.1%	1.0%	1.0%	4.5%	4.5%	1.5%	0.0%	0.0%	2.7%	2.7%	-1.0%	0.0%	0.0%	5.2%	5.2%
	Energy for navigation, annual growth rate	1.5%	4.9%	4.9%	4.9%	4.9%										
	Energy for total transport, annual growh rate	4.0%	3.1%	2.5%	1.8%	0.6%	2.6%	2.8%	2.3%	1.7%	0.2%	2.2%	3.0%	2.5%	1.8%	0.3%
Agriculture and waste	**Agriculture and waste**															
	Agriculture															
	Annual production growth (Livestock)		0.6%	1.5%	1.5%	2.7%		3.3%	0.1%	0.1%	0.3%		1.9%	1.3%	1.3%	0.5%
	Annual production growth (Use of fertiliser)		-0.9%	-0.9%	-0.9%	-0.9%		5.1%	5.1%	5.1%	5.1%		1.2%	1.2%	1.2%	1.2%
	Annual production growth (crop production)		1.6%	1.6%	1.6%	1.6%		2.5%	2.5%	2.5%	2.5%		1.6%	1.6%	1.6%	1.6%
	Annual production growth (rice)		0.1%	0.1%	0.1%	-1.4%		0.0%	0.0%	0.0%	0.0%		0.9%	0.9%	0.9%	0.3%
	Annual change in emission factor (CH4 manure management)		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%
	Annual change in emission factor (CH4 enteric fermentation)		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%
	Annual change in emission factor (CH4 rice)		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%
	Waste															
	Percentage of waste landfilled	43%	80%	80%	80%	80%	57%	82%	82%	82%	82%	54%	73%	73%	73%	73%
	Waste generation per capita	0.37	0.67	0.67	0.67	0.67	0.26	0.37	0.37	0.37	0.37	0.34	0.46	0.46	0.46	0.46
	Methane conversion factor	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Fraction of potential CH4 emissions recovered	0%	1%	1%	10%	50%	0%	1%	1%	10%	50%	0%	1%	1%	10%	50%
	LUCF															
	Emissions, annual growth		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%

	Scenario parameters	India					China					Brazil				
		Historical	BAU 2020	No regret 2020	Co-benefit 2020	Ambitious mitigation 2020	Historical	BAU 2020	No regret 2020	Co-benefit 2020	Ambitious mitigation 2020	Historical	BAU 2020	No regret 2020	Co-benefit 2020	Ambitious mitigation 2020
Domestic	**Domestic**															
	Households															
	People per household	5.2	4.8	4.8	4.8	4.8	3.5	3.2	3.2	3.2	3.2	3.5	3.2	3.2	3.2	3.2
	Share of households connected to electricity grid											96%	99%	99%	99%	99%
	Share of people with electricity access	56%	61%	61%	61%	61%	99%	99%	99%	99%	99%					
	Share coal	3%	3%	3%	3%	3%	16%	16%	16%	16%	16%	0%	0%	0%	0%	0%
	Share petroleum products	11%	11%	11%	11%	11%	6%	6%	6%	6%	6%	40%	40%	40%	40%	40%
	Share gas	0%	0%	0%	0%	0%	3%	3%	3%	3%	3%	1%	1%	1%	1%	1%
	Share solar, wind, others	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Share combustable renewables and waste	86%	86%	86%	86%	86%	75%	75%	75%	75%	75%	59%	59%	59%	59%	59%
	FE excl. electricity per household (toe/household)	1.13	1.22	1.22	1.22	1.22	0.79	0.85	0.85	0.85	0.85	0.31	0.34	0.34	0.34	0.34
	Electricity use/household connected to the grid (toe/cap)											0.18	0.21	0.21	0.21	0.21
	Electricity use/cap (toe/household)	0.01	0.01	0.01	0.01	0.01	0.02	0.06	0.06	0.06	0.03	0.05	0.06	0.06	0.06	0.06
	Commercial and services															
	Active labour force (people employed) (% of working age population)	59%	59%	59%	59%	59%	59%	59%	59%	59%	59%	62%	75%	75%	75%	75%
	Share coal	100%	100%	100%	100%	100%	23%	23%	23%	23%	23%	0%	0%	0%	0%	0%
	Share petroleum products	0%	0%	0%	0%	0%	71%	71%	71%	71%	71%	75%	75%	75%	75%	75%
	Share gas	0%	0%	0%	0%	0%	3%	3%	3%	3%	3%	15%	15%	15%	15%	15%
	Share solar, wind, others	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Share combustable renewables and waste	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	10%	10%	10%	10%
	FE excl. electricity per employee (ktoe/employee)	7	8	8	8	8	36	81	81	81	81	22	24	24	24	24
	Electricity use per employee (ktoe/employee)	5	5	5	5	5	12	40	40	40	40	91	98	98	98	98
Transport	**Transport**															
	Energy for aviation, annual growth rate	3.1%	9.7%	9.2%	9.2%	7.4%	16.5%	8.4%	7.9%	7.9%	6.2%	2.6%	5.1%	4.6%	4.6%	3.0%
	Energy for road transport, annual growth rate	2.3%	8.6%	8.1%	7.1%	5.5%	8.0%	6.8%	6.3%	5.4%	3.8%	3.2%	4.0%	3.5%	2.6%	1.1%
	Energy for rail transport, annual growth rate	-4.1%	0.7%	0.7%	3.4%	3.4%	2.5%	3.4%	3.4%	3.9%	3.9%	-1.0%	0.0%	0.0%	7.2%	7.2%
	Energy for navigation, annual growth rate	-1.4%	0.0%	0.0%	0.0%	0.0%	9.8%	5.8%	5.8%	5.8%	5.8%	-0.9%	0.0%	0.0%	0.0%	0.0%
	Energy for total transport, annual growh rate	1.6%	8.3%	7.8%	7.1%	5.5%	7.0%	6.3%	5.9%	5.4%	4.2%	3.0%	4.0%	3.5%	2.8%	1.3%
Agriculture and waste	**Agriculture and waste**															
	Agriculture															
	Annual production growth (Livestock)		2.8%	1.0%	1.0%	0.7%		1.6%	2.0%	2.0%	1.4%		1.3%	1.3%	1.3%	1.3%
	Annual production growth (Use of fertiliser)		1.0%	1.0%	1.0%	1.0%		1.1%	1.1%	1.1%	1.1%		5.8%	5.5%	5.5%	5.0%
	Annual production growth (crop production)		1.5%	1.5%	1.5%	1.5%		1.1%	1.1%	1.1%	1.1%		0.0%	0.0%	0.0%	0.0%
	Annual production growth (rice)		1.0%	1.0%	1.0%	-0.2%		0.4%	0.4%	0.4%	-0.7%		0.0%	0.0%	0.0%	0.0%
	Annual change in emission factor (CH4 manure management)		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%
	Annual change in emission factor (CH4 enteric fermentation)		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%		0.0%	-0.2%	-0.2%	-1.0%
	Annual change in emission factor (CH4 rice)		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%
	Waste															
	Percentage of waste landfilled	70%	100%	100%	100%	100%	97%	100%	100%	100%	100%	22%	33%	33%	33%	33%
	Waste generation per capita	0.17	0.49	0.49	0.49	0.49	0.27	0.66	0.66	0.66	0.66	0.50	0.76	0.70	0.70	0.70
	Methane conversion factor	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Fraction of potential CH4 emissions recovered	0%	1%	1%	10%	50%	0%	1%	1%	10%	50%	0%	0%	2%	10%	50%
	LUCF															
	Emissions, annual growth		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%

2.2.2.1 Power production sector

The power production sector includes total primary energy supply, including all final energy supply as well as distribution and conversion losses. Historic values are mainly based on IEA (2005a).

Future demand for power production is a result of

- electricity and fuel demand as given as input from the demand sectors, industry, domestic, agriculture and waste as well as transport;
- the share of own use in other energy industry, including all energy transformation except power production, i.e. mainly coal transformation and petroleum refineries;
- distribution losses;
- conversion efficiency of electricity;
- imports and stock changes.

When no country specific data were available, we extrapolated historical trends.

Future emissions from this sector are determined by the overall primary energy supply as given above as well as by the fuel mix. The emission factors for all sectors are taken from IPCC (2006).

For all countries we assume a constant share of fuels in electricity production under BAU until 2020, except for Mexico, where a significant shift toward gas is assumed, and Brazil, where the additional hydropower capacity is minimal, which will lead to an increasing share of fossil fuels. For the co-benefit scenario we usually assume 10% renewables in addition to hydropower, for the ambitious scenario 20%, except for Brazil, where the biomass potential is assumed to be 10% under the no regret and co-benefit and 30% under the ambitious scenario.

In all countries the efficiency of thermal power plants increases slightly under business-as-usual and reaches the current best value under the ambitious scenario.

Distribution losses, significant in Mexico, India and Brazil (according to the IEA dataset used) are constant under BAU, reduced slightly under no regret and co-benefit and reduced significantly under the ambitious scenario.

2.2.2.2 Industry sector

In the industry sector all manufacturing industry is included. Subsectors are iron and steel, cement, pulp and paper, and the rest of industry. Historic physical production values for iron, steel, cement, clinker, pulp and paper are taken from different country specific sources. The rest of industry is not based on physical production. Energy demand values are mainly based on IEA (2005a). Emissions are mainly derived from energy consumption. Process emissions and non-CO_2 emissions are based on production values and USEPA (2006a).

Future development of energy demand in this sector is based on physical production trends for iron and steel, cement, pulp and paper, taken from country studies or trend interpolations mainly, combined with trends for specific energy consumption. For the rest of industry, energy demand is based on trend interpolations of historic years. Future emissions are then for all subsectors based on the fuel mix of all energy sources except electricity. Process and non-CO_2 emissions are based on production and on USEPA (2006a) scenarios. Emissions for electricity generation are allocated to the power production sector.

For iron and steel we assumed that 10% of the energy input can be taken from renewables and waste already under the no-regret scenario in 2020, except for Brazil where it is currently already at 40%.

One option to reduce emissions in cement production is to decrease the percentage of the energy intensive product clinker in the cement. We assume that this ration declines to 65% in 2020 already as no regret option due to decreasing energy costs. Renewable and waste fuels are assumed to be 30% in 2020 as no regret option, as these fuels are usually available at lower costs than fossil fuels.

For pulp and paper we assumed 5% of the fuels from renewable sources as no regret potential in 2020. These can be taken from the waste products from pulp and paper making. For the ambitious scenario we assumed 20% renewables, except for Brazil, where the current share of 66% is kept constant.

In the remaining industries we assumed a share of renewable fuels in 2020 of 5% under no regret and co-benefit and 20% as ambitious, except where the current level is already higher (e.g. Brazil 33%).

For all sectors energy efficiency increases faster for countries with less efficient processes (often e.g. India) and slower for already efficient countries (often e.g. South Korea).

2.2.2.3 Domestic sector

The domestic sector includes private households as well as the commercial and public services sectors. Historic energy demand values are mainly based on IEA (2005a). Important input parameters are population and number of households as well as active labour force. Data on floor space and detailed use of electricity according to appliances would have been more accurate indicators but were not available for most countries.

Future energy demand for households was modelled based on the trends of number of households with connection to the electricity grid, final energy demand per household and electricity use per household connected to the grid or per person with grid access. These were taken from country studies (see spreadsheets) or own estimates. Future energy demand for commercial and public services was modelled based on the number of people employed as well as on final energy and electricity use per employee. Future emissions for both subsectors are then based on the fuel mix of all energy sources except electricity. Emissions for electricity generation are allocated to the power production sector.

The reduction potential in this sector was difficult to estimate due to the lack of detailed data. Efficiency of appliances or heating demand per square meter are not available. These indicators could have been used to estimate the mitigation potential. We therefore only assumed that electricity consumption per capita in Korea does not increase under the ambitious scenario. All other values are the same across all scenarios.

2.2.2.4 Agriculture and waste sector

The agriculture and waste sector includes, besides these two subsectors, also LUCF as a memo item, unspecified others, e.g. fishing, and non-energy use of fossil fuels. Historic energy demand is based on IEA (2005a). Energy related emissions are derived from fuel use, non-CO_2 emissions are mainly based on USEPA (2006a).

Future fuel demand for agriculture, the non-specified rest and non-energy use is based on population growth, demand in the last available year or population growth and trend interpolations for previous years, respectively. Energy related emissions from agriculture and non-specified others are based on this fuel use. Non-energy related historical emissions and future scenarios in the agriculture sector (usually the larger part) are based on USEPA (2006a). Influencing factors include the change in livestock, use of fertilisers, manure management and others.

Future emissions resulting from waste management depend mainly on population growth, recovered methane, composition and share of landfilled waste as well as waste generation per capita. We assumed that under the co benefit scenario 10% of the CH_4 from landfills is

recovered as this has other side benefits to local pollution. The ambitious scenario assumes 50% recovery.

LUCF emissions are kept constant for all years. LUCF is included to provide completeness, but due to a lack of consistent and reliable data it is not analysed in detail. Emissions from non-energy use are included in the industry sector.

2.2.2.5 Transport sector

The transport sector includes national and international aviation, road transport of persons and freight, rail transport and domestic navigation. Historic energy consumption is based on IEA (2005a).

Future sector performance is mainly based on fuel demand trends related to GDP growth, efficiency gains and shifts among means of transportation. We choose this comparatively simple methodology based on expert judgements because more precise parameters like modal split, kilometres per person or tonne and number of cars were not available for most countries. Only for South Korea the data availability was better.

Emissions in the transport sector are derived from fuel use. As the share of non-CO_2 emissions is very small it is included in the industry sector.

2.3 Analysis of national climate policies

A literature review and assessments of country experts served as a starting point for identifying the existing mix of major climate policy instruments for the six countries. However, the list of existing policies should not be regarded as complete. It makes an attempt to provide an overview of the main climate policy instruments in the selected sectors with the highest GHG emissions. Results of phase II of the project were used in order to identify the three sectors with the highest GHG emissions in the respective country. Furthermore, we developed a generic country-independent sourcebook for good practice climate policy instruments as a basis of which climate policies could be implemented. The sourcebook is further described in Appendix C.

The sourcebook, assessments of country experts, and the circumstances of the respective country served as a basis for our suggestions on how to improve the existing mix of climate policies and measures. However, it should be noted that difficulties in gathering detailed information on climate policy instruments in the selected countries did not allow a more in-depth analyses of the countries. Therefore, this study merely provided a general framework. The concrete tailoring of policy packages including their evaluation and, if necessary, adaptation is a further task of the respective countries.

To be effective, climate policy strategies must take into account the complex interplay of barriers, which usually requires a package of well-designed and mutually supportive policy instruments. It will be necessary to package different policies and measures into target group- and sector-specific market transformation programmes adequately addressing the different actors in a certain sector or sub-sector on a specific field of action (e.g. renewable energy for electricity production, energy end-use efficiency in buildings, etc.). These packages together will strengthen incentives and overcome barriers for all actors in the particular field. For the sectoral policy sourcebook, the policies and measures are grouped into a number of categories in order to provide a more systematic overview of the range of instruments.

In general, we distinguish between five groups of policies and measures. These policy instruments target different types of GHG reduction potential such as the no-regret potential (individual benefits outweigh individual costs of GHG reduction options), the co-benefits potential (societal benefits approximately equal societal costs) and the ambitious potential (societal costs are bigger than societal benefits). The following policies can significantly

contribute to exploiting the achievable GHG reduction potential by addressing various barriers through giving economic incentives, reducing transaction efforts for market actors, or setting standards:

A) General economic and fiscal policies and measures have an impact on GHG emission reductions by providing for the right price signals in the markets and economic sectors by altering price ratios: energy/CO_2 taxation, emissions trading, sustainable subsidy reform.

Through internalising external costs or benefits and making them visible to the different actors, the no-regret and co-benefits potential for GHG reductions are targeted. In particular, part of the co-benefit potential becomes no-regret potential: better price signals lead to higher individual benefits. Only if market actors expect further increases in energy or GHG (certificate) prices, such policies may also lead to early adoption of parts of the ambitious potential. These policies and measures are often cross-cutting to the sectoral approach but sometimes also sector-specific.

B) Targeted economic and fiscal policies and measures support the search for, or implementation of sector- and technology-specific potential, such as subsidies for energy analyses (energy audits) or investment, feed-in tariffs for electricity from renewable energy sources or from cogeneration of heat and power, or certificate schemes for energy savings or electricity from renewable energy sources. Besides the no-regret potential, these policy instruments aim at the co-benefits and ambitious potential for GHG reduction options since they directly aim at specific fields of application, sectors or technologies.

They either overcome barriers related to lack of information that impede the utilisation even of the cost-effective no-regret potential, or (partly) compensate investors for costs resulting from the GHG reduction activity. Such costs can be search costs (in the cases of no-regret and co-benefits potential) or investment costs. The latter can be too high from the individual perspective but attractive from the societal perspective, i.e. in cases of a co-benefits potential; the justification for targeted financial support in such cases is to make it attractive for individuals to pursue co-benefit potential that has a net benefit for society. However, experience shows that financial support for investments often has the biggest effect through creating awareness of the existence and the (net) benefits of GHG mitigation options, rather than through investors making a detailed calculation of their costs and benefits.

In a case of the ambitious potential, investment costs would even be too high from the societal perspective in the short run. In such cases, targeted investment support may still be justified to address the ambitious potential, if in the long run the potential is expected to become cost-effective due to technology learning curves.

C) Standards and voluntary agreements make specific technologies or measures mandatory or the default for actors and transform markets by taking certain products off the market. Depending on their strength, these policies bear the potential for a full exploitation of the co-benefits and ambitious potential. In many cases, however, considerations regarding the ability of suppliers to adapt their product ranges or the cost-effectiveness for investors limit these policies to the no-regret or co-benefits potential. They reduce transaction costs and information barriers. However, such policies can only be introduced for technologies that are easy to standardise.

Standards and voluntary agreements can also create obligations to improve or exchange existing production processes or technologies, apart from the market-based incentives or disincentives provided by the economic and fiscal measures. Regulations on the use of planning procedures, e.g. in the transport sector, are also included here. Such obligations and regulations intend to widen the technology focus of public and market actors and, thereby, both to overcome information barriers and to create a level playing field. They, too, are instruments to improve the utilisation of no-regret and co-benefits potential. Voluntary agreements are best to use when the number of market actors is relatively small, while legal standards are more widely applicable.

The following policies are more of a supportive character and should be combined with targeted policies and measures (i.e., categories B) and C)) in order to realise significant GHG reductions:

D) Information, know-how transfer and education improve the knowledge basis of actors, thereby reducing transaction costs and increasing availability and uptake of climate-friendly technologies and solutions. This category also includes the necessary institutions for the know-how transfer as well as specific services that are provided for emission reduction, such as energy analyses (audits) and specialised consultancy, which can play an important role in increasing knowledge and capacity of actors and sectors.

All in all, this category of policies and measures mainly targets a better exploitation of no-regrets and, partly, co-benefit potential. Reduced transaction costs may also increase the size of both types of potential relative to the overall (ambitious mitigation) potential.

E) Research and technology transfer in order to develop new technologies for GHG mitigation and to make these technologies available. This can also be supported by demand pull through public or private targeted procurement, or through co-operative procurement. These types of policies will thus increase the size of the overall GHG mitigation potential, and will convert part of the ambitious potential into co-benefit or even no-regret potential.

For each of the sectors analysed, technology areas or subsectors with a significant potential for reduction of GHG emissions have been identified, based on results from Part II of the project and existing literature (e.g. Deutscher Bundestag 2002; IPCC 2007a). For each of these areas and subsectors, a package of policies and measures from the above five categories that can be considered good practice was identified. This is based, again, on the literature as well as on the Wuppertal Institute's expertise. Usually, one to three policy instruments in the package are considered to be principal instruments. These are often targeted policies and measures from categories B) or C) that have shown to be effective in practice either in OECD countries or in emerging economies, but also often include a sustainable reform of energy subsidies that still exist in some emerging economies.

2.4 Link to the international climate regime

In the fourth phase, we transferred the findings of phases II and III into the international arena. We suggest potential contributions by the six countries to the mitigation of climate change and outline financial and non-financial ways of supporting the emerging economies in their efforts to reduce greenhouse gas emissions, based on the options and potential identified in phase II and the measures identified in phase III. The analysis concentrates on support in the context of the UNFCCC and the Kyoto Protocol.

The suggestions for potential contributions to the climate regime by the six countries considered are based on two main principles:

- ecological adequacy (contribution to stabilisation of GHG concentration)
- differentiation according to national circumstances to implement the principle of common but differentiated responsibilities and respective capabilities

As for ecological adequacy (stabilisation of GHG concentration), the starting point for the analysis is that any post-2012 regime should aim for containing global temperature increase at below 2°C above pre-industrial levels.

As shown in section 11, meeting the 2°C target requires that almost the full ambitious mitigation potential of all six countries considered in this project is mobilised in addition to a domestic emission reduction of at least 30% below 1990 levels by Annex I countries. The following therefore outlines options for varying combinations of non-Annex I contributions and Annex I support that could be used to mobilise the ambitious mitigation potential.

As for differentiation, the analysis followed the staged South-North-Dialogue proposal (Ott et al. 2004). It bases the differentiation between countries on three principles: responsibility,

capability and potential. Ott et al. apply a comprehensive set of indicators to link types of contributions to different groups of countries (Table 5). The contributions include mitigation of emissions as well as providing or receiving funding.

The South-North-Proposal assigns indicators to each of the principles. Responsibility is linked to the cumulative emissions per capita. The capability to mitigate depends on the development level of a country. This is expressed by the human development index surveyed by the UNDP and the per capita income. The potential to mitigate can be linked to GHG emissions per GDP and per capita and emission growth. For this report, those proxy indicators can be replaced by the results from Part II of the project.

Table 5. Indicators to differentiate between countries as used in the South-North-Dialogue (Ott et al. 2004)

Responsibility	Capability	Potential
Cumulative CO_2/cap	GDP/cap	Results from Part II of this project (Chapters 4 to 9)
	HDI	

As a further, more qualitative, criterion for differentiating between countries, the analysis also considers whether countries dispose of the technical capacity necessary to quantify emissions and reductions and to report their emissions and policies and measures implemented to limit/reduce emissions.

As for the provision of international support, we proceeded from the assumption that the no-regret potential as a rule does not require permanent financial support from the international community. However, countries may well be eligible for other support to remove non-economic barriers, and potentially seed funding for, e.g. national revolving funds and for implementing policies and measures to overcome non-market barriers. The analysis furthermore proceeded from the assumption that co-benefit potential needs some financial support because it may not be realised despite the benefits and that countries will profit from non-financial support. It finally proceeded from the assumption that utilising the options identified under the ambitious potential scenario would crucially depend on international financial support in order to remove economic and other barriers as well as on other support.

3. Current mechanisms of engagement of developing countries in the international regime

3.1 Introduction

Non-Annex I countries are in many ways already involved in mitigation and limitation activities. This section provides a short overview regarding the activities within the Convention and the Protocol, namely Financial Mechanisms, Technology Transfer, and Clean Development Mechanism (CDM), with a view to exploring ways to enhance non-Annex I parties' participation. The section illustrates the complexity of the current setting and the necessity to develop ways to facilitate the required resources in a streamlined manner within the FCCC and the KP, but also in relation to official development aid.

3.1.1 Financial mechanisms

The Convention and the Protocol mandate Annex II parties to provide financial resources to cover implementation of general commitments, reporting, adaptation costs and technology transfer (Articles 4.3, 4.4, 4.5 and 11 of the Convention, Article 11 of the Protocol). The Financial Mechanisms under the UNFCCC have encountered various difficulties, among others their complexity in operation and lack of sufficient resources. This has led to

widespread dissatisfaction on the part of non-Annex I countries, which increasingly demand more substantial offers from Annex I countries.

The complexity in operation mainly results from the fact that the Convention entrusts the day-to-day operation of the mechanisms to the Global Environment Facility (GEF), while the COP decides on the policies, programme priorities and eligibility requirements for the financial mechanisms. This arrangement is meant to ensure that non-Annex I parties have some control over the GEF, in order to reflect their interests (cf. Matz 2002, p. 483). The COP has thus continuously adopted guidance for the GEF. They are difficult to track down, however, and often too general, which makes it difficult for the GEF to operationalise them (Yamin and Depledge 2004, p. 285).

Furthermore, the calculation of "incremental costs" increases the complexity. For the UNFCCC, the GEF has defined incremental costs as the difference between the full costs of the measures taken and the sum of the costs of the least expensive way to deliver an equivalent economic benefit plus the short-term benefits to the local economy (baseline) that would result from the proposed measure (GEF 1993, p. 31). Therefore, the full costs are covered in the case of projects to develop GHG inventories and national communications. In other cases, defining the baseline is very difficult and subjective. This results in delays in the submission and approval of GEF projects (Yamin and Depledge 2004, p. 281). The decision adopted in Nairobi provides guidance to the GEF to simplify its procedures and improve the efficiency of the process through which non-Annex I parties receive funding for projects (3/CP.12).

The above mentioned arrangement also makes it difficult to ensure adequacy and predictability of resources, partly because the resources are provided from the money pledged by donor countries for all GEF related funds (cf. Yamin and Depledge 2004, p. 283). In the fourth replenishment, 3,130 million USD were donated and 1,000 million USD were allocated to climate change (GEF 2006, p.3).

In order to secure budgets for specific objectives, in addition to the above mentioned financial mechanisms the Marrakech Accords established three special funds for transfers to developing countries, namely the Least Developed Countries Fund (LDCF), and the Special Climate Change Fund (SCCF) under the FCCC, and the Adaptation Fund (AF) under the Kyoto Protocol.

Concerning the lack of sufficient resources, a technical paper by the secretariat has reviewed existing and projected investment flows and financing relevant to the development of an effective and appropriate international response to climate change. It concluded with the necessity to increase financial flows from 379.5 billion. The need for adaptation is estimated at „several tens of billion dollars". (UNFCCC 2007, p. 91, 125).

In order to address the outstanding issues concerning the financial mechanisms, the fourth review process is currently being undertaken. Regarding the adequacy and predictability of resources, the SBI 28 will consider the submissions by parties on the report prepared by the UNFCCC Secretariat in collaboration with the GEF Secretariat and recommend a draft decision for adoption by COP14 (FCCC/SBI/2007/L.34/Add.1). Concerning the lack of sufficient resources, the decision further requests the GEF to simplify and streamline the application of the incremental cost principle, and to improve access to GEF funds for those countries that are particularly vulnerable to the adverse effects of climate change.

3.1.2 Technology transfer

Annex II parties are required to take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly to developing countries to enable them to implement the provisions of the Convention (Article 4.5 of the Convention, Article 10 c of the Protocol). At COP7, Parties adopted decision 5/CP7 to guide the discussions regarding technology transfer and development. It provides a framework for actions to enhance the implementation

of Article 4.5, covering five themes: technology needs assessments, technology information, enabling environments, capacity building, and mechanisms for technology transfer.

Based on this decision, the secretariat has developed a web-based technology information system (TT:CLEAR) that includes an inventory of environmentally friendly technologies and projects, and its technology web page. The decision further established an Expert Group on Technology Transfer (EGTT), nominated by the Parties. The Expert Group comprises 20 experts, it facilitates and advances technology transfer activities and makes recommendations to the Subsidiary Body for Scientific and Technological Advice (SBSTA). Although the current climate regime sees some development in technology needs assessment, identification of barriers and capacity building, it has not succeeded in developing mechanisms to effectively enhance technology development and deployment.

The challenge, therefore, is to develop an appropriate framework to address the identified barriers, including intellectual property issues, and to create a flow of sufficient finance for R&D, in particular energy-related R&D. According to the secretariat paper on investment and financial flows, additional global investment and financial flows of 200-210 billion USD will be necessary in 2030 in order to return global GHG emissions to around 26 $GtCO_2$ – and almost half of the amount in developing countries (UNFCCC 2007, pp. 100-102). At present, however, government spending on energy related R&D is stagnating (UNFCCC 2007, p. 9) and private sector spending has sharply fallen (Margolis and Kammen 1999).

In Bali, developing countries introduced the agenda item of Technology Transfer into the SBI in addition to the SBSTA and proposed to establish a new technology fund under the Convention. The EU and the UG proposed a program or facility under the GEF instead. Parties could reach a compromise on establishing a strategic programme under the GEF to scale up the level of investment for technology transfer.

3.1.3 The Clean Development Mechanism

Currently, the Clean Development Mechanism is the only means under the Kyoto Protocol by which developing countries are directly involved in mitigation activities. Having started with many delays, the CDM is now fully functional and expanding rapidly. The current pipeline of projects that have been registered or are at the validation stage expects cumulative emission reductions of 2.4 $GtCO_2eq$ by 2012 (Fenhann and Lema 2008).

However, the CDM is fraught with many concerns. One important concern is that projects are overwhelmingly concentrated in very few countries. The four leading countries, India, Brazil, China and Mexico, together account for no less than three quarters of all projects in the pipeline. Many developing countries have so far been almost completely bypassed (Fenhann and Lema 2008).

Even more importantly, the additionality of many projects has recently been severely called into question.

For example, a survey by Axel Michaelowa, a member of the CDM Registration and Issuance Team, and Pallov Purohit of 52 CDM projects registered in India by May 2006 found significant deficiencies as regards the demonstration of additionality by the project developers and the evaluation of the projects by the validators (Michaelowa and Purohit 2007). Lambert Schneider, a member of the CDM Methodologies Panel, recently estimated that additionality is unlikely or questionable for 40% of the projects registered so far (Schneider 2007) . Given the currently expected volume of 2.4 billion CERs by 2012, the CDM could thus severely undermine the environmental effectiveness of the Kyoto Protocol.

Other key concerns relate to the lack of sustainable development benefits of many projects and the limited incentives for sectoral transformation provided by the project-based approach. Post-2012 discussions therefore currently revolve around the concept of a sectoral CDM, in the hope that a sectoral approach would help to resolve the additionality problem

and provide incentives for emission reductions on the scale required to tackle the climate challenge.

3.2 The post-2012 negotiations under the UNFCCC and the Kyoto Protocol

The negotiations in the context of the UNFCCC and the Kyoto Protocol are the main pillar of the global efforts to fight climate change. This regime provides not only the global framework for a host of other multi- and bilateral activities; it is furthermore the only forum that is all-inclusive. This presents enormous challenges regarding the complexity and manageability of the negotiations, but it also presents unique opportunities for a truly global agreement to result from the process.

The post-2012 negotiations currently run along several tracks. First, the parties to the Kyoto Protocol in 2005 established an Ad-hoc Working Group on further commitments for Annex I Parties pursuant to Article 3.9 KP. Second (AWG-Article 3.9), parties to the FCCC have launched a 'dialogue' under the Framework Convention in the hope of integrating large developing countries and the United States in constructive discussions on the future of the climate regime (see Wittneben et al. 2006). In 2006 in Nairobi, two new items relevant to the post-2012 regime, namely a review of the Kyoto Protocol under its Article 9 and the Russian proposal on voluntary commitments for developing countries, were put on the agenda (see Sterk et al. 2007b, p. 140). At the most recent conference in Bali, the 'dialogue' was transformed into full-fledged negotiations under an "Ad-hoc working group on Long-Term Cooperative Action under the Convention" (AWG-Long Term).

One of the main challenges in the run-up to Copenhagen 2009 will be to, first, keep track of the various negotiation threads, second, make sure they do not contradict each other and, third, finally bring all these threads together in order to adopt a coherent and effective post-2012 agreement. This analysis will not formally differentiate the proposals according to the various fora, since this would lead to a rather intractable and confusing structure. Instead, it will explore the substantive issues and identify the kind of international cooperation that might be helpful.

Since the proposals are meant to support the diplomatic efforts of the post-2012 negotiations in and after COP 13 in Bali, they have been structured according to the main issues. To be adequate for meeting the ultimate objective of the Climate Convention to "prevent dangerous anthropogenic interference with the climate system" (Article 2 UNFCCC), the post-2012 framework will need to be considerably more multidimensional than the Kyoto Protocol in its current form (Brouns et al. 2005). The negotiators have recognised this challenge. Recently, several attempts have been undertaken to lay out the possible elements for a post 2012 package, including the ministerial "Midnight Sun Dialogue" (Riksgränsen 2007, p. 4) and the "Global Leadership for Climate Action" (Club de Madrid and United Nations Foundation 2007, p. 2). They are inter alia, stressing the role of the following issues:

- Enhanced mitigation action by developing countries;
- Financial support (through developing and strengthening carbon markets and improving financial mechanisms);
- Non-financial support (technology development, diffusion and commercialisation, capacity-building, awareness and education).

These elements are crucial to enhance mitigation actions by developing countries and more ambitious reduction targets for all developed countries. This is because developing countries would not take on any commitments without more financial resources and technologies; and, on the other hand, developed countries would not have any incentive to provide financial resources without serious commitments of some kind by developing countries.

Of the many possible types of mitigation commitments of developing countries in a future framework, the following options/combinations appear to be most promising:

Absolute emission targets: The target approach with legally binding, absolute emission reductions from a certain base-year used in the Kyoto Protocol has its advantages and disadvantages. On the negative side, it does not provide any support on how to reach these targets and needs to be supplemented with concrete measures. It also presumes the ability to gather and process large amounts of data – difficult for most countries except the most advanced. On the positive side, it provides for a high degree of stringency and certainty while at the same time leaving enough room for individual countries to choose the policies they think fit best to their particular circumstances, making the approach highly efficient.

Absolute emission targets of the kind employed by the Kyoto Protocol for Annex B countries could also be a suitable commitment by the most advanced developing countries. These countries have the capability to act due to a comparatively high per capita income. At the same time they have high emissions and the necessary infrastructure to implement and monitor this kind of target, including inventories.

Dual targets/no-lose targets: One way to render targets more suitable for less advanced developing countries is presented by so-called "dual targets": Under this approach, a country would have two quantitative targets. If the lower target (meaning higher reductions) is reached, the country is in compliance and can sell the excess allowances on the carbon market. If the higher target is achieved (meaning lower reductions), this country would still be presumed to be in compliance but could not take part in emissions trading. Only if the higher target is exceeded the country would be in non-compliance. A variant of this proposal is called "no-lose" target: There is only one target and if this is reached, the country may take part in emissions trading. If the target is missed, nothing happens – a country can gain, but not lose under this approach (Philibert 2000).

Dynamic sectoral no-lose targets: Dynamic sectoral no-lose targets could be suitable options for advanced developing countries. These countries have higher per capita income than the average group of non-Annex I countries. Their emissions are increasing considerably and different sectors might have the necessary prerequisites for no-lose targets. The difference to the no-lose targets described above lies in the fact that they, first, cover only certain sectors of a countries' economy and, second, that they are "relative" targets, indexed to the production in the sector. For the electricity sector, for example, they could be expressed in terms of gCO_2/kWh.

Each country would first have to make a sound analysis of the emissions, efficiencies and future trajectories in the respective sectors. It would first quantify emissions under a reference scenario. It would then quantify the future emissions taking into account the policies that are already in place given domestic initiatives and international support. From that level a further reduction is made as the domestic contribution of each country. These emission levels could be the "no-lose" target. Any reductions below this level could be sold on the international market.

For the sectors under the no-lose target, each country would not longer be eligible to implement CDM projects. In fact, the sectoral no-lose targets can be seen as sector-wide CDM projects. The no-lose target includes a domestic contribution and not all reductions below the baseline can be credited, but sector-wide implementation would lower transaction costs substantially and would attract a much higher investments and therefore can be more beneficial than only participating in CDM.

It is up to each government how companies can benefit from the sales. E.g. each electricity producer could receive allowances if the installations emit below the dynamic target measured in $kgCO_2$/kWh. Another option would be to implement a national emission trading system.

Registry of sustainable development policies and measures: For the majority of developing countries, quantitative emission targets are not an option. An alternative

approach concentrates instead on specific policy objectives like a certain share of renewable energy or energy efficiency improvements. This type of target would take the development objectives of developing countries as a start and couple these with measures that achieve lower emissions than would be achieved under a business-as-usual case (Winkler et al. 2002). If industrialised countries support these “Sustainable Development Policies and Measures” (SD PAMs) financially, this option is especially interesting for countries with a lower level of economic development.

The registry of SD PAMs might be suitable for medium developing countries, such as India, with rapidly increasing emissions and low capability. However, it should be noted that the SD PAMs approach also requires a certain level of infrastructure. For example, more frequent submission of national communications is necessary to evaluate whether the registered SD PAMs are implemented.

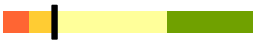
4. Brazil

This and the following sections include the results of this project for Brazil, China, India, Mexico, South Africa and South Korea.

4.1 Brazil in comparison to other countries

Table 6 provides a range of energy and emission indicators. The right column shows in “performance meters” how Brazil performs compared to other countries. The data shows that Brazil ranks very high among developing countries with respect to its state of development. Its GDP per capita is above that of most developing countries and is at around world average. Brazil’s emissions per capita are around world average and increasing. Emissions from electricity generation and transport are relatively low due to the extensive use of hydropower in electricity generation and biofuels in the transport sector. On the other hand, emissions from agriculture and industry are relatively high.

Table 6. Energy and emission indicators for Brazil

	Indicator	Value	Meter
Responsibility	Cumulative emissions 1900 to 2004 per capita per year	1.7 $tCO_2eq/cap./y$	
Capability	GDP per capita (2004)	8,100 US $ PPP 2000/cap.	
	Human development index 2002	0.775 (medium)	
Potential	Past emission trend from 1990 to 2004	+35%	
	Emissions per capita (2003)	5.2 $tCO_2eq/cap.$	
	Emissions per GDP (2004)	636 tCO_2eq/MUS (2000)$	
	Emissions per kWh electricity (2003)	78 gCO_2/kWh	
	Energy efficiency in industry	Low/medium	
	Emissions in transport per capita (2003)	0.74 tCO_2eq/cap	
	Emissions in households and services per capita (2003)	0.20 $tCO_2eq/cap.$	
	Emissions in agriculture per capita (2000)	3.22 $tCO_2eq/cap.$	
	Emissions in waste per capita (2000)	0.24 $tCO_2eq/cap.$	
	Emissions in land use change and forestry per capita (2000)	8.06 $tCO_2eq/cap.$	

For detailed explanation of the meters and data sources see Appendix A.

Figure 4 shows the shares of Brazil's primary energy supply until 2003. Oil supplies constitute nearly half of Brazil's primary energy demand (44%). About one quarter is supplied from biomass (26%). The share of residential use of biomass is very high but decreasing. Also hydropower is an important source for primary energy supply (14%), followed by coal (7%), gas (7%) and nuclear power (2%).

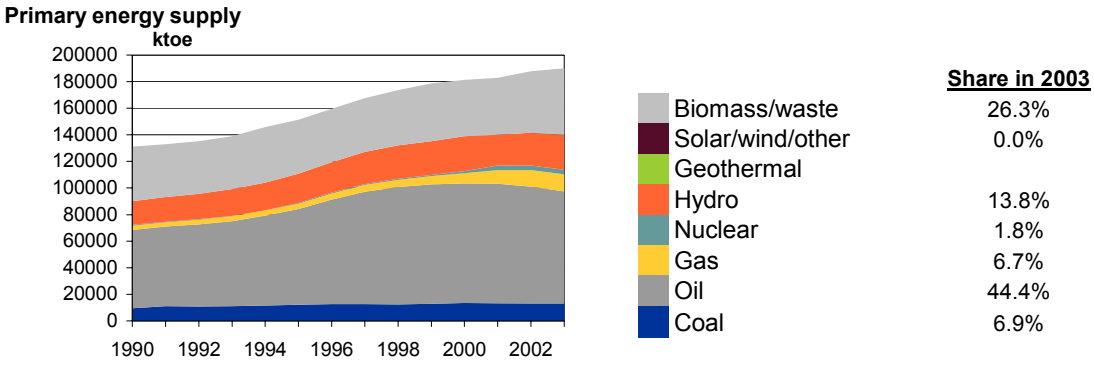


Figure 4. Brazil's primary energy supply between 1990 and 2003 (IEA 2005b)

Overall, the strong position of renewable sources in Brazil's energy mix leads to comparatively low emission intensity in electricity generation. Due to Brazil's level of development and its fuel mix, per capita emissions are low compared to industrialised countries but high compared to other Latin American countries.

4.2 Reference emissions and mitigation potential

Figure 5 below shows Brazil's greenhouse gas emissions under the business-as-usual scenario and all three reduction scenarios as calculated in this report. The scenario parameters are based on national studies as far as possible. Major sources for future data in Brazil are Centro Clima et al. (2006), USEPA (2006b) and trend extrapolation of official national and IEA statistics (IEA 2005a).

As illustrated in Figure 5, the reduction potential for Brazil is 3% (no-regret), 6% (co-benefit) and 14% (ambitious potential) below BAU. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the (1) transportation, (2) power and (3) industrial sector. The ambitious mitigation potential in the transportation sector is estimated at 164 $MtCO_2eq$ in 2020. In the power sector, there exists an ambitious potential of 120 $MtCO_2eq$. The ambitious potential in the industrial sector is estimated at 59 $MtCO_2eq$ in 2020. The total ambitious mitigation potential in Brazil is estimated at 429 $MtCO_2eq$ in the year 2020. A detailed overview of the potential per sector and scenario can be found in Appendix B.

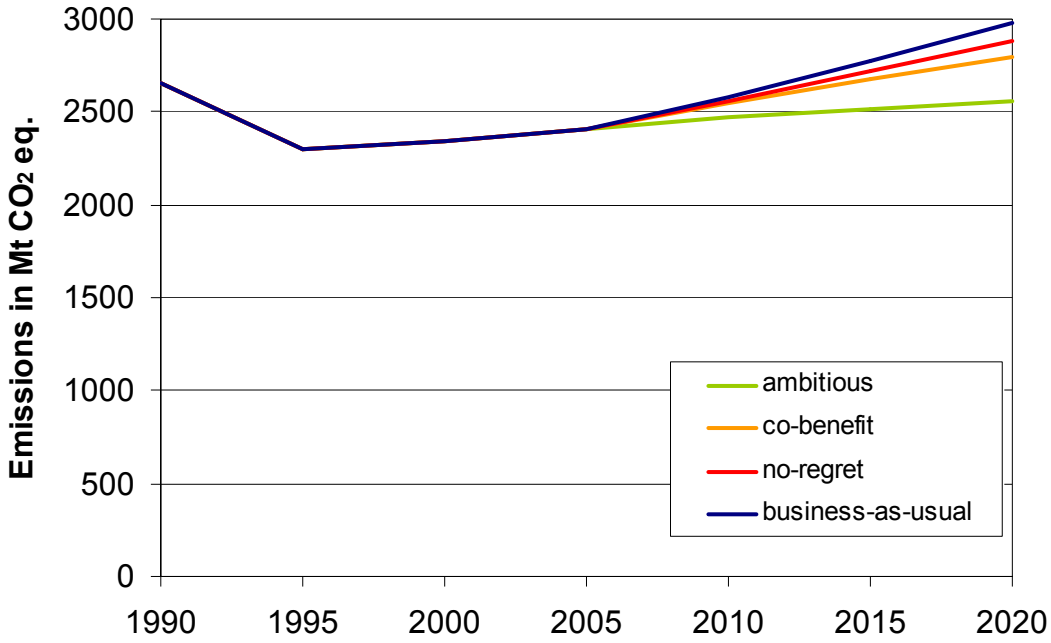


Figure 5. Scenarios for greenhouse gas emissions in Brazil between 1990 and 2020.

Figure 6 shows Brazil's total reduction potential on the sector level under the ambitious potential scenario compared to the business-as-usual scenario and the remaining emissions according to sectors.

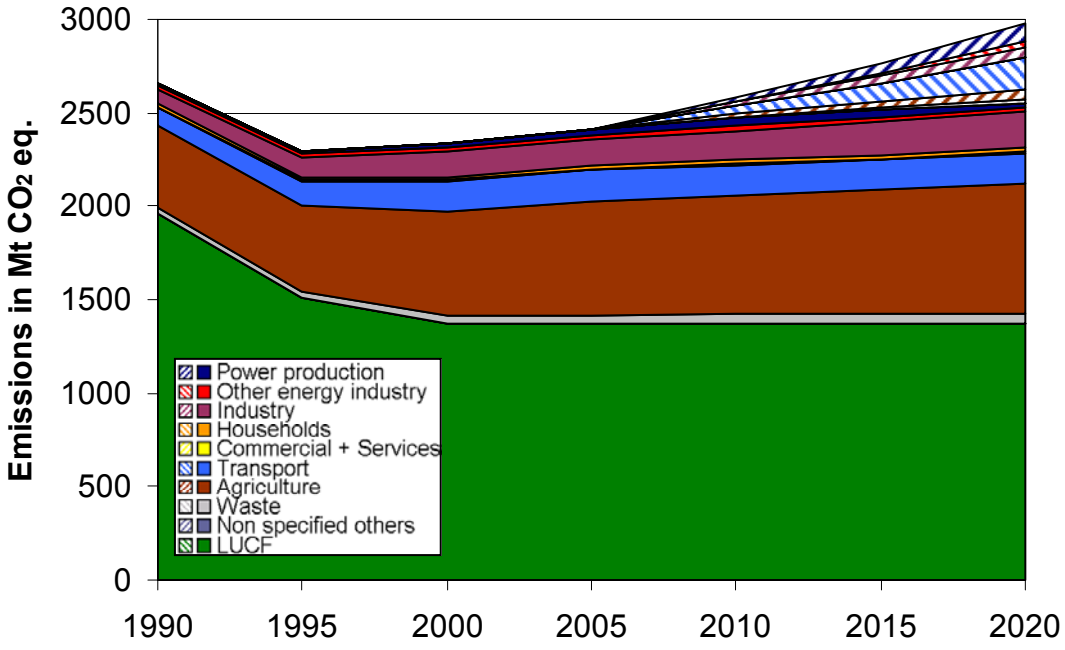


Figure 6. Brazil's emissions under the business-as-usual and the ambitious potential scenario on a sector basis between 1990 and 2020. Striped areas show the sectoral emission reduction potential under the ambitious potential scenario compared to the business-as-usual scenario. (Emissions from LUCF kept constant after 2003 due to data availability)

Most important findings for Brazil:

- Brazil's emissions are projected to increase constantly by about 1.2% per year between 2000 and 2020 due to development and a related increase of transport and energy demand per capita under the business-as-usual scenario. However, this trend could be changed considerably depending upon the policies and measures implemented to curb deforestation in the Amazon region, as the bulk of Brazilian GHG emissions comes from LUCF. This issue is mainly one of governance, as it relates to the capacity of enforcing already existing laws and regulations, and it is not easily translated into mitigation costs.
- In 2000, most emissions resulted from LUCF and agriculture (85%), followed by the transport and the industry sectors (6-7% each). Under the business-as-usual scenario, this trend is assumed to be similar, but strongly influenced by the outcome of governance issues on LUCF emissions, as mentioned above.
- Since power generation is largely based on hydropower, the emission reduction potential of current installations is limited. However, new capacity may be build based on fossil fuels. A crucial issue is the availability of financial resources to meet the large investment requirements associated with hydropower and sugar cane bagasse-fired generation capacity. Potential for further hydropower is however decreasing. Distribution losses can be significantly reduced and efficiency improvements in the fossil fuel power plants are available.
- The industry sector already uses a high share of renewable energy sources such as charcoal (if the wood is taken from the rain forest it is not considered renewable) and sugar cane bagasse. There is potential for energy efficiency improvements in many industrial branches, one fifth of which can be achieved at no costs.
- Some limited reduction potential is available in the agricultural sector, e.g. through optimised use of fertilisers.
- The transport sector offers big opportunities for mitigation. There is potential for significantly increasing the production and use of biofuels such as ethanol from sugar cane and biodiesel from vegetal oils. Energy efficiency improvements in vehicles (cars, trucks, buses) may play an important role. The building of energy efficient transport infrastructure both for passengers and freight (railways, waterways, mass public transportation) would be crucial to avoid the lock-in effect on GHG emissions from perpetuating the current overwhelming reliance on road and individual transport.
- Under the no-regret potential scenario reductions of 3% below BAU (20% above 2005 emissions) might be possible. Under the co-benefit potential scenario reductions of 6% below BAU (16% above 2005 emissions) could be feasible. Under the ambitious potential scenario reductions of 14% below BAU (6% above 2005 emissions) might be possible.

4.3 Existing and possible further national climate policies

4.3.1 Overview of existing climate policies and measures

This section gives a general overview of existing climate policies and measures in Brazil. For this purpose, we distinguish between policies and measures targeting energy efficiency improvements, renewable energy, and other relevant sources of GHG emissions.

If not stated otherwise, the source for this section is Brazil's first national communication (MCT 2004). Moreover, comments by a country expert for Brazil (Emilio Lèbre La Rovere) were also used for this section.

Brazilian climate policy mainly focuses on the transport sector (substitution of petrol by bioethanol), the industry sector (energy efficiency improvements, substitution of fossil fuels

by charcoal and other biomass, promotion of natural gas) and power from renewable energy sources. Low-income households receive subsidised electricity tariffs. However, Brazil is lacking an adequate regulatory and financial framework that would reduce risks and allow accelerated investments in climate change mitigation options.

A number of policies and measures targeting **energy efficiency** and **demand-side management** have been implemented in Brazil. The framework is set by the national electricity saving programme (PROCEL), which aims at increasing energy efficiency in the production and use of electricity. PROCEL's target was to reduce electricity consumption and supply-side losses by about 8.4 terawatt-hours per year by 2003, equivalent to 2.5 percent of Brazil's power consumption. The program has met these targets. Focus areas are energy labelling, minimum energy efficiency standards, energy audits, information campaigns, energy efficiency in public and residential buildings, demand-side management programmes by electric utilities, as well as technical and financial support for energy saving measures. Another important programme is the national programme for the rational use of fuel (CONPET). This programme targets fuel efficiency in different sectors through information measures such as labelling, energy audits or training activities. Furthermore, there are policy instruments such as tax incentives to purchase less powerful cars.

Renewable energy is promoted through the programmes PROINFA and PROALCOOL. The programme PROINFA aims at increasing the electricity generating capacity from "new" RES by additional 3300 MW through guaranteed direct sales contracts by the year 2008. The main driver behind this target is to offset seasonality of the current hydro powered electricity supplies. Brazil has the long-term goal to increase the share of "new" RES to 15% of the primary energy supply until 2020. PROALCOOL aims at substituting petrol by bioethanol in the transportation sector. The programme is a very successful climate policy instrument in Brazil. Today, Brazil is a leading country in the production of bioethanol and has relatively low emissions in the transport sector. The success has been achieved by subsidising sugarcane and ethanol production, a lower price for bioethanol compared to petrol set by the government and a large research programme.

Only a small number of climate policies and measures targeting **other relevant sources of GHG emissions** are in place in Brazil. These instruments include programmes to monitor and decrease the deforestation of rainforests, strategies focusing on utilising landfill gas or emission standards for vehicles and air quality in general (e.g. the national programme on air quality, PRONAR).

4.3.2 Suggestions for additional climate policy instruments and measures

The following section analyses the existing climate policies and measures for sectors with the highest GHG emissions reduction potential in Brazil. Based on the sourcebook, we provide suggestions for improving the existing mix of climate policy instruments and measures with additional policies and measures in order to exploit the full GHG emissions reduction potential. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the (1) transportation, (2) power and (3) industrial sector.

Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics* in the following tables. Such instruments are mainly investment support or RD&D schemes. Section 2.3 presents more generally which category of policy instruments is considered appropriate for addressing the no-regret, co-benefits, and ambitious potential, respectively.

4.3.2.1 Transport

This section makes suggestions for improving the existing mix of climate policy instruments in the transportation sector.

Table 7: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the transportation sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy		
General economic and fiscal policy		• Energy taxation on fossil fuels • Phase-out of subsidies and tax exemptions for vehicle fuels • *Domestic emission trading scheme*
Targeted economic and fiscal policy	• National alcohol programme (Proalcool) • Tax incentives for less powerful vehicles	• Road fees, congestion charges • CO_2 differentiated vehicle taxation • Depreciation rules favouring energy efficient vehicles • Financial support for switching from road-based to rail- or waterway based transportation
Regulations and voluntary agreements	• Programme for air pollution from automotive vehicles (PROCONVE)	• Average specific emissions target for new vehicles regarding GHG emissions • Dynamic MEPS for vehicle components • Tighter speed limits • Spatial planning favouring non-motorised and public transport • Integrated transport planning
Information and know-how transfer	• Driver training programmes for truck drivers	• Vehicle labelling • Driver training programmes for car and bus drivers • Promotion of public transport
Research and technology transfer	• National alcohol programme (Proalcool)	• *Research on sustainable transportation systems*

The existing mix of climate policy instruments and measures in the Brazilian transportation sector consists of several instruments. They include mainly targeted economic and fiscal policies (e.g. financial support for bioethanol production, tax incentives for less powerful cars), regulations (e.g. emission standards) and research activities (research on using bioethanol from sugarcane as a fuel).

The ambitious potential of about 164 $MtCO_2eq$ in 2020 in the transportation sector can be realised by introducing a number of additional climate policies and measures. Section 2.3 presents more generally which category of policy instruments is considered appropriate for addressing the no-regret, co-benefits, and ambitious potential, respectively.

Potential additional cross-cutting policy instruments are a phase out of subsidies and the introduction of energy taxation on fossil fuels as well as a domestic emission trading scheme in the transport sector (connected to setting an average specific emission target, cf. below).

Aiming at different fields of application (individual motor car transport, air transport, public transport and freight transport), additional policy instruments could support the realisation of the ambitious potential. For targeting vehicles, several policy instruments are available. Such policy instruments could be targeted economic and fiscal policies and measures like for example road charges, a CO_2-differentiated vehicle taxation or favourable depreciation rules for efficient vehicles. Regulations could consist of setting average specific emission targets for new vehicles, dynamic minimum energy performance standards (MEPS) for vehicle components, tighter speed limits, or integrated transport planning. Additional climate policy instruments of the category information and know how transfer could be vehicle labelling, driver training programmes for car and bus drivers or promotion of public transport. A shift from road-based to rail- or waterway-based transport can be induced by direct financial support such as tax reductions or subsidies. However, a functioning regulatory and financial framework is needed, which reduces risks and fosters investments in such infrastructure.

4.3.2.2 Power

This section outlines existing climate policies and measures in the power sector. Suggestions for improving the existing climate policy mix are made in order to exploit the GHG emissions reduction potential.

Table 8: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the power and heat sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy	• Goal of a power generating capacity from RES of 3300 MW until 2008, long-term goal of a 15% RES share of the primary energy supply until 2020	• Renewable energy targets for heat and cold supply
General economic and fiscal policy		• Ecological finance reform • *Domestic emissions trading scheme* • Gradual phase-out of energy subsidies backed by *financial and technical support for energy-efficiency and RES*
Targeted economic and fiscal policy	• PROINFA: Guaranteed sales contracts for electricity from renewable energy sources • PROCEL: Financial incentives for reducing supply side losses	• *Financial support for the installation of RES technologies for cold and heat* • *Investment support for improvements in the conversion efficiency of fossil fuel power plants (linked to MEPS, see below)*
Regulations and voluntary agreements		• Favourable regulations on grid access and power purchase agreements for RES and CHP plants • Create target for reduction of annual energy consumption from DSM by utilities of 1% per year (compared against the baseline) • Accelerated building permission procedures for RES and CHP plants

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
		• Building codes with stringent energy efficiency levels and a mandatory share of RES for heat and cold • Dynamic minimum conversion efficiency standards, regularly updated • *"CCS-ready" obligation for new-built power plants*
Information and know-how transfer		• Network of local actors • Demonstration and training on RES technologies targeting contractors, retails sales staff, architects and engineers
Research and technology transfer	• Research on utilising landfill gas	• *RD&D schemes for accelerated development, technical improvement and market introduction of RES technologies for electricity, heat and cold, efficient fossil fuel power plants, and for analysis of CCS* • Public and co-operative procurement of RES technologies

A number of additional climate policies and measures are suggested for strengthening the existing mix in the power sector in order to exploit the ambitious potential of 120 $MtCO_2eq$ in the year 2020.

The framework for realising further emission reduction potential in the power sector could be set by an ecological finance reform, a domestic emissions trading scheme and a gradual phase out of fossil fuel subsidies, backed by technical and financial support for RES technologies and energy efficiency. This could contribute to levelling the playing field for RES and energy efficiency technologies.

The existing programme targeting RES technologies (PROINFA) provides a good starting point for increasing the share of renewable electricity in Brazil. However, strengthening the existing RES programme with additional policy instruments such as favourable regulations on grid access and power purchase or accelerated building permission procedures for RES and CHP plants, information measures such as networks of local actors or demonstration and training on RES technologies for relevant actors could improve the effectiveness of the existing policy instruments in this field. Furthermore, research in RES technologies and public and co-operative procurement schemes for such technologies could also be feasible policy instruments.

RES technologies for heat and cold could contribute to reducing fossil fuel and electricity consumption for these fields of application. Based on a target for heat and cold from RES, additional policy instruments like direct investment support, building codes with stringent energy efficiency levels and a mandatory share of RES for heating and cooling, or training activities for relevant actors would help to realise the emission reduction potential in this field.

Additional policies and measures for promoting efficient fossil fuel power plants could be targeted financial policies such as investment support for power plants with a high conversion efficiency, regulation such as minimum standards for the conversion efficiency of new built plants or a RD&D scheme.

Requiring new-built fossil fuel power plants to be designed "capture ready" could bring CCS forward. This would also have indirect implications on energy prices and make energy from fossil fuels more expensive. Support and co-operation with Annex I countries will be needed in this field.

GHG emissions stemming from the power production sector can also be indirectly targeted. Climate policy instruments and measures aiming at improving energy end-use efficiency and energy conservation in households or industry have an effect on the country's energy demand. Especially for the household sector, a promising policy instrument, the national electricity saving programme (PROCEL), is already in place. The programme consists of a package of regulatory (e.g. MEPS), information (e.g. energy labelling) and targeted policy instruments (e.g. funding for DSM activities). A more detailed discussion of additional policy instruments for improving energy end-use efficiency in the household and service sector can be found in the sourcebook (see Appendix C).

4.3.2.3 Industry

Suggestions for improving the climate policy mix in the industrial sector are made in the following.

Table 9: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the industrial sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy	• National electricity saving programme (PROCEL) • National programme for the rational use of fuel (CONPET)	
General economic and fiscal policy		• Gradual phase-out of energy subsidies backed by *financial and technical support for energy efficiency and RES* • *Domestic emissions trading scheme*
Targeted economic and fiscal policy	• Direct investment support for energy efficiency measures	• *Enhanced financial support for the optimisation and installation of energy-efficient technologies linked to energy audits and management systems*
Regulations and voluntary agreements	• MEPS for electric motors	• Minimum energy efficiency standards (for energy using equipment as well as included in building permits for new industrial production facilities)
Information and know-how transfer	• Energy audits • Load management • Training activities	• Energy management systems
Research and technology transfer	• Research activities	• *RD&D scheme for energy efficient production technologies and methods*

For exploiting the ambitious potential of 59 $MtCO_2eq$ in 2020 in the industrial sector, the following additional climate policies and measures are suggested.

Cross-cutting issues are the gradual phase-out of subsidies for energy from fossil fuels and the potential introduction of a domestic emissions trading scheme.

In Brazil, promising climate policy instruments targeting the industrial sector such as the national electricity saving programme (PROCEL) and the national programme for the rational use of fuel (CONPET) are already in place. These programmes consist of a package of different instruments such as investment support for energy efficiency measures, MEPS for electric motors, or energy audits. A number of additional policy instruments can contribute to realising the emissions reduction potential. Such policy instruments include enhanced direct financial support for energy efficiency measures, which should be combined with energy audits and energy management systems, an extension of MEPS to other appliances and fields of application, energy management systems, as well as RD&D on energy efficient production technologies and methods.

4.4 Options for a stronger involvement of Brazil in the international regime

Brazil has so far not been very positive about taking on international commitments to protect the climate. It rather stressed the responsibility of Annex I countries for reducing GHG emissions, as evidenced by the "Brazilian proposal". Recently, Brazil showed some willingness to take on sectoral commitments. Brazil is a speaker of the G77/China and in this position blocks the attempt of Annex I countries to require more frequent submissions of National Communications and Inventories, which would be a prerequisite for any country-wide commitment.

4.4.1 Analysis

Brazil has the responsibility, capability and potential to make a contribution to the international effort to reducing emissions. Brazil is still a developing country and its indicators are only at the very low end of the range of those of Annex I countries. But Brazil could be capable of handling an emission limitation or reduction target of limited scope and stringency compared to those of Annex I countries:

- *Responsibility*: Brazil's responsibility for climate change due to its emissions excluding LULUCF is below world average but above non-Annex I average. With LULUCF emissions it is likely to be higher, but sound historical estimates of emissions from the LULCUF sector are not available.
- *Capability*: Brazil's per capita income is about world average. However, the regional and social income distribution is still very unequal. Its human development index is far above world average. It has in place many initiatives, laws and standards to reduce the emission intensity of electricity, transport and industry. But some institutional difficulties exist in terms of implementing policies.
- *Potential:* Despite the high share of renewable sources in electricity production, Brazil has a substantial mitigation potential. According to the figures from Phase II of the project, the no-regret potential to reduce 2020 emissions below BAU levels amounts to 104 Mt, the co-benefit potential to 187 Mt and the ambitious mitigation potential to 429 $MtCO_2eq$. These would be equal to a 3%, 6% or 14% reduction compared to BAU levels respectively and a 20%, 16% or 6% increase compared to 2005 emissions levels.

Earlier analyses also put Brazil at a high level compared to other developing countries. Ott et al. (2004) classify Brazil as "rapidly industrialising country" implying an absolute limitation target if funding and technology are provided by Annex I countries. Others find that Brazil would have to accede to Annex I soon if emissions/capita or GDP/capita thresholds were applied (Gupta 2003; Höhne et al. 2005).

In addition, Brazil disposes of the technical capacity necessary to quantify emissions and reductions. National statistics for Brazil are available and they include economic, financial, social, energy and industry indicators (IBGE 2006; MME 2006). In the National Communication, detailed GHG emission data are available for all gases and sectors for 1990 and 1994 (MCT 2004). GHG emissions data for more recent years exist, but are not officially published. Existing institutions in Brazil have the ability to quantify future emissions and the effect of policies (e.g. La Rovere and do Valle Costa 2005). Already in the Initial National Communication (MCT 2004) estimates were made on emission reductions due to single policies, e.g. taxes.

4.4.2 Suggestions for a potential contribution

Given the amount of global emission reductions required to keep temperature change below 2°C and based on the above analysis, we suggest that it would be equitable and feasible for Brazil to commit to an absolute country-wide no-lose emission target.

We propose two options for the level of stringency based on the assessment of what amount of reductions is necessary by 2020 to bring global emissions on a 2°C trajectory (see section 11):

The target could either be set at a stringent level correlated to the ambitious potential as analysed in this project, but implementation be made contingent on the provision of financial and technical support from Annex I countries. The target would in this case amount to about 2,555 $MtCO_2eq$ annual emissions in 2020, 14% below the BAU level.

Alternatively, the target could be set at a less stringent level, for instance correlated to the co-benefit mitigation potential. This target would amount to about 2,796 $MtCO_2eq$, 16% above 2005 levels. Brazil could then nevertheless implement ambitious policies and measures to overachieve the target and sell the resulting surplus on the carbon market. This alternative would require less direct financial and technical support from Annex I countries but more support through the carbon market and hence emission reduction targets for Annex I countries of 45% compared to 1990, as opposed to the -30% target as assumed in the option above.

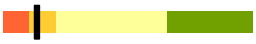
If a country-wide target is not politically feasible, a second-best option could be to implement sectoral or policy-based CDM projects in the power, industry and transport sectors. Sectoral/policy CDM would probably be politically more acceptable for developing countries. However, the technical implementation of sectoral/policy CDM and sectoral no-lose targets would probably be very similar and no-lose targets have a twofold advantage over sectoral/policy CDM: first, there would be no need to assess the additionality of emission reductions, and second, no-lose targets open the opportunity to achieve net reductions, namely the difference between BAU and the target. Under the CDM, by contrast, everything below BAU would be credited and lead to higher emissions in Annex I countries.

5. China

5.1 China in comparison to other countries

Table 10 provides a range of energy and emission indicators. The right column shows how China performs compared to other countries. The basic data illustrates that China ranks at around the average of developing countries with respect to its state of development. Its emissions and GDP per capita are slightly above non-Annex I average. China has experienced strong economic and emission growth in the last 5 years. Growth rates are among the highest in the world. China is strongly dependant on coal; its emissions per kWh electricity are among the highest in the world. China's energy consumption per unit of GDP declined by about 50% between 1990 and 2002 (NDRC 2004).

Table 10. Energy and emission indicators for China

	Indicator	Value	Meter
Responsibility	Cumulative emissions 1900 to 2004 per capita per year	1.1 $tCO_2eq/cap./y$	
Capability	GDP per capita (2004)	5,700 US $ PPP 2000/cap.	
	Human development index 2002	0.745 (medium)	
Potential	Past emission trend from 1990 to 2004	+48%	
	Emissions per capita (2003)	3.9 $tCO_2eq/cap.$	
	Emissions per GDP (2004)	688 tCO_2eq/MUS (2000)$	
	Emissions per kWh electricity (2003)	771 gCO_2/kWh	
	Energy efficiency in industry	Low	
	Emissions in transport per capita (2003)	0.22 $tCO_2eq/cap.$	
	Emissions in households and services per capita (2003)	0.34 $tCO_2eq/cap.$	
	Emissions in agriculture per capita (2000)	0.83 $tCO_2eq/cap.$	
	Emissions in waste per capita (2000)	0.13 $tCO_2eq/cap.$	
	Emissions in land use change and forestry per capita (2000)	-0.04 $tCO_2eq/cap.$	

For detailed explanation of the meters and data sources see Appendix A.

Figure 7 shows the shares of China's energy sources up to the year 2003. Coal is by far the most important energy source (60% in 2003). Oil (20%), biomass and waste (15%) also contribute considerably to total primary energy supply. Gas, nuclear energy and hydropower only play a minor role. Lately the use of oil and gas has increased while the share of coal has declined (Chandler et al. 2002). The share of biomass is significant but decreasing.

China is the largest coal producing and consuming country (Jiang et al. 2003). Coal is responsible for about 80% of national emissions. China's remaining proven coal reserves could be large, but depending on the source the figures vary. Coal is assumed to be the dominant energy source for the future (World Bank 2006). Also for oil and natural gas considerable domestic resources are available. There is furthermore a huge potential of renewable energy sources, such as hydropower, biomass, wind, solar and geothermal (van Vuuren et al. 2003).

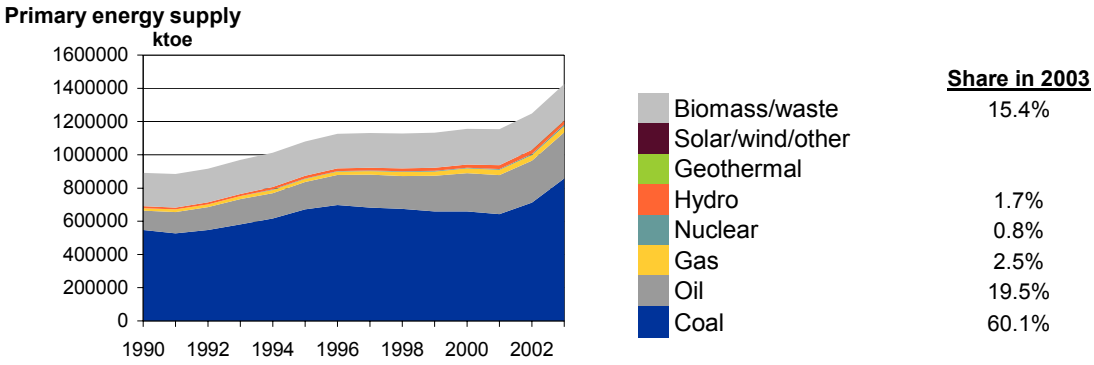


Figure 7. China's primary energy supply between 1990 and 2003 (IEA 2005b)

Apart from the high share of coal, the low energy efficiency and the importance of the energy intensive industry for the national economy are currently responsible for China's relatively high emissions. Despite the unequalled reduction of energy and emission intensity combined with high economic growth, China's energy intensity is still very high compared to that of industrialised countries.

Overall, China is classified as country with a medium human development. Its per capita income is on a developing country average level. The dominance of coal in China's energy mix and the comparatively low energy efficiency leads to high emission intensity in electricity generation. The overall per capita emissions are still low. Nevertheless, its national emissions are high, also due to substantial exports (Arquit Niederberger et al. 2006, to be published). Although China's energy intensity declined considerably during the last decades, its absolute energy demand strongly increased. This trend makes China a very important party in the future global climate regime.

5.2 Reference emissions and mitigation potential

Figure 8 below shows China's greenhouse gas emissions under the business-as-usual scenario and all three reduction scenarios calculated in this project. The scenario parameters are based on national studies as far as possible. Major sources for future data in China are Chen et al. 2006; USEPA 2006b and trend extrapolation of national and IEA statistics (IEA 2006).

As illustrated in Figure 8, the reduction potential for China is 8% (no-regret), 15% (co-benefit) and 32% (ambitious potential) below BAU. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the (1) power, (2) industrial and (3) transportation sector. In the power sector, there exists an ambitious mitigation potential of 1322 $MtCO_2eq$ in 2020. The ambitious potential in the industry sector is estimated at 770 $MtCO_2eq$. In the transportation sector, there is an ambitious potential of about 395 $MtCO_2eq$. The total ambitious mitigation potential in China is estimated at 2930 $MtCO_2eq$ in the year 2020. A detailed overview of the potential per sector and scenario can be found in Appendix B.

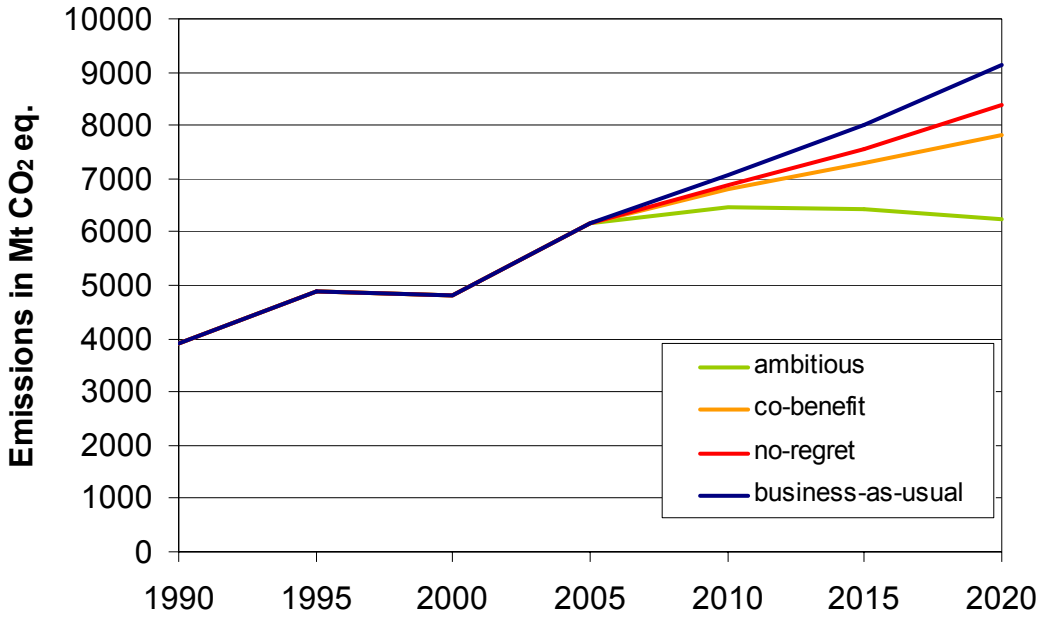


Figure 8. Scenarios for greenhouse gas emissions in China between 1990 and 2020.

Figure 9 shows China's total reduction potential on the sector level under the ambitious potential scenario compared to the business-as-usual scenario and the remaining emissions according to sectors.

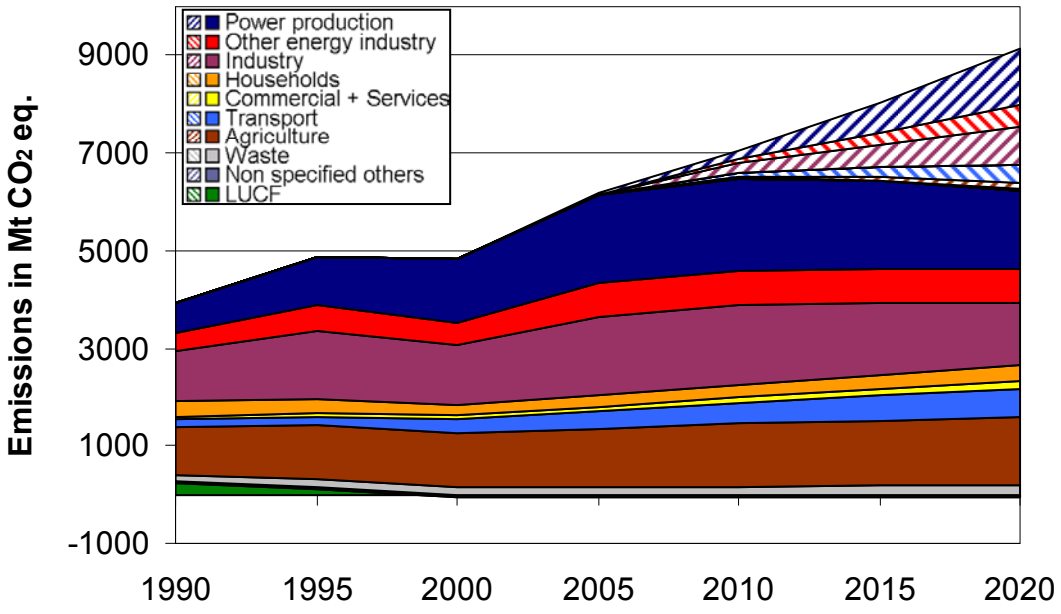


Figure 9. China's emissions under the business-as-usual and the ambitious potential scenario on a sector basis between 1990 and 2020. Striped areas show the sectoral emission reduction potential under the ambitious potential scenario compared to the business-as-usual scenario. (Emissions from LUCF kept constant after 2003 due to data availability)

Most important findings for China:

- China's emissions are projected to increase by about 3.3% per year between 2000 and 2020 under the business-as-usual scenario.

- In 2000 most emissions resulted from power production, agriculture and industry (31%, 25%, and 23% respectively). Under the business-as-usual scenario, this trend is projected to be more or less similar, although the importance of power production will increase slightly, while the share of agriculture will decrease.
- In the power sector, a major reduction opportunity would be to move away from coal to renewable energy sources (under optimistic assumptions). Energy end-use efficiency especially in industry can contribute with reductions. We also assumed 1% of electricity generation with CCS technology by 2020 as ambitious potential.
- In industry, the move to renewable energy sources, efficiency improvements and process changes are major reduction options.
- Reduction options in agriculture are limited.
- In the transport sector reduction options are considerable compared to the share of transport in overall emissions but limited regarding national emissions as a whole. Options are e.g. to increase the share of natural gas, efficiency gains, especially in aviation and road transport, and a shift to increase the relative share of rail and shipping.
- Under the no-regret potential scenario reductions of 8% below BAU (36% above 2005 emissions) might be possible. Under the co-benefit potential scenario reductions of 15% below BAU (27% above 2005 emissions) could be feasible. Under the ambitious potential scenario overall emission reductions of 32% below BAU (1% above 2005 emissions) might be possible.

5.3 Existing and possible further national climate policies

5.3.1 Overview of existing climate policies and measures

This section provides a general overview of existing climate policies and measures in China. For this purpose, we distinguish between policies and measures targeting energy efficiency improvements, renewable energy and other relevant sources of GHG emissions. If not stated otherwise, sources for this section include NDRC (2004; 2006), Peiyan (2005), Government China (2004; 2005) and Jiang et al (2003).

Climate policy in China is mainly implemented and enforced at the regional level. The central government imposes standards that often have the form of directives and leaves their implementation and enforcement to the local governments. Often, local governments do not have the capacity or will to implement such policies. There is little experience with market-based mechanisms, while energy efficiency standards and voluntary agreements are widely-used policy instruments. An important driver for implementing climate policy instruments is combating air pollution and securing energy supply. The main focus of climate policy in China is on reducing the energy intensity of its economy. Framework policies include China's National Climate Change Programme (outlines China's energy policy until 2010) and the 11th five year plan, which foresees an energy intensity target (-20% until 2010) and a pollution reduction target (-10% until 2010).

A number of policies and measures targeting **energy efficiency** and **demand side management** have been implemented in China. The framework is set by the energy intensity target of the 11th five year plan. Furthermore, there are instruments targeting different sectors such as the law on energy conservation (targeting energy intensive products) or programmes consisting of MEPS and energy labelling. For the industrial sector, the 1000 enterprises programme (voluntary agreements between the government and the energy intensive companies) is one major instrument. Other important instruments include energy conservation management systems or standards on industrial energy efficiency. For the residential and commercial sector, instruments such as guidelines and standards for energy conservation in buildings, the China energy label or public procurement of energy saving

products have been implemented. Energy consumption standards for cars have been set for targeting energy efficiency in the transportation sector. However, consumers of energy receive subsidies and often do not have to pay directly for their individual consumption (e.g. energy consumption for heating is charged according to square meters and not according to actual consumption). For energy efficiency on the supply side, there is a programme aiming at the upgrading of existing coal power plants.

The framework for promoting **renewable energy** is outlined by the renewable energy target (15% renewable energy in total energy supply by 2020). Another important climate policy instrument is the renewable energy law, which sets the financial and regulative framework for renewable electricity production. However, a pitfall of the law can be seen in the fact that selling green electricity to the grid is often connected with difficulties for the producers. Furthermore, there is a law targeting electricity production from wind, which puts trade restrictions on the import of wind power equipment from outside China.

A number of climate policies and measures targeting **other relevant sources of GHG emissions** are in place in China. These instruments include programmes targeting waste reduction and minimisation and a law on cleaner production aiming at GHG emissions from the waste sector. In the agricultural sector, there are standards on the rational use of fertilisers; requirements to built manure treatment facilities, a law protecting grasslands and a campaign promoting organic farming.

5.3.2 Suggestions for additional climate policy instruments and measures

The following section analyses the existing climate policies and measures for sectors with the highest GHG emissions reduction potential in China. Based on the sourcebook, we make suggestions for improving the existing mix of climate policy instruments and measures with additional policies and measures in order to exploit the full GHG emissions reduction potential. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the (1) power, (2) industrial and (3) transportation sector.

Climate policy measures and instruments for which the country needs financial assistance from Annex I countries are highlighted in *italics* in the following tables. Such instruments are mainly investment support or RD&D schemes. Section 2.3 presents more generally which category of policy instruments is considered appropriate for addressing the no-regret, co-benefits, and ambitious potential, respectively.

5.3.2.1 Power

This section outlines existing climate policies and measures in the power sector. Suggestions for improving the existing climate policy mix are given in order to exploit the GHG emissions reduction potential.

Table 11: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the power and heat sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy	• Overall renewable energy target	• Specific renewable energy targets for electricity, heat and cold supply
General economic and fiscal policy		• Ecological finance reform • *Domestic emissions trading scheme*

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
		• Gradual phase-out of energy subsidies backed by *financial and technical support for energy efficiency and RES*
Targeted economic and fiscal policy	• Renewable energy law • Projects and policies to improve the infrastructure for gas transmission	• *Financial support for the installation of RES technologies for cold and heat* • *Investment support for improvements in the conversion efficiency of fossil fuel power plants (linked to MEPS, see below)*
Regulations and voluntary agreements	• Wind power Construction Administration • Up scaling of power generation plants ("guimohua programme")	• Favourable regulations on grid access and power purchase agreements for RES and CHP plants • Create target for electric utilities and other energy companies to reduce annual energy consumption through DSM by 1% per year (compared to the baseline, i.e. compared to business-as-usual) • Accelerated building permission procedures for RES and CHP plants • Building codes with stringent energy efficiency levels and a mandatory share of RES for heat and cold • Dynamic minimum conversion efficiency standards, regularly updated • *"CCS-ready" obligation for new built power plants*
Information and know-how transfer		• Network of local actors • Demonstration and training on RES and CHP technologies targeting contractors, retails sales staff, architects and engineers
Research and technology transfer		• *RD&D schemes for accelerated development, technical improvement, and market introduction of RES and CHP technologies for electricity, heat and cold, efficient fossil fuel power plants and for analysis of CCS* • Public and co-operative procurement of RES and CHP technologies

A number of additional climate policies and measures are suggested for strengthening the existing mix in the power sector in order to exploit the ambitious potential of 1322 $MtCO_2eq$ in the year 2020.

The framework for realising further emission reduction potential in the power sector could be set by an ecological finance reform, a domestic emissions trading scheme, and a gradual

phase-out of fossil fuel subsidies backed by technical and financial support for RES technologies and energy (end-use) efficiency. This could contribute to levelling the playing field for RES and energy efficiency technologies.

The existing target for RES and the renewable energy law provide a good starting point for increasing the share of renewable electricity in China.

However, strengthening the existing RES programme with additional policy instruments such as favourable regulations on grid access and power purchase or accelerated building permission procedures for RES and CHP plants, information measures such as networks of local actors, or demonstration and training on RES technologies for relevant actors could improve the effectiveness of the existing policy instruments in this field. Furthermore, research in RES technologies and public and co-operative procurement schemes for such technologies could also be feasible policy instruments for increasing the share of RES.

RES technologies for heat and cold could contribute to reducing fossil fuel and electricity consumption for these fields of application. Based on a target for heat and cold from RES, additional policy instruments like direct investment support, building codes with stringent energy efficiency levels and a mandatory share of RES for heating and cooling, or training activities for relevant actors help to realise the emission reduction potential in this field.

Additional policies and measures for promoting efficient fossil fuel power plants could be targeted financial policies such as investment support for power plants with high conversion efficiency, regulation such as minimum standards for the conversion efficiency of new built plants, or a RD&D scheme.

Requiring new built fossil fuel power plants to be designed “capture ready” could bring CCS forward. This would also have indirect implications on energy prices and make energy from fossil fuels more expensive. Support and co-operation with Annex I countries will be particularly needed in this field.

GHG emissions stemming from the power production sector can also be indirectly targeted. Climate policy instruments and measures aiming at improving energy end-use efficiency and energy conservation in households, services, or industry have an effect on the country’s energy demand. Especially for the household sector, promising policy instruments such as building standards or the China energy label are already in place.

A more detailed discussion of additional policy instruments for improving energy end-use efficiency in the household and service sector can be found in the sourcebook.

5.3.2.2 Industry

Suggestions for improving the climate policy mix in the industrial sector are made in the following.

Table 12: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the industrial sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy	• Medium- and Long-term Plan for Energy Conservation	
General economic and fiscal policy	• Energy tax under discussion	• Gradual phase-out of energy subsidies backed by *financial and technical support for energy-efficiency and RES* • *Domestic emissions trading scheme*

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Targeted economic and fiscal policy	• Green credits	• *Financial support for the optimisation and installation of energy efficient technologies linked to energy audits and management systems*
Regulations and voluntary agreements	• Top 1000 Enterprises Programme • Energy efficiency standards	• Extension of the existing minimum energy efficiency standards (for energy using equipment as well as building permits for new industrial production facilities)
Information and know-how transfer	• Energy conservation management system • Environmental friendly company status	• Energy management systems • Energy audits
Research and technology transfer		• *RD&D scheme for energy efficient production technologies and methods*

For exploiting the ambitious potential of 770 $MtCO_2eq$ in 2020 in the industrial sector, the following additional climate policies and measures are suggested.

Cross-cutting issues are the gradual phase out of subsidies for energy from fossil fuels and the potential introduction of a domestic emissions trading scheme.

In China, some promising climate policy instruments targeting the industrial sector are already in place, such as plans for energy conservation, voluntary agreements like the top 1000 enterprises programme (agreement of the top 1000 energy-intensive companies to reduce their energy consumption), energy efficiency standards for equipment or information measures such as energy conservation management systems or the environmental friendly company status which also includes “green credits” (allowance of credits is connected to the environmental performance of a company).

A number of additional policy instruments can contribute in realising the emission reduction potential. Such policy instruments include direct financial support for energy efficiency measures (should be combined with energy audits and energy management systems), an extension of MEPS to other appliances and fields of application, energy management systems as well as RD&D on energy efficient production technologies and methods.

5.3.2.3 Transport

This section makes suggestions for improving the mix of climate policy instruments in the transportation sector.

Table 13: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the transportation sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy	• Policy framework for improving public transport	• Targets/quotas for biofuels
General economic and fiscal policy		• Tax exemptions for sustainable biofuels

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
		• Energy taxation on fuels • Phase-out of subsidies and tax exemptions for vehicle fuels • *Domestic emissions trading scheme*
Targeted economic and fiscal policy		• Road fees, congestion charges • CO_2-differentiated vehicle taxation • Depreciation rules favouring energy efficient vehicles
Regulations and voluntary agreements	• Energy consumption standards for cars	• Dynamic MEPS for vehicles components • Tighter speed limits • Spatial planning favouring non-motorised and public transport • Integrated transport planning
Information and know-how transfer		• Vehicle labelling • Driver training programmes • Promotion of public transport
Research and technology transfer		• *Research on sustainable transportation systems*

Currently, GHG emissions of the transportation sector in China are mainly targeted by energy consumption standards for cars. Moreover, there are efforts aiming at improving public transport or temporarily rationing of petrol due to shortages in supply.

The ambitious potential of about 395 $MtCO_2eq$ in 2020 in the transport sector can be realised by introducing a number of additional climate policies and measures.

Cross-cutting policy instruments are a phase out of subsidies and price setting by the government as well as energy taxation on fuels. Furthermore, a domestic emission trading scheme in the transport sector could also be a feasible instrument (connected to an average specific emission target).

Aiming at different fields of application (biofuels, individual motor car transport, air transport, public transport and freight transport), additional policy instruments could support the realisation of the ambitious potential. Policy instruments for targeting biofuels include a quota and tax exemptions. For targeting vehicles, a number of different policy instruments are available. Such policy instruments could be targeted economic and fiscal policies and measures such as road charges, CO_2-differentiated vehicle taxation or favourable depreciation rules for efficient vehicles. Standards could consist of dynamic MEPS for vehicle components, speed limits or integrated transport planning. Additional climate policy instruments of the category information and know how transfer could be vehicle labelling, driver training programmes or promotion of public transport. A shift from road-based to rail- or waterway-based transport can be induced by direct financial support such as tax reductions or subsidies.

5.4 Options for a stronger involvement of China in the international regime

China has consistently stressed the responsibility of Annex I countries for the climate problem. Regarding potential commitments by non-Annex I countries, however, China has recently softened its position and indicated the readiness to take on sectoral commitments in return for technology transfer. Technology transfer is crucial for China in order to ensure a steady energy supply for its rapid economic development. Therefore, China is keen on enhancing technology cooperation, as evidenced by its proposal to establish an international fund to purchase intellectual property rights.

5.4.1 Analysis

China has slightly more responsibility and capability than the average of the developing countries and has very large potential to mitigate emissions. Therefore, efforts have to be made to stabilise emissions with support by other countries:

- *Responsibility:* China's responsibility for climate change due to its emissions excluding LULUCF is at about non-Annex I average compared on a per capita basis. Its current per capita emissions are above non-Annex I average. In absolute terms considering all gases and sources, China is almost equal to the USA, the largest emitter in the World, and emissions are rapidly increasing.
- *Capability:* Per capita income is slightly above developing country average and the human development index score is medium. Income is very unequally distributed amongst the population.
- *Potential:* The mitigation potential is very high. According to the figures from Phase II of the project, the no-regret potential to reduce 2020 emissions below BAU levels amounts to 777 Mt, the co-benefit potential to 1,342 Mt and the ambitious mitigation potential to 2,930 $MtCO_2eq$. These would be equal to an 8%, 15% or 32% reduction compared to BAU levels respectively and a 36%, 27% or 1% increase compared to 2005 emissions levels.

Earlier analyses put China at medium/high level compared to other developing countries. Ott et al. (2004) classify China as "rapidly industrialising country" implying an absolute limitation target if funding and technology is provided by Annex I countries. Others find that China would have to take on further action in the early half of this century if emissions/capita or emissions/GDP are applied (Gupta 2003; Höhne et al. 2005).

China has some of the capacity necessary to quantify emissions and reductions in place. Comprehensive statistics do exist in China, which include mainly economic, financial, social and energy-related indicators but also data on environmental protection (NBS 2006). Energy consumption per unit of GDP is already estimated each month. In addition, some data are available on Chinese greenhouse gas emission in the National Communication (Government China 2004). Additional data are available, but have not officially been published.

5.4.2 Suggestions for a potential contribution

Given the amount of global emission reductions required to keep temperature change below 2°C and based on the above analysis, we suggest that it would be equitable and feasible for China to commit to no-lose sectoral targets for the power production, iron/steel and cement sectors, where relatively good data are available.

We propose two options for the level of stringency of the no-lose targets based on the assessment of what amount of reductions is necessary by 2020 to bring global emissions on a 2°C trajectory (see section 11):

The target could either be set at a stringent level correlated to the ambitious mitigation potential but implementation be made contingent on the provision of financial and technical support from Annex I countries. The total target for the covered sectors would in this case amount to annual emissions of about 2,754 $MtCO_2$ in 2020, about 39% below the BAU level.

Alternatively, the targets could be set at a lower level, for instance at the level indicated by the co-benefit mitigation potential. In this case the total target for all covered sectors would amount to 3,678 $MtCO_2$, about 19% below BAU levels. China could then nevertheless implement ambitious policies and measures to overachieve the target and sell the resulting surplus on the carbon market. This alternative would require less direct financial and non-financial support from Annex I countries but more support through the carbon market and hence more stringent emission reduction targets for Annex I countries of 45% compared to 1990 as opposed to -30% as assumed for the option above.

If targets are not politically feasible, a second-best option could be to implement sectoral or policy-based CDM projects in the power production, iron/steel and cement sectors. Sectoral CDM would probably be politically more acceptable for developing countries. However, the technical implementation of sectoral CDM and sectoral no-lose targets would probably be very similar and no-lose targets have a twofold advantage: first, there would be no need to assess the additionality of emission reductions, and secondly, no-lose targets open the opportunity to achieve net reductions, namely the difference between BAU and the target. Under the CDM, everything below BAU would be credited and lead to higher emissions in Annex I countries.

In addition, China could commit to implementing a set of SD PAMs for the sectors not covered by the sectoral targets or sectoral CDM. China would quantify the effect of the package of SD PAMs in advance. The total package of sectoral no-lose targets and SD PAMs should aim at mobilising the full ambitious mitigation potential. However, the implementation of these policies and measures would be conditional on additional international funding to cover the higher costs compared to business-as-usual development.

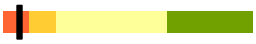
Due to missing capacity in these sectors, the emission reductions achieved through PAMs could probably only be roughly estimated. Therefore, no direct link is assumed between policies and the international carbon markets. Practical measures related to investment needs could be linked to international funding, e.g. through the GEF or other multilateral funds, but also to private sector CDM projects.

6. India

6.1 India in comparison to other countries

Table 14 provides a range of energy and emission indicators. The right column shows how India performs compared to other countries. In absolute terms India is one of the biggest emitters. In 2002 it contributed about 4.5% to global CO_2 emissions (WRI 2006). Nevertheless, per capita emissions as well as cumulative emissions are very low. The emission intensity in electricity generation is quite high due to inefficient production based on coal and oil. India's per capita GDP ranges far behind the world average and even behind non-Annex I average.

Table 14. Energy and emission indicators for India

	Indicator	Value	Meter
Responsibility	Cumulative emissions 1900 to 2004 per capita per year	0.6 $tCO_2eq/cap./y$	
Capability	GDP per capita (2004)	3,100 US $ PPP 2000/cap.	
	Human development index 2002	0.595 (medium)	
Potential	Past emission trend from 1990 to 2004	+50%	
	Emissions per capita (2003)	1.5 $tCO_2eq/cap.$	
	Emissions per GDP (2004)	490 tCO_2eq/MUS (2000)$	
	Emissions per kWh electricity (2003)	912 gCO_2/kWh	
	Energy efficiency in industry	Low	
	Emissions in transport per capita (2003)	0.09 $tCO_2eq/cap.$	
	Emissions in households and services per capita (2003)	0.15 $tCO_2eq/cap.$	
	Emissions in agriculture per capita (2000)	0.37 $tCO_2eq/cap.$	
	Emissions in waste per capita (2000)	0.11 $tCO_2eq/cap.$	
	Emissions in land use change and forestry per capita (2000)	-0.04 $tCO_2eq/cap.$	

For detailed explanation of the meters and data sources see Appendix A.

Figure 10 shows the shares of India's energy sources up to the year 2003. Overall, slightly more than half of India's primary energy is supplied with coal or oil (56% in 2003). Coal is assumed to remain important for India's energy supply in the future. Partly, it is mined domestically (MoEF 2004). The rest of India's primary energy consumption is currently supplied mainly with biomass (38%). A large share of the biomass is used in small domestic appliances (e.g. for cooking). Solar and hydropower are becoming more important.

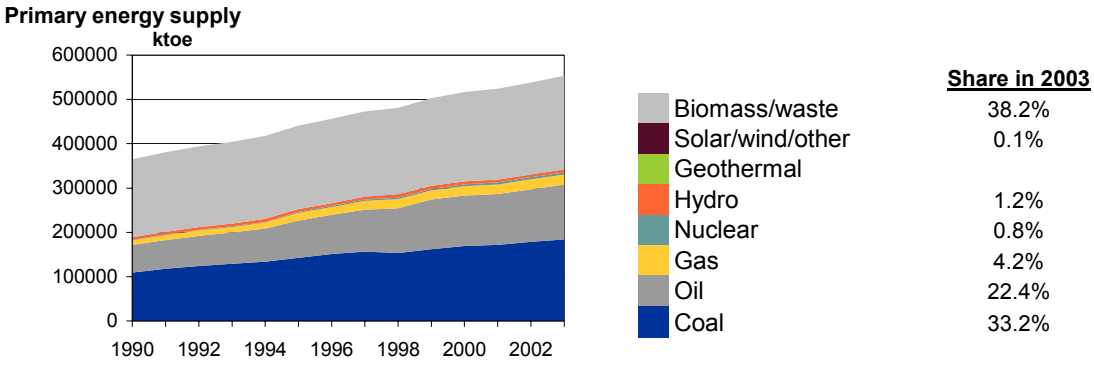


Figure 10. India's primary energy supply between 1990 and 2003 (IEA 2005b)

Overall, India is in a medium development state. GDP/cap and HDI are below development countries' average and close to the average of low income countries (UNDP 2004). Its emissions are strongly increasing. The emissions per unit of GDP are comparatively high, the emissions per capita are low, also because still about half of the population is without reliable electricity access (World Bank 2006). Although India has a high share of carbon free energy sources, low conversion efficiency and an intensive use of coal lead to comparatively high specific emissions in energy production. However, India's energy and carbon intensities declined after 1995 (Chandler et al. 2002). Similar to Brazil, the share of biomass for residential use is high but decreasing.

6.2 Reference emissions and mitigation potential

Figure 11 below shows India's greenhouse gas emissions under the business-as-usual scenario and all three reduction scenarios. The scenario parameters are based on national studies as far as possible. Major sources for future data in India are TERI 2006; USEPA 2006b and trend extrapolation of national and IEA statistics (IEA 2005a).

As illustrated in Figure 11, the reduction potential for India is 12% (no-regret), 22% (co-benefit) and 38% (mitigation potential) below BAU. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious mitigation potential) are the (1) power, (2) industrial and (3) transport sector. In the power sector, there exists an ambitious potential of 647 $MtCO_2eq$. For the industrial sector, the ambitious potential is estimated at 245 $MtCO_2eq$. The ambitious potential in the transport sector is estimated at 231 $MtCO_2eq$. The total ambitious mitigation potential in India is estimated at 1,336 $MtCO_2eq$. A detailed overview of the potential per sector and scenario can be found in Appendix B.

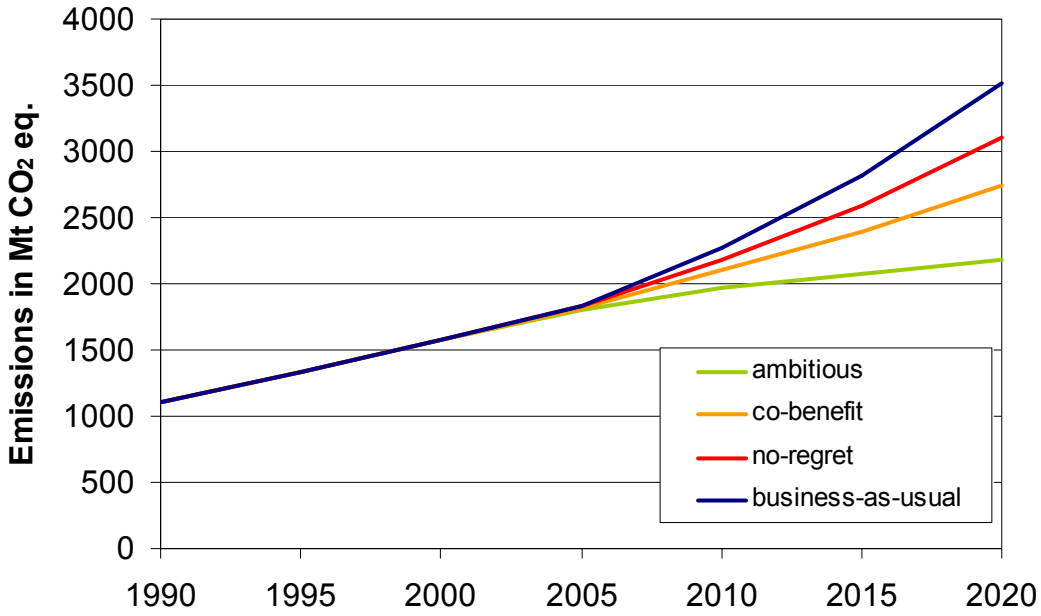


Figure 11. Scenarios for greenhouse gas emissions in India between 1990 and 2020.

Figure 12 shows India's total reduction potential on the sector level under the ambitious potential scenario compared to the business-as-usual scenario and the remaining emissions according to sectors.

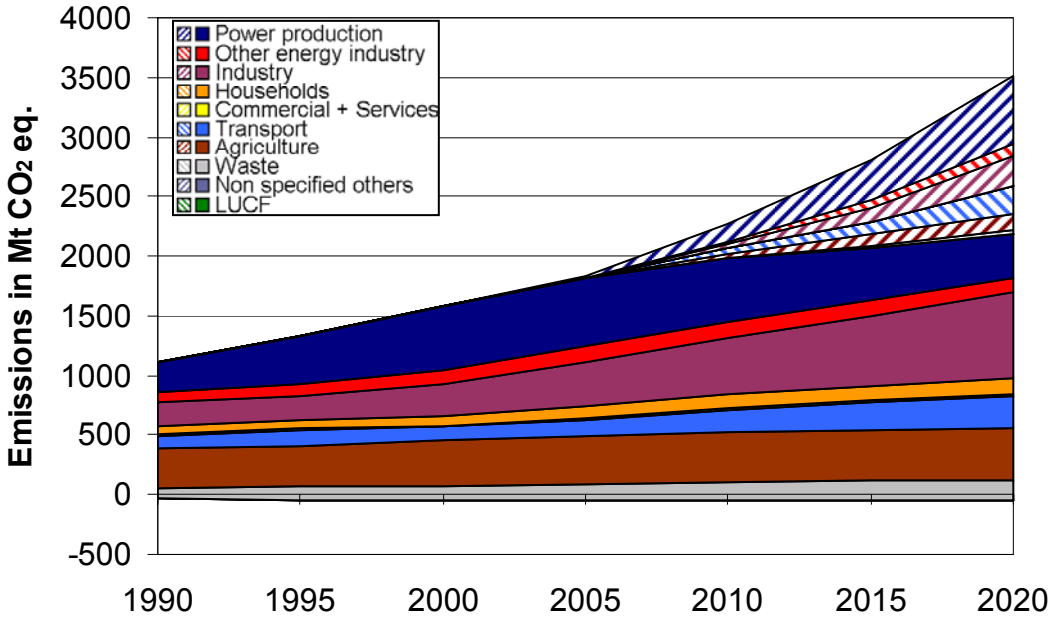


Figure 12. India's emissions under the business-as-usual and the ambitious potential scenario on a sector basis between 1990 and 2020. Striped areas show the sectoral emission reduction potential under the ambitious potential scenario compared to the business-as-usual scenario. (Emissions from LUCF kept constant after 2003 due to data availability)

Most important findings for India:

- India's emissions are projected to increase constantly by about 4.2% per year between 2000 and 2020 under the business-as-usual scenario.
- In 2000, most emissions resulted from power production (36%), agriculture (22%) and industry (16%). Under the business-as-usual scenario, this trend is projected to be

more or less similar, although the importance of power production will decrease slightly, while the share of industry will increase.

- In the power sector, a major reduction opportunity would be to move away from coal to renewable energy sources. We also assumed 1% of electricity generation with CCS technology by 2020 as ambitious potential. Efficiency of current power plants can be increased substantially. In addition, the decrease of distribution losses is a major reduction option.
- Major reductions can be achieved in the industry sector by increasing efficiency and moving to renewable energy sources. (It should be noted that our estimates for India's industry are lower compared to other estimates, c.f. TERI 2006).
- In the transport sector reduction options are considerable. A shift to more natural gas and biomass is one emission reduction option. Another element is to increase efficiency, especially in aviation and road transport, and a shift to increase the absolute amount of rail transport.
- Under the no-regret potential scenario reductions of 12% below BAU (69% above 2005 emissions) might be possible. Under the co-benefit potential scenario reductions of 22% below BAU (49% above 2005 emissions) could be feasible. Under the ambitious potential scenario, overall emission reductions of 38% below BAU (19% above 2005 emissions) might be possible.

6.3 Existing and possible further national climate policies

6.3.1 Overview of existing climate policies and measures

The following section provides a general overview of India's climate policy instruments and measures. For this purpose, it distinguishes between policies and measures targeting energy efficiency improvements, renewable energy and other relevant sources of GHG emissions. If not stated otherwise, sources for this section include IREDA (2006), MNES (2005), MoEF (1992), Shukla (2003) and Chandler et al. (2002).

Indian energy policy can be characterised by a strong focus on environmental (energy) audits, energy management and technical measures. The Bureau of Energy Efficiency (BEE) plays an important role in bringing energy efficiency forward. Furthermore, there is a focus on RES such as wind and biomass. Big challenges for India's energy policy are the transmission and distribution losses as well as the outdated infrastructure of the energy system. The framework for climate policy is set by the 11th five-year plan, which sets e.g. targets for energy efficiency improvements and the energy conservation act, which foresees different measures such as MEPS for electric equipment, energy audits for different target groups, awareness campaigns or financial support for energy saving measures. Moreover, there is a policy statement for abatement of pollution that sets standards for different types of emissions, foresees fiscal incentives for the installation of pollution abatement technologies and environmental audits.

A number of policies and measures targeting **energy efficiency** and **demand side management** have been introduced in recent years. They include MEPS for electronic equipment (refrigerator, tubular fluorescent lamps, room air conditioners, direct cool refrigerator, distribution transformers), energy labelling, direct investment support for energy efficiency measures, energy audits, energy management systems, mandatory reporting requirements on energy efficiency improvements for companies, training of different actors, awareness campaigns or standardisation of energy efficient water pumps. Moreover, there are measures targeting distribution losses in the electricity grid.

Renewable energy is promoted through a renewable electricity target (10% of additional installed capacity until 2012 shall come from renewables). The renewable energy programme

promotes RES technologies by providing subsidies. Furthermore, there are programmes aiming at a more efficient use of biomass.

A number of climate policies and measures targeting **other relevant sources of GHG emissions** have been implemented in India. They include general improvements on the supply side of energy such as investments in the infrastructure for natural gas, clean coal initiatives (restructuring of the coal sector), emission limiting performance standards for cars, conversion of public vehicles from petrol to gas, the promotion of the efficient use of fertilisers or measures targeting livestock.

6.3.2 Suggestions for additional climate policy instruments and measures

This section analyses the existing climate policies and measures for sectors with the highest GHG emissions reduction potential in India. Using the sourcebook as a starting point, this section makes suggestions for improving the existing mix of climate policy instruments and measures with additional policies and measures in order to exploit the full GHG emissions reduction potential. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the (1) power, (2) industrial and (3) transport sector.

Climate policy measures and instruments for which the country needs financial assistance from Annex I countries are highlighted in *italics* in the following tables. Such instruments are mainly investment support or RD&D schemes. Section 2.3 presents more generally which category of policy instruments is considered appropriate for addressing the no-regret, co-benefits, and ambitious potential, respectively.

6.3.2.1 Power

This section outlines existing climate policies and measures in the power sector. Suggestions for improving the existing climate policy mix are made in order to exploit the GHG emission reduction potential.

Table 15: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the power and heat sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy	• Renewable electricity target (10% of additional capacity installed until 2012 from RES)	• Renewable energy targets heat and cold supply
General economic and fiscal policy		• Gradual phase-out of energy subsidies backed by *financial and technical support for energy-efficiency and RES Domestic emission trading scheme* • *Ecological Finance Reform*
Targeted economic and fiscal policy	• Renewable energy programme • New and renewable energy policy statement • Improvement of infrastructure for natural gas	• Feed-in tariffs or electricity quota (green certificates) for RES and CHP • *Financial support for the installation of RES technologies for cold and heat* • *Investment support for*

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
		improvements in the conversion efficiency of fossil fuel power plants (linked to MEPS, see below)
Regulations and voluntary agreements	• Triple biomass conversion efficiency	• Favourable regulations on grid access and power purchase agreements for RES and CHP plants • Create target for energy savings of 1% per year (compared against the baseline) • Accelerated building permission procedures for RES and CHP plants • Building codes with a mandatory share of RES for heat and cold • Dynamic minimum conversion efficiency standards, regularly updated • *"CCS-ready" obligation for new built power plants*
Information and know-how transfer		• Network of local actors • Demonstration and training on RES technologies targeting contractors, retails sales staff, architects and engineers
Research and technology transfer	• Technology development in the energy sector	• *RD&D schemes for accelerated development, technical improvement and market introduction of RES technologies for electricity, heat and cold, efficient fossil fuel power plants and for analysis of CCS* • Public and co-operative procurement of RES technologies

In order to exploit the ambitious potential of 647 $MtCO_2eq$ in the power sector, a number of additional climate policies and measures are suggested for strengthening the existing mix.

A first and necessary step is the gradual phase out of subsidies for power from fossil fuels and coal. This would contribute to levelling the playing field for RES technologies and make investments in energy efficiency more profitable. Unused subsidies for coal and other fossil fuels could be used for financing energy-efficiency and RES. In turn, improved energy-efficiency would contribute to lowering the energy costs for consumers and outweigh the higher costs of energy due to the phase-out of subsidies. General economic and fiscal policies such as an ecological finance reform or an emissions trading scheme could also contribute to achieving the GHG emissions reduction potential in the power sector.

The existing policy mix for RES technologies or CHP for electricity could be supplemented by feed-in tariffs or green certificates, by introducing favourable regulations on grid access and power purchase agreements, accelerated building permission procedures, strengthening information measures by training for relevant actors as well as promoting research and technology transfer through RD&D schemes and co-operative procurement.

Today, there are no specific policy instruments targeting RES technologies for heat and cold. These technologies could be promoted through targeted financial support for the installation of RES technologies for cold and heat, standards like building codes with a mandatory share of RES for heat and cold, information such as networks and training for relevant actors as well as research and technology transfer measures like RD&D schemes as well as public and co-operative procurement.

Additional policies and measures for promoting efficient fossil fuel power plants could be targeted financial policies such as investment support for power plants with high conversion efficiency, regulation such as minimum standards for the conversion efficiency of new built plants or a RD&D scheme.

Requiring new built fossil fuel power plants to be designed "capture ready" could bring CCS forward. This would also have indirect implications on energy prices and make energy from fossil fuels more expensive. Support and co-operation with Annex I countries will be needed in this field.

GHG emissions stemming from the power production sector can also be indirectly targeted. Climate policy instruments and measures aiming at improving energy end-use efficiency and energy conservation in households or industry have an effect on the country's energy demand. Especially in the household sector, there are already a number of promising energy efficiency policy instruments in place. They include a range of activities on the demand side such as labelling, MEPS or information campaigns. A more detailed discussion of additional policy instruments for improving energy end-use efficiency in the household and service sector can be found in the sourcebook.

6.3.2.2 Industry

This section gives suggestions for improving the climate policy mix in the industrial sector.

Table 16: Overview over existing climate policies and measures and suggestions for improving the existing policy mix in the industrial sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy		
General economic and fiscal policy		• Gradual phase-out of energy subsidies backed by *financial and technical support for energy-efficiency and RES* • *Domestic emissions trading scheme*
Targeted economic and fiscal policy		• *Financial support for the optimisation and installation of energy efficient technologies linked to energy audits and management systems*
Regulations and voluntary agreements	• Clean coal initiatives (restructuring of the coal sector) • Mandatory reporting on energy efficiency improvements	• Extension of the energy efficiency accord • Minimum energy efficiency standards (for energy using equipment as well as building permits for new industrial production facilities)
Information and know-how transfer	• Energy audits • Energy management training by	• Information and training of relevant actors

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
	the Bureau on Energy Efficiency	
Research and technology transfer		• *RD&D scheme for energy efficient production technologies and methods*

The existing policy mix in the industrial sector in India has a focus on energy audits and energy management activities.

For exploiting the ambitious potential of 245 $MtCO_2eq$ in the industrial sector, the following paragraph suggests additional climate policies and measures.

Crosscutting issues are the gradual phase out of subsidies for coal and energy from fossil fuels as well as the potential introduction of a domestic emissions trading scheme.

The recent mix of policy instruments could be supplemented by direct financial support for introducing energy efficient technologies and production methods. Such an instrument should also be linked to other policy instruments such as the participation in energy audits or the introduction of energy management systems. Furthermore, additional policy instruments include information and training of relevant actors or a RD&D scheme for energy efficient production technologies and methods.

6.3.2.3 Transport

This section gives suggestions for improving the existing mix of climate policy instruments in the transportation sector.

Table 17: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the transportation sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy		• Targets/quotas for sustainable biofuels
General economic and fiscal policy		• Tax exemptions for sustainable biofuels • Energy taxation on fuels • Phase-out of subsidies and tax exemptions for vehicle fuels • *Domestic emission trading scheme*
Targeted economic and fiscal policy		• Road fees, congestion charges • CO_2 differentiated vehicle taxation • Depreciation rules favouring energy efficient vehicles • Financial support for switching from road-based to rail- or waterway based transportation
Regulations and voluntary agreements	• Emission limiting performance standards • Conversion of public vehicles from petrol to gas	• Average specific emissions target for new vehicles regarding GHG emissions • Dynamic MEPS for vehicles components

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
		• Tighter speed limits • Spatial planning favouring non-motorised and public transport • Integrated transport planning
Information and know-how transfer		• Vehicle labelling • Driver training programmes • Promotion of public transport
Research and technology transfer		• *Research on sustainable transportation systems*

The existing mix of climate policy instruments and measures in the Indian transportation sector consists mainly of standards (e.g. emission standards).

The ambitious potential of about 231 $MtCO_2eq$ in 2020 in the transport sector can be realised by introducing a number of additional climate policies and measures.

Crosscutting policy instruments are a phase out of subsidies and energy taxation on fuels as well as a domestic emissions trading scheme in the transport sector (connected to an average specific emission target).

Aiming at different fields of application (biofuels, individual motor car transport, air transport, public transport and freight transport), additional policy instruments could support the realisation of the ambitious potential. Policy instruments for targeting biofuels include a quota and tax exemptions. For targeting vehicles, several policy instruments are available. Such policy instruments could be targeted economic and fiscal policies and measures like for example road charges, a CO_2-differentiated vehicle taxation or favourable depreciation rules for efficient vehicles. Standards could consist of average specific emission targets for new vehicles, dynamic MEPS for vehicle components, speed limits or integrated transport planning. Additional climate policy instruments of the category information and know how transfer could be vehicle labelling, driver training programmes or promotion of public transport and modal split. A shift from road-based to rail- or waterway-based transport can be induced by direct financial support such as tax reductions or subsidies.

6.4 Options for a stronger involvement of India in the international regime

India is the least advanced among the six countries analysed in this study and is not comparable to the others in terms of either GDP or emissions per capita. This is why it has for many years stressed the developing countries' need to increase their energy use and put economic development upfront. For some years India has been advocating the principle of "Contraction and Convergence" with the aim of reaching equal per capita emissions globally in 2050. It has put less emphasis on technology cooperation than China.

6.4.1 Analysis

India has less responsibility and capability compared to the average of developing countries but has a very large potential to mitigate emissions:

- *Responsibility:* India's responsibility for climate change due to its emissions excluding LULUCF is below non-Annex I average compared on a per capita basis. Its current per capita emissions are well below non-Annex I average. In absolute terms, India's emissions are substantial and increasing rapidly.

- *Capability:* Per capita income and the human development index score are below non-Annex I average. Income is very unequally distributed amongst the population. Policy implementation may be difficult.
- *Potential:* The mitigation potential is high due to low efficiency and strongly increasing emissions in absolute and relative terms. According to the figures from Phase II of the project, the no-regret potential to reduce 2020 emissions below BAU levels amounts to 416 Mt, the co-benefit potential to 775 Mt and the ambitious mitigation potential to 1,336 $MtCO_2eq$. These would be equal to a 12%, 22% or 38% reduction compared to BAU levels respectively and a 69%, 49% or 19% increase compared to 2005 emissions levels.

Earlier analyses put India at a low level compared to other developing countries. Ott et al. (2004) classify India as "other developing country" implying no emission targets, but support for emission reductions through policies and measures. Others find that India would first have to be supported and would only have to take on further action in the later half of this century if emissions/capita or emissions/GDP are applied (Gupta 2003; Höhne et al. 2005).

India disposes of some capacity to quantify emissions and reductions. A wide range of statistics does exist. Economic, financial, social and energy indicators are usually included (MOSPI 2006, MPNG 2006). The reliability is difficult to estimate, though. The Initial National Communication gives detailed data for all gases and sectors for 1990 and 1994 (MoEF 2004). Apart from that no emissions data have been officially published yet.

Generally, the institutional infrastructure in India is comparatively weak. The implementation and monitoring of measures appears to be very difficult. This would have to be improved in order to be able to implement climate change policies successfully and to attract foreign capital. India will for the foreseeable future probably not be able to quantify emissions and reductions on a large scale.

6.4.2 Suggestions for a potential contribution

Based on the above analysis, we suggest that it would be feasible and equitable for India to implement a set of SD PAMs. India would quantify the effect of the package of SD PAMs in advance. The total package should aim at mobilising the full ambitious mitigation potential. However, the implementation of these policies and measures would be conditional on additional international funding to cover the higher costs compared to business-as-usual development.

Due to the lack of technical capacity, the emission reductions achieved through policies implemented in India can probably only be roughly estimated. Therefore, no direct link is assumed between policies and the international carbon markets. Practical measures related to investment needs (e.g. extension of supply grids and renewable or cleaner technologies) could be linked to international funding, e.g. through the GEF or other international funds, but also to private sector CDM projects. However, given the need for a 30% domestic reduction by Annex I countries (see section 11), a large-scale utilisation of the CDM would require correspondingly more stringent commitments from Annex I countries to keep global emissions on a 2° trajectory.

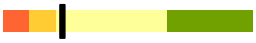
7. Mexico

7.1 Mexico in comparison to other countries

Table 18 provides different energy and emission indicators. The right column shows how Mexico performs compared to other countries. On the national level Mexico is the largest emitter in Latin America.

The basic data illustrate that Mexico ranks very high among developing countries with respect to its state of development. Its GDP per capita is above that of most developing countries and is at above world average. Mexico's emissions per capita are around world average and increasing. The energy system is dependant on oil and gas and emissions mostly occur in the electricity and transport sectors where emissions are well above world average. Emissions from land-use change are also substantial. At the same time a high reduction potential at comparatively low costs exists.

Table 18. Energy and emission indicators for Mexico

	Indicator	Value	Meter
Responsibility	Cumulative emissions 1900 to 2004 per capita per year	1.4 $tCO_2eq/cap./y$	
Capability	GDP per capita (2004)	9,500 US $ PPP 2000/cap.	
	Human development index 2002	0.802 (high)	
Potential	Past emission trend from 1990 to 2004	+30%	
	Emissions per capita (2003)	4.9 $tCO_2eq/cap.$	
	Emissions per GDP (2004)	521 tCO_2eq/MUS (2000)$	
	Emissions per kWh electricity (2003)	576 gCO_2/kWh	
	Energy efficiency in industry	Low	
	Emissions in transport per capita (2003)	1.27 $tCO_2eq/cap.$	
	Emissions in households and services per capita (2003)	0.33 $tCO_2eq/cap.$	
	Emissions in agriculture per capita (2000)	0.41 $tCO_2eq/cap.$	
	Emissions in waste per capita (2000)	0.15 $tCO_2eq/cap.$	
	Emissions in land use change and forestry per capita (1990)	1.37 $tCO_2eq/cap.$	

For detailed explanation of the meters and data sources see Appendix A.

Figure 13 shows the shares of Mexico's energy sources up to the year 2003. Oil is by far the most important energy source. Mexico is an oil processing and exporting country. It also has own natural gas reserves. About 57% of the domestic primary energy supply were provided by oil in 2003. Gas supplied about 26%. Biomass (5%), other renewable sources (3%), coal (5%) and nuclear energy (2%) play only a minor role.

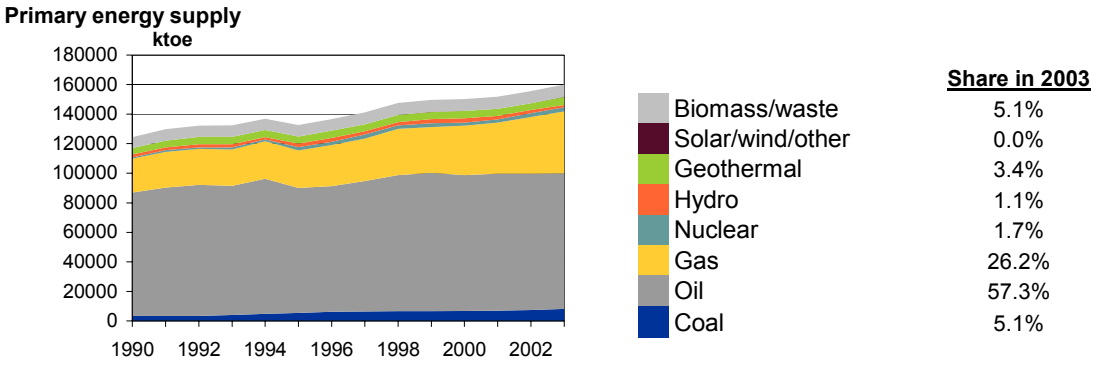


Figure 13. Mexico's primary energy supply between 1990 and 2003 (IEA 2005b)

Overall, Mexico is classified as a country with a high human development index. Its GDP lies well above world average and middle income countries average. After the establishment of the UNFCCC it became member of the OECD and is therefore, similar to South Korea, non-Annex I but OECD country. The dominance of oil in Mexico's energy mix leads to comparatively high emissions. Mexico's per capita emissions in 2002 were considerable and even slightly higher than those of some low-emission Annex I countries, namely Lithuania, Turkey and Latvia. Over the last years Mexico's emissions have been increasing.

7.2 Reference emissions and mitigation potential

Figure 14 below shows Mexico's greenhouse gas emissions under the business-as-usual scenario and all three reduction scenarios as calculated in this project. The scenario parameters are based on national studies as far as possible. Major sources for future data in Mexico are USEPA 2006b and trend extrapolation of national statistics.

As illustrated in Figure 14, the reduction potential for Mexico is 8% (no-regret), 16% (co-benefit) and 39% (ambitious potential) below BAU. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the (1) power, (2) transport and (3) industrial sector. In the power sector, there exists an ambitious potential of 186 $MtCO_2eq$. For the transport sector, the ambitious potential is estimated at 111 $MtCO_2eq$. The ambitious potential in the industrial sector is estimated at 41 $MtCO_2eq$. The total ambitious mitigation potential in Mexico is estimated at 417 $MtCO_2eq$. A detailed overview of the potential per sector and scenario can be found in Appendix B.

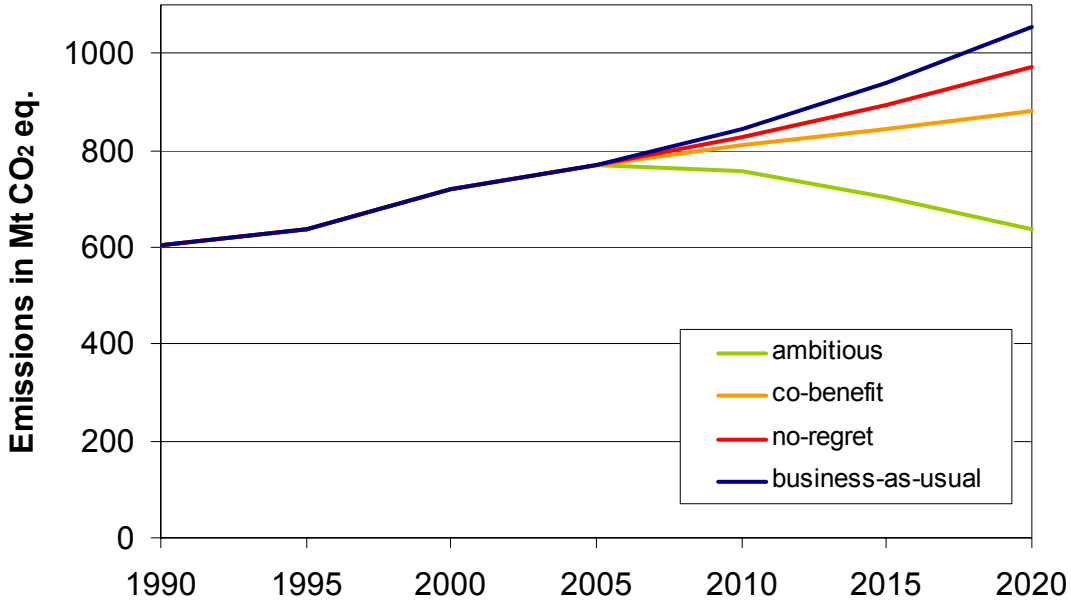


Figure 14. Scenarios for greenhouse gas emissions in Mexico between 1990 and 2020.

Figure 15 shows Mexico's total reduction potential on the sector level under the ambitious potential scenario compared to the business-as-usual scenario and the remaining emissions according to sectors.

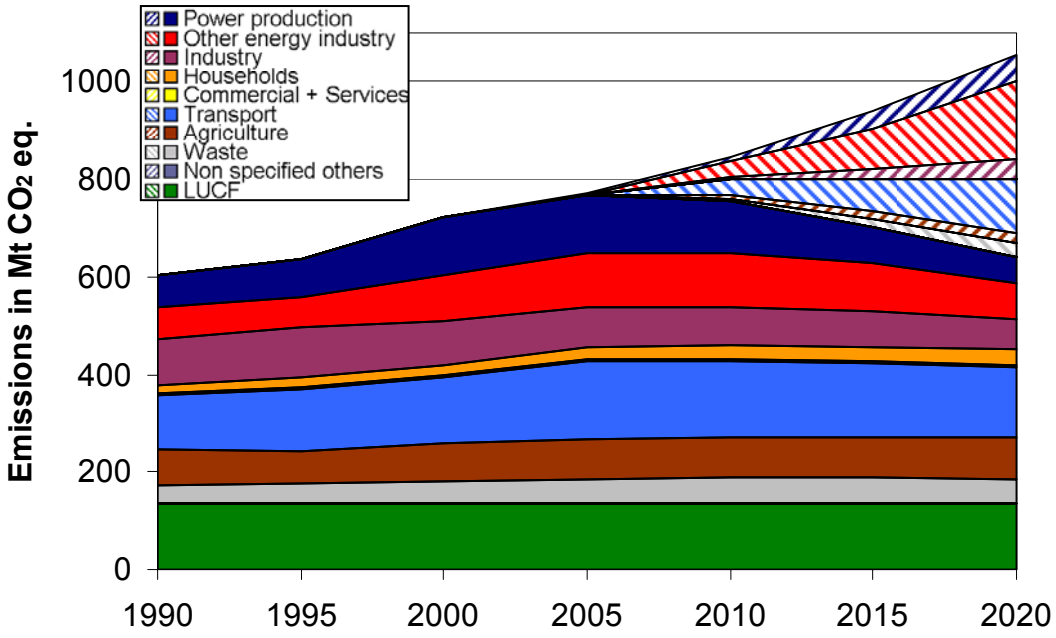


Figure 15. Mexico's emissions under the business-as-usual and the ambitious potential scenario on a sector basis between 1990 and 2020. Striped areas show the sectoral emission reduction potential under the ambitious potential scenario compared to the business-as-usual scenario. (Emissions from LUCF kept constant after 2003 due to data availability)

Most important findings for Mexico:

- Mexico's emissions are projected to increase slightly by about 1.9% per year between 2000 and 2020 under the business-as-usual scenario.

- In 2000 most emissions result from power production (26%), transport (19%) and industry (13%). Under the business-as-usual scenario, this trend is projected to be more or less similar although the importance of transport and power production will increase slightly, while the shares of industry and agriculture will increase slightly.
- Mexico has already a high share of gas in electricity production. Movement to renewable energy sources would be a significant reduction option as well as reduction of distribution losses.
- Major reductions can be achieved in the industry sector by increasing efficiency and moving to renewable energy sources.
- Some limited reduction potential is available in the agriculture and waste sectors.
- In the transport sector reduction options are considerable. A shift to more biomass use is one emission reduction option. Another element is to increase efficiency, especially in aviation and road transport, and a shift to increase the absolute amount of rail transport.
- Under the no-regret potential scenario reductions of 8% below BAU (26% above 2005 emissions) might be possible. Under the co-benefit potential scenario reductions of 16% below BAU (14% above 2005 emissions) could be feasible. Under the ambitious potential scenario overall emission reductions of 39% below BAU (17% below 2005 emissions) might be possible.

7.3 Existing and possible further national climate policies

7.3.1 Overview of existing climate policies and measures

The following section gives a general overview of Mexico's climate policy instruments and measures. For this purpose, it distinguishes between policies and measures targeting energy efficiency improvements, renewable energy and other relevant sources of GHG emissions. If not stated otherwise, sources for this section include a review of a country expert (Odón de Buen), Government of Mexico (1997; 2001), Inclan-Gallardo (2004), SEMARNAT (2001), and Sussman et al. (2006).

Energy suppliers in Mexico are obliged by the constitution to use the least expensive energy option at all times. No feed-in tariffs for RES exist which makes investments in these technologies difficult. Furthermore, the Mexican energy industry is subsidised which keeps energy prices for residential and agricultural consumers low. At this point, electricity and gasoline are subsidised to some extent. In the case of electricity, the subsidy applies mainly to the residential and agricultural (water pumping) sectors. The estimated monetary value of these subsidies is close to 5,000 Million US$. In the case of gasoline, as the price is controlled and close to 40% of the gasoline is imported from the US, as long as the gasoline price in the US remains higher than Mexico's, gasoline will be subsidised to an extent. If gasoline prices go down in the US and below prices in Mexico, chances are that the price will remain higher (as has happened in the past during other shifts in the price differential).

Regarding the possible introduction of energy taxes, it has to be noted that Mexico is a country with very low tax collection and uses part of its oil revenues to finance 30% of its government expenses. Up to now high oil prices have meant more income than predicted. However, the decline of its largest oil field (Cantarell, the second largest in the world) is reducing the exported volume by about 10% per year. It is also an economy that tries to keep inflation at bay and one of the strategies is to control energy prices (with electricity and gasoline under government control). Attempts to implement a complete and effective fiscal reform have failed as a result of politically weak governments and politicians not wanting to be blamed for affecting people's livelihoods. One clear example of this is the proposal of a fiscal reform that includes a 5% increase in gasoline prices (in many ways to help pay for a two digit prices differential that is paid to import 40% of the gasoline used in Mexico).

However, this reform had to be frozen (postponed for at least four months) as a price escalation was affecting macroeconomic stability. Due to this reasons, there will be difficulties in introducing energy taxes in Mexico.

However, the Mexican government has a remarkable energy efficiency standards programme and has started to improve the conditions for RES by giving economic incentives. Nevertheless, the enforcement and follow-up of climate policy instruments and long term goals is often poor in Mexico (according to the view of a country expert). As a result, this leads to a reduced effectiveness of the climate policy instruments in place.

A number of policies and measures targeting **energy efficiency** and **demand side management** have been introduced in recent years. For the industrial sector there is the SIRG programme for industrial regulation and management, which sets standards for industrial appliances such as motors or commercial refrigerators. The Energy Efficiency Industry Partnership (EEIP) aims at reducing energy consumption in this sector by training activities. For the petroleum industry, there is a programme aiming at reducing energy consumption by promoting best practice examples. For the residential and commercial sector instruments such as building codes, electric appliance standards or programmes aiming at energy efficient lighting and air conditioning in commercial buildings are in place.

Renewable energy is promoted through a renewable energy target, which aims at a share of 8% of renewable electricity generation in 2012. Mexico is on track to meeting this target due to a number of large-scale hydropower projects that will be realised in the coming years. A number of financial incentives such as depreciation rules for RES technologies, a green fund, financial support for solar water heating or accelerated depreciation rules can be found.

Only a small number of climate policies and measures targeting **other relevant sources of GHG emissions** have been implemented in Mexico. They include measures aiming at reducing the leakage of natural gas, promotion of public transport, and programmes to use waste for energy generation or aiming at reducing deforestation.

7.3.2 Suggestions for additional climate policy instruments and measures

The following section analyses the existing climate policies and measures for sectors with the highest GHG emissions reduction potential in Mexico. Using the sourcebook as a starting point, this section gives suggestions for improving the existing mix of climate policy instruments and measures with additional policies and measures in order to exploit the full reduction GHG emissions reduction potential. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the (1) power, (2) transport and (3) industrial sector.

Climate policy measures and instruments for which the country needs financial assistance from Annex I countries are highlighted in *italics* in the following tables. Such instruments are mainly investment support or RD&D schemes. Section 2.3 presents more generally which category of policy instruments is considered appropriate for addressing the no-regret, co-benefits, and ambitious potential, respectively.

7.3.2.1 Power

This section outlines existing climate policies and measures in the power sector. Suggestions for improving the existing climate policy mix are made in order to exploit the GHG emissions reduction potential.

Table 19: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the power and heat sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy	• 8% renewable energy target	• Renewable energy targets for electricity, heat and cold supply
General economic and fiscal policy		• Gradual phase-out of energy subsidies backed by *financial and technical support for energy-efficiency and RES* • *Domestic emission trading scheme* • *Ecological Finance Reform*
Targeted economic and fiscal policy	• Accelerated depreciation rules for renewable technologies • Green Fund • National programme for rural energy • Standard contract for renewable energy self-supply power projects • Programme for energy efficiency in buildings and solar water heating (CONAE)	• Feed-in tariffs or electricity quota (green certificates) for RES and CHP • *Financial support for the installation of RES technologies for cold and heat* • *Investment support for improvements in the conversion efficiency of fossil fuel power plants (linked to MEPS, see below)*
Regulations and voluntary agreements	• National Plan of Environment and Resources	• Favourable regulations on grid access and power purchase agreements for RES and CHP plants • Create target for energy savings from DSM of 1% per year (compared against the baseline) • Accelerated building permission procedures for RES and CHP plants • Building codes with a mandatory share of RES for heat and cold • Dynamic minimum conversion efficiency standards, regularly updated • *"CCS-ready" obligation for new built power plants*
Information and know-how transfer		• Network of local actors • Demonstration and training on RES technologies targeting contractors, retails sales staff, architects and engineers
Research and technology transfer		• *RD&D schemes for accelerated development, technical improvement and market introduction of RES technologies for electricity, heat and cold, efficient fossil fuel power plants and for analysis of CCS*

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
		• Public and co-operative procurement of RES technologies

The existing mix of policy instruments targeting RES technologies consists mainly of targeted economic instruments such as direct investment support. However, an overall framework for promoting RES is missing in Mexico.

In order to exploit the ambitious potential of 186 $MtCO_2eq$ in the power sector, a number of additional climate policies and measures are suggested for strengthening the existing mix.

A first and necessary step is the gradual phase out of subsidies for the energy industry. This would contribute to levelling the playing field for RES technologies and make investments in energy efficiency more profitable. Saved subsidies for the energy industry could be used for financing energy-efficiency and RES. In turn, improved energy-efficiency would contribute to lowering the energy costs for consumers and outweigh the higher costs of energy due to the phase-out of subsidies. General economic and fiscal policies such as an ecological finance reform or an emission trading scheme could also contribute to achieving the GHG emissions reduction potential in the Mexican power sector.

The existing policy mix for RES technologies for electricity could be supplemented through extending the targeted economic policy instruments by feed-in tariffs or green certificates, improving the legal framework by introducing favourable regulations on grid access and power purchase agreements, accelerated building permission procedures, strengthening information measures by training for relevant actors as well as promoting research and technology transfer through RD&D schemes and co-operative procurement.

RES technologies for heat and cold could be promoted through targeted financial support for the installation of RES technologies for cold and heat, standards like building codes with a mandatory share of RES for heat and cold, information such as networks and training for relevant actors as well as research and technology transfer measures like RD&D schemes and public and co-operative procurement.

Additional policies and measures for promoting efficient fossil fuel power plants could be targeted financial policies such as investment support for power plants with high conversion efficiency, minimum standards for the conversion efficiency of new built plants or a RD&D scheme.

Requiring newly-built fossil fuel power plants to be designed “capture ready” could bring CCS forward. This would also have indirect implications on energy prices and make energy from fossil fuels more expensive. Support and co-operation with Annex I countries will be needed in this field.

GHG emissions stemming from the power production sector can also be indirectly targeted. Climate policy instruments and measures aiming at improving energy end-use efficiency and energy conservation in households or the industry have an effect on the country’s energy demand. In the household sector, there are already a number of energy efficiency policy instruments in place. They aim at energy efficiency in buildings, domestic appliances or lighting. A more detailed discussion of additional policy instruments for improving energy end-use efficiency in the household and service sector can be found in the sourcebook.

7.3.2.2 Transport

This section gives suggestions for improving the existing mix of climate policy instruments in the transportation sector.

Table 20: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the transportation sector (Climate policy measures and instruments

for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy		• Targets/quotas for sustainable biofuels
General economic and fiscal policy		• Tax exemptions for sustainable biofuels • Energy taxation on fuels • Phase-out of subsidies and tax exemptions for vehicle fuels • *Domestic emission trading scheme*
Targeted economic and fiscal policy	• Use of hybrid buses in public transport	• Road fees, congestion charges • CO_2-differentiated vehicle taxation • Depreciation rules favouring energy efficient vehicles • Financial support for switching from road-based to rail- or waterway based transportation
Regulations and voluntary agreements	• Programmes to improve air quality in metropolitan areas • Programmes to promote public transport	• Average specific emissions target for new vehicles regarding GHG emissions • Dynamic MEPS for vehicles components • Tighter speed limits • Spatial planning favouring non-motorised and public transport • Integrated transport planning
Information and know-how transfer		• Vehicle labelling • Driver training programmes • Promotion of public transport
Research and technology transfer		• *Research on sustainable transportation systems*

The existing mix of climate policy instruments and measures in the Mexican transportation sector consists of several instruments. They include targeted economic and fiscal policies (financial support for the use of hybrid busses) and regulations (programmes to improve air quality in metropolitan areas and promotion of public transport through bus lanes, etc.).

The ambitious potential of about 111 $MtCO_2eq$ in 2020 in the transport sector can be realised by introducing a number of additional climate policies and measures.

Crosscutting policy instruments are a phase out of subsidies and energy taxation on fuels as well as a domestic emissions trading scheme in the transport sector (connected to an average specific emission target).

Aiming at different fields of application (biofuels, individual motor car transport, air transport, public transport and freight transport), additional policy instruments could support the realisation of the ambitious potential. Policy instruments for targeting biofuels include a quota and tax exemptions. For targeting vehicles, several policy instruments are available. Such policy instruments could be targeted economic and fiscal policies and measures like for example road charges, a CO_2-differentiated vehicle taxation or favourable depreciation rules

for efficient vehicles. Standards could consist of average specific emission targets for new vehicles, dynamic MEPS for vehicle components, speed limits or integrated transport planning. Additional climate policy instruments of the category information and know how transfer could be vehicle labelling, driver training programmes or promotion of public transport and modal split. A shift from road-based to rail- or waterway-based transport can be induced by direct financial support such as tax reductions or subsidies.

7.3.2.3 Industry

This section gives suggestions for improving the climate policy mix in the industrial sector in Mexico.

Table 21: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the industrial sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy		
General economic and fiscal policy		• Gradual phase-out of energy subsidies backed by *financial and technical support for energy-efficiency and RES* • *Domestic emissions trading scheme*
Targeted economic and fiscal policy		• *Financial support for the optimisation and installation of energy efficient technologies linked to energy audits and management systems*
Regulations and voluntary agreements	• Integrated system of industrial environmental regulation and management (SIRG programme) • Promotion of the use of natural gas	• Minimum energy efficiency standards (for energy using equipment as well as building permits for new industrial production facilities)
Information and know-how transfer	• Registration of emissions and pollution transfer • Energy Efficiency Industry Partnership (EEIP) • Programme for energy saving of the national Mexican petroleum company	• Information and training of relevant actors
Research and technology transfer		• *RD&D scheme for energy efficient production technologies and methods*

The existing policy mix in the industrial sector consists of several policy instruments. The SIRG programme sets standards for industrial appliances such as motors or commercial refrigerators. The Energy Efficiency Industry Partnership (EEIP) aims at reducing energy consumption in this sector by training activities. For the petroleum industry, there is a programme aiming at reducing energy consumption by promoting best practice examples.

For exploiting the ambitious potential of 41 $MtCO_2eq$ in the industrial sector, the following additional climate policies and measures are suggested.

Cross-cutting issues are the gradual phase out of subsidies for energy from fossil fuels and the potential introduction of a domestic emissions trading scheme.

The recent mix of policy instruments could be supplemented by direct financial support for introducing energy efficient technologies and production methods. Such an instrument should also be linked to other policy instruments such as the participation in energy audits or the introduction of energy management systems. Furthermore, additional policy instruments include information and training of relevant actors or a RD&D scheme for energy efficient production technologies and methods.

7.4 Options for a stronger involvement of Mexico in the international regime

Mexico belongs not only to G77/China but also to the Environmental Integrity Group. As it is an OECD member and its GDP exceeds those of some countries with economies in transition, it is one of the first candidates for graduating from the group of non-Annex I countries and taking a comparable level of commitments as Annex I countries. Mexico has substantial capacities not only in economic terms but also in technical terms, as evidenced in its recent submission of the third National Communication. Mexico has been relatively positive towards taking some commitments, for example in its AWG 4 statement that stresses the need for an evolution of the current division between Annex I and non-Annex I countries into a more realistic form of differentiation.

7.4.1 Analysis

Mexico has the responsibility, capability and potential to make a contribution to the international effort to reducing emissions. Mexico is still a developing country and its indicators are only at the low end of the range of those of Annex I countries. But Mexico could be capable to handle an emission limitation or reduction target of limited scope and stringency compared to those of Annex I countries:

- *Responsibility*: Mexico's responsibility for climate change due to its emissions excluding LULUCF is below world average but slightly above non-Annex I average.
- *Capability*: Mexico's per capita income is slightly above world average. Its human development index is far above world average.
- *Potential:* Mexico has a substantial mitigation potential. According to the figures from Phase II of the project, the no-regret potential to reduce 2020 emissions below BAU levels amounts to 82 Mt, the co-benefit potential to 173 Mt and the ambitious potential to 417 $MtCO_2eq$. These would be equal to a 8%, 16% or 39% reduction compared to BAU levels respectively and a +26%, +14% or -17% change compared to 2005 emissions levels.

Earlier analyses put Mexico also at a high level compared to other developing countries. Ott et al. (2004) classify Mexico as "rapidly industrialising country" implying an absolute limitation target if funding and technology are provided by Annex I countries. Others find that Mexico would have to accede to Annex I soon if emissions/capita or GDP/capita thresholds are applied, a little earlier for GDP/capita (Gupta 2003; Höhne et al. 2005).

In addition, Mexico disposes of the technical capacity necessary for quantifying emissions and reductions. Comprehensive statistics exist in Mexico, which include economic, financial, social and energy indicators. Mexico is one of the few non-Annex I countries that officially publish emissions data. Mexico is also the only non-Annex I country that has already submitted its third National Communication.

7.4.2 Suggestions for a potential contribution

Given the amount of global emission reductions required to keep temperature change below 2°C and based on the above analysis, we suggest that it would be equitable and feasible for Mexico to commit to an absolute country-wide no-lose emission target.

We propose two options for the level of stringency based on the assessment of what amount of reductions is necessary by 2020 to bring global emissions on a 2°C trajectory (see section 11):

The target could either be set at a stringent level correlated to the ambitious mitigation potential but implementation would have to be made contingent on the provision of financial and technical support from Annex I countries. The target would in this case amount to about 638 $MtCO_2eq$ annual emissions in 2020, 39% below the BAU level and 17% below 2005 emissions.

Alternatively, the target could be set at a lower level, for instance at a level correlated to the co-benefit mitigation potential. This target would amount to 882 $MtCO_2eq$, 16% below the BAU level and 14% above 2005 level. Mexico could then, nevertheless, implement ambitious policies and measures to overachieve the target and sell the resulting surplus on the carbon market. This alternative would require less direct financial and technical support from Annex I countries but more support through the carbon market and hence more stringent emission reduction targets for Annex I countries 45% compared to 1990 as opposed to 30% as assumed for the option above.

If a country-wide target is not politically feasible, a second-best option could be to implement sectoral CDM or policy-based CDM projects in the power, transport and industry sectors. Sectoral/policy CDM would probably be politically more acceptable for developing countries. However, the technical implementation of sectoral/policy CDM and sectoral no-lose targets would probably be very similar and no-lose targets have a twofold advantage over sectoral/policy CDM: first, there would be no need to assess the additionality of emission reductions, and second, no-lose targets open the opportunity to achieve net reductions, namely the difference between BAU and the target. Under the CDM, by contrast, everything below BAU would be credited and lead to higher emissions in Annex I countries.

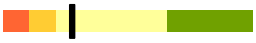
8. South Africa

8.1 South Africa in comparison to other countries

Table 22 provides different energy and emission indicators. The right column shows how South Africa performs compared to other countries. The basic data illustrates that South Africa ranks above the average of developing countries with respect to its state of development. However, large inequalities can be found within the country.

Its emissions and GDP per capita are well above world average. Its emissions per capita are close to Annex I average. Due to the extensive use of coal, South Africa's emissions per kWh electricity are among the highest in the world. Its emissions per capita are close to Annex I average, but have only increased slightly in the last 10 years. It is by far the largest emitter of greenhouse gas emissions in Africa (DME 2005).

Table 22. Energy and emission indicators for South Africa

	Indicator	Value	Meter
Responsibility	Cumulative emissions 1900 to 2004 per capita per year	3.4 $tCO_2eq/cap./y$	
Capability	GDP per capita (2004)	10,800 US $ PPP 2000/cap.[3]	
	Human development index 2002	0.666 (medium)	
Potential	Past emission trend from 1990 to 2004	+18%	
	Emissions per capita (2003)	10.5 $tCO_2eq/cap.$	
	Emissions per GDP (2004)	969 tCO_2eq/MUS (2000)$	
	Emissions per kWh electricity (2003)	853 gCO_2/kWh	
	Energy efficiency in industry	Low	
	Emissions in transport per capita (2003)	0.93 $tCO_2eq/cap.$	
	Emissions in households and services per capita (2003)	0.58 $tCO_2eq/cap.$	
	Emissions in agriculture per capita (2000)	0.93 $tCO_2eq/cap.$	
	Emissions in waste per capita (2000)	0.49 $tCO_2eq/cap.$	
	Emissions in land use change and forestry per capita (2000)	0.04 $tCO_2eq/cap.$	

For detailed explanation of the meters and data sources see Appendix A.

Figure 16 shows the shares of South Africa's energy sources up to the year 2003. Coal is by far the most important energy source. About 70% of South Africa's primary energy supply and about 90% of electricity supply are provided by coal (Winkler 2006, p. 4). Coal can be assumed to remain the most important energy source for South Africa during the next 20-30 years (Mwakasonda and Winkler 2005). Biomass (11%)[4], oil (10%), nuclear energy, gas and hydropower only play a minor role today.

[3] However, per capita GDP is much lower at market exchange rate.

[4] Alternative to the IEA data shown here, a lower figure for biomass of around 8% could also be realistic.

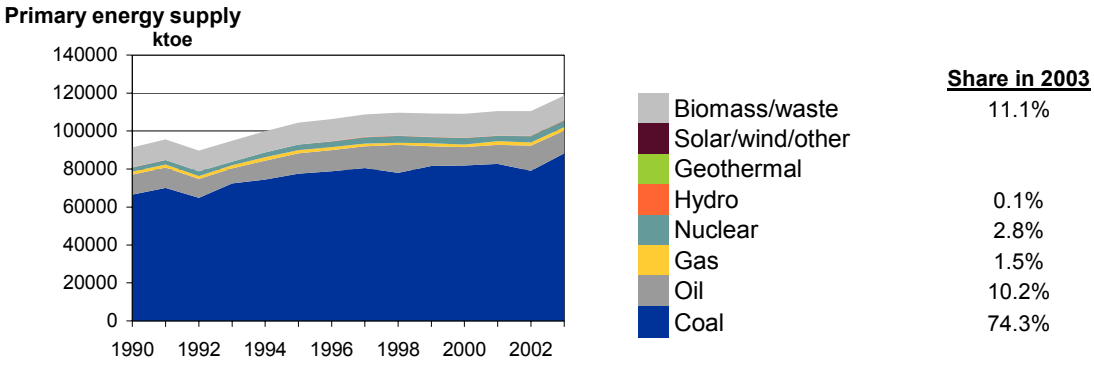


Figure 16. South Africa's primary energy supply between 1990 and 2003 (IEA 2005b)

Overall, the dominance of coal in South Africa's energy mix leads to high emission intensity in electricity generation. This and the energy intensive industry result in very high emissions per GDP. Per capita emissions are lower than those of most Annex I countries but they are high for developing countries. South Africa's emissions are likely to increase in the future due to development and a remaining high importance of coal as energy source.

8.2 Reference emissions and mitigation potential

Figure 17 below shows South Africa's greenhouse gas emissions under the business-as-usual scenario and all three reduction scenarios. The scenario parameters are based on national studies as far as possible. Major sources for future data in South Africa are EDRC 2003; Winkler et al. 2005a; USEPA 2006b and trend extrapolation of official national and IEA statistics (IEA 2005a).

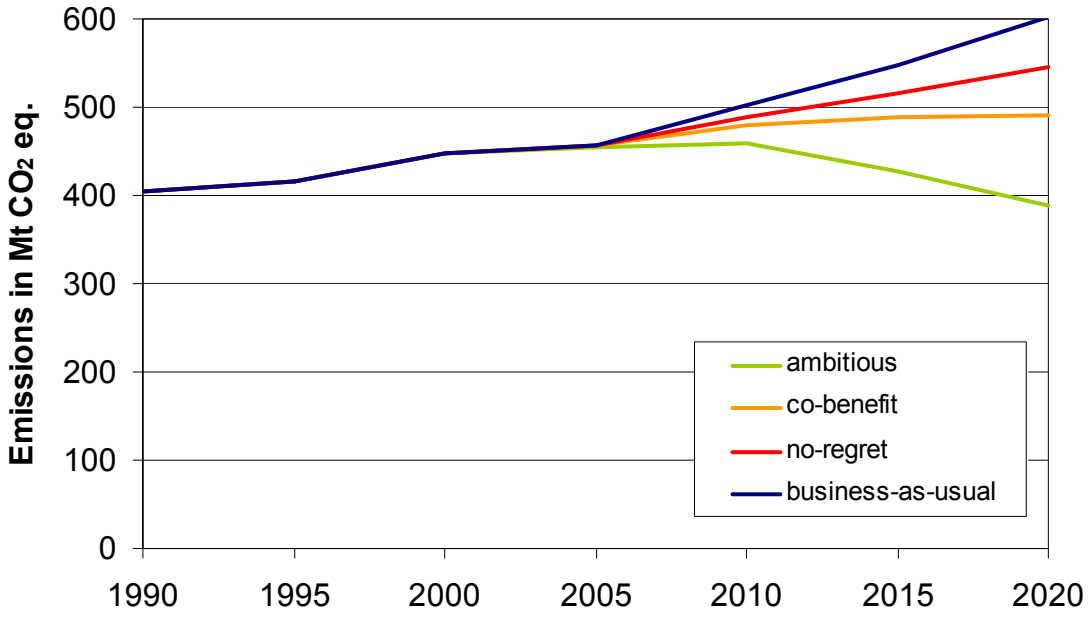


Figure 17. Scenarios for greenhouse gas emissions in South Africa between 1990 and 2020.

As illustrated in Figure 17, the reduction potential for South Africa is 9% (no-regret), 18% (co-benefit) and 35% (ambitious potential) below BAU. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the (1) power, (2) transport and (3) industrial sector. In the power sector, there exists an ambitious potential of 67 $MtCO_2eq$. For the transport sector, the ambitious potential is estimated at 42 $MtCO_2eq$. The ambitious potential in the industrial sector is estimated at 41 $MtCO_2eq$. The

total ambitious potential in South Africa is estimated at 212 $MtCO_2eq$. A detailed overview of the potential per sector and scenario can be found in Appendix B.

Figure 18 shows South Africa's total reduction potential on the sector level under the ambitious potential scenario compared to the business-as-usual scenario and the remaining emissions according to sectors.

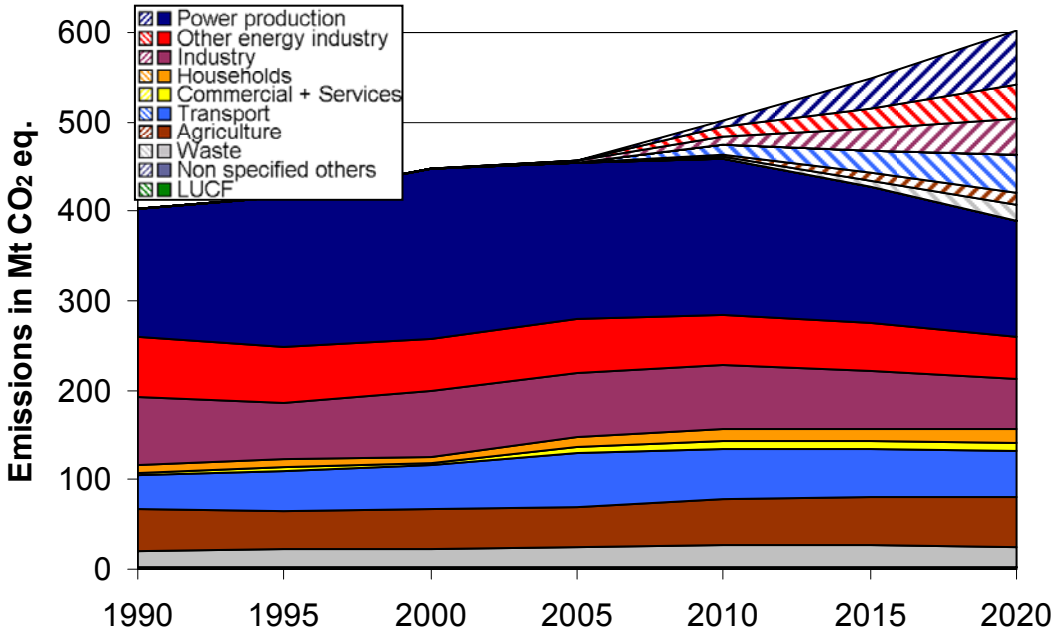


Figure 18. South Africa's emissions under the business-as-usual and the ambitious potential scenario on a sector basis between 1990 and 2020. Striped areas show the sectoral emission reduction potential under the ambitious potential scenario compared to the business-as-usual scenario. (Emissions from LUCF kept constant after 2003 due to data availability)

Most important findings for South Africa:

- South Africa's emissions are projected to increase slightly by about 1.5% per year between 2000 and 2020 under the business-as-usual scenario.
- In 2000 most emissions result from power production (45%), industry (17%) and transport (11%). Under the business-as-usual scenario, this trend is projected to be more or less similar, although the importance of power production will decrease, while the shares of most other sectors will increase by a few percentage points.
- South Africa is highly dependent on domestic coal. Movement to renewable energy sources would be a significant reduction option.
- Major reductions can be achieved in the industry sector by increasing efficiency and moving to renewable energy sources.
- Some limited reduction potential is available in the agriculture and waste sectors.
- In the transport sector reduction options are considerable. A shift to more natural gas and biomass use is one emission reduction option. Another element is to increase efficiency, especially in aviation and road transport, and a shift to increase the absolute amount of rail transport.
- Under the no-regret potential scenario reductions of 9% below BAU (19% above 2005 emissions) might be possible. Under the co-benefit potential scenario reductions of 18% below BAU (7% above 2005 emissions) could be feasible. Under the ambitious potential scenario overall emission reductions of 35% below BAU (15% below 2005 emissions) might be possible.

8.3 Existing and possible further national climate policies

8.3.1 Overview of existing climate policies and measures

The following section gives a general overview of South Africa's climate policy instruments and measures. For this purpose, it distinguishes between policies and measures targeting energy efficiency improvements, renewable energy and other relevant sources of GHG emissions.

If not stated otherwise, sources for this section include Chandler et al. 2002; DEAT 2004; RSA 2006; Winkler 2006), DME 2003), DME 2005) and Parliament SA 2000). Furthermore, a country expert (Stanford Mwakasonda) for South Africa has reviewed and commented the list of existing policy instruments.

South African energy policy can be characterised by an overstrained power generating capacity and subsidies for power from fossil fuels. Today, South Africa faces an overstrained power generating capacity since energy demand is growing faster than supply. In order to deal with this problem, a number of policies and measures towards improving energy efficiency and demand side management have been taken in recent years. However, there are direct and indirect subsidies for power from fossil fuels and for fossil fuels as end-use energy, which counteract such policies and measures. For instance, there is no VAT on kerosene and an indirect support of electricity consumption through subsidies for coal. Such subsidies are not very likely to be removed in the near future. There is fear that it would make energy unaffordable for large parts of the population and slow down the current economic development.

A number of policies and measures targeting **energy efficiency** and **demand side management** have been introduced in recent years in order to cope with the limited power generating capacity. The framework for energy efficiency policy is set by the South African energy efficiency strategy which aims at reducing final energy consumption by at least 12% compared against the BAU scenario until 2014 (with the year 2000 as the basis). For this purpose, several policies and measures targeting different sectors (with the main focus on industry and households) are foreseen. Such policy instruments include minimum efficiency standards for buildings and appliances, support mechanisms (appliance labelling, energy audits, information, training, research, and energy management systems) and financial instruments (moving from cross-subsidies to cost-reflective prices, fiscal and financial incentives such as subsidies for energy-efficient retrofitting of public buildings, fee-bates for less efficient vehicles or subsidies for replacing old taxis). However, there is no funding for financial support on a larger scale since there are more urgent development issues. A national "Energy Efficiency Agency" and an "Energy Sector Education and Training Authority" have been established. The Danish government has also supported capacity building on energy efficiency and renewable energy. Furthermore, the South African energy company ESKOM has been obliged to carry out demand side management activities targeting households as well as commercial and industrial consumers. For instance, one such activity has been a large programme for replacing old light bulbs with energy-efficient ones.

Renewable energy is promoted through a renewable electricity target (additional 10,000 GWh from renewables until 2013). In order to meet this target, subsidies for renewable energy technologies (renewable energy subsidy scheme) are available – however no progress has been made in introducing feed-in tariffs so far. The Renewable Energy Finance and Subsidy Office (REFSO), whose mandate includes the management of renewable energy subsidies and provision of advice to developers and other stakeholders on renewable energy finance and subsidies has been established. There is also an off-grid electrification programme that is based on PV.

Only a small number of climate policies and measures targeting **other relevant sources of GHG emissions** have been implemented in South Africa. For instance, the white paper on integrated pollution and waste management led to the introduction of a national waste

management strategy. The focus of this strategy is on waste minimisation and utilisation. So far, household waste has been the main target while industrial waste has only been marginally addressed. In the agricultural sector, the land care framework policy targets GHG emissions stemming from this sector. The main aim is sustainable land management through e.g. capacity building and training, research and standards.

8.3.2 Suggestions for additional climate policy instruments and measures

The following section analyses the existing climate policies and measures for sectors with the highest GHG emissions reduction potential in South Africa. Using the sourcebook as a starting point, this section gives suggestions for improving the existing mix of climate policy instruments and measures with additional policies and measures in order to exploit the full reduction GHG emissions reduction potential. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the (1) power, (2) transport and (3) industrial sector.

Climate policy measures and instruments for which the country needs financial assistance from Annex I countries are highlighted in *italics* in the following tables. Such instruments are mainly investment support or RD&D schemes. Section 2.3 presents more generally which category of policy instruments is considered appropriate for addressing the no-regret, co-benefits, and ambitious potential, respectively.

8.3.2.1 Power

This section outlines existing climate policies and measures in the power sector. Based on this, the following section gives suggestions for improving the existing climate policy mix in order to exploit the GHG emissions reduction potential. Due to the prevailing infrastructure and circumstances in South Africa the CHP technology is unlikely to be applicable for district heating in the near future. Therefore, CHP for district heating is not considered in the following. However, CHP for industrial use can be an option in the future.

Table 23: Overview over existing climate policies and measures and suggestions for improving the existing policy mix in the power and heat sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy	• Renewable electricity target • White paper on renewable and energy policy	• Renewable energy targets for electricity, heat and cold supply
General economic and fiscal policy		• Gradual phase-out of energy subsidies backed by *financial and technical support for energy efficiency and RES* (e.g. backed by the ESKOM DSM scheme) • *Domestic emission trading scheme* • *Ecological Finance Reform*
Targeted economic and fiscal policy	• Subsidy scheme for renewable energy technologies • Power sector reforms • Off-grid electrification programme	• Feed-in tariffs or electricity quota (green certificates) for RES and CHP • *Financial support for the installation of RES technologies for cold and heat* • *Investment support for*

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
		improvements in the conversion efficiency of fossil fuel power plants (linked to MEPS, see below)
Regulations and voluntary agreements	• Gas act: Substitution of coal by gas • National energy bill • ESKOM obligation for DSM	• Favourable regulations on grid access and power purchase agreements for RES and CHP plants • Create/increase target for energy savings from DSM by ESKOM to 1% per year (compared against the baseline) • Accelerated building permission procedures for RES and CHP plants • Building codes with a mandatory share of RES for heat and cold • Dynamic minimum conversion efficiency standards, regularly updated • *"CCS-ready" obligation for new built power plants*
Information and know-how transfer	• Capacity building on energy efficiency and renewable energy	• Network of local actors • Demonstration and training on RES technologies targeting contractors, retails sales staff, architects and engineers
Research and technology transfer		• *RD&D schemes for accelerated development, technical improvement and market introduction of RES technologies for electricity, heat and cold, efficient fossil fuel power plants and for analysis of CCS* • Public and co-operative procurement of RES technologies

In order to exploit the ambitious potential of 67 $MtCO_2eq$ in the power sector, a number of additional climate policies and measures are suggested for strengthening the existing mix.

A first and necessary step is the gradual phase out of subsidies for power from fossil fuels and coal. This could contribute to levelling the playing field for RES technologies and make investments in energy efficiency more profitable. Saved subsidies for coal and other fossil fuels could be used for financing energy-efficiency and RES. In turn, improved energy-efficiency would contribute to lowering the energy costs for consumers and outweigh the higher costs of energy due to the phase-out of subsidies. General economic and fiscal policies such as an ecological finance reform or an emission trading scheme could also contribute to achieving the GHG emissions reduction potential in the power sector.

An extension of the ESKOM DSM obligation to an energy saving target from DSM of e.g. 1% per year (compared against the baseline) would increase the effectiveness of the current obligation.

The existing policy mix for RES technologies or CHP for electricity could be supplemented through extending the targeted economic policy instruments by feed-in tariffs or green

certificates, improving the legal framework by introducing favourable regulations on grid access and power purchase agreements, accelerated building permission procedures, strengthening information measures by training for relevant actors as well as promoting research and technology transfer through RD&D schemes and co-operative procurement.

Today, there are no specific policy instruments targeting RES technologies for heat and cold. These technologies could be promoted through targeted financial support for the installation of RES technologies for cold and heat, standards like building codes with a mandatory share of RES for heat and cold, information such as networks and training for relevant actors as well as research and technology transfer measures like RD&D schemes and public and co-operative procurement.

Additional policies and measures for promoting efficient fossil fuel power plants could be targeted financial policies such as investment support for power plants with a high conversion efficiency, regulation such as minimum standards for the conversion efficiency of new built plants or a RD&D scheme.

Requiring new built fossil fuel power plants to be designed “capture ready” could bring CCS forward. This would also have indirect implications on energy prices and make energy from fossil fuels more expensive. Support and co-operation with Annex I countries will be needed in this field.

GHG emissions stemming from the power production sector can also be indirectly targeted. Climate policy instruments and measures aiming at improving energy end-use efficiency and energy conservation in households or the industry have an effect on the country’s energy demand. Especially in the household sector, there are already a number of promising energy efficiency policy instruments in place. They include an energy label for household appliances, minimum energy efficiency standards or demand side activities carried out by energy companies. A more detailed discussion of additional policy instruments for improving energy end-use efficiency in the household and service sector can be found in the sourcebook.

8.3.2.2 Transport

This section gives suggestions for improving the existing mix of climate policy instruments in the transportation sector.

Table 24: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the transportation sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy		• Targets/quotas for sustainable biofuels
General economic and fiscal policy		• Tax exemptions for sustainable biofuels • Energy taxation on fuels • Phase-out of subsidies and tax exemptions for vehicle fuels • *Domestic emission trading scheme*
Targeted economic and fiscal policy	• Support of efficient vehicles • Taxi recapitalisation programme	• Road fees, congestion charges • CO_2-differentiated vehicle taxation • Depreciation rules favouring energy efficient vehicles • Financial support for switching from road-based to rail- or waterway

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
		based transportation
Regulations and voluntary agreements	• National Land Transport Transition Act • Vehicle emission strategy	• Average specific emissions target for new vehicles regarding GHG emissions • Dynamic MEPS for vehicles components • Tighter speed limits • Spatial planning favouring non-motorised and public transport • Integrated transport planning
Information and know-how transfer	• Public awareness campaigns for using public transport	• Vehicle labelling • Driver training programmes • Promotion of public transport
Research and technology transfer		• *Research on sustainable transportation systems*

The existing mix of climate policy instruments and measures in the South African transportation sector consists of several instruments. They include mainly targeted economic and fiscal policies (e.g. financial support for efficient and low polluting vehicles, subsidies for scrapping old taxis), regulations (e.g. emission standards) and information measures (e.g. public awareness campaigns for using public transport).

The ambitious potential of about 42 $MtCO_2eq$ in 2020 in the transport sector can be realised by introducing a number of additional climate policies and measures.

Crosscutting policy instruments are a phase out of subsidies and energy taxation on fuels as well as a domestic emission trading scheme in the transport sector (connected to an average specific emission target).

Aiming at different fields of application (biofuels, individual motor car transport, air transport, public transport and freight transport), additional policy instruments could support the realisation of the ambitious potential. Policy instruments for targeting biofuels include a quota and tax exemptions. For targeting vehicles, several policy instruments are available. Such policy instruments could be targeted economic and fiscal policies and measures like for example road charges, a CO_2-differentiated vehicle taxation or favourable depreciation rules for efficient vehicles. Standards could consist of average specific emission targets for new vehicles, dynamic MEPS for vehicle components, speed limits or integrated transport planning. Additional climate policy instruments of the category information and know how transfer could be vehicle labelling, driver training programmes or promotion of public transport and modal split. A shift from road-based to rail- or waterway-based transport can be induced by direct financial support such as tax reductions or subsidies.

8.3.2.3 Industry

Suggestions for improving the climate policy mix in the industrial sector are made in the following.

Table 25: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the industrial sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy	• Energy efficiency strategy for the industrial sector	
General economic and fiscal policy		• Gradual phase-out of energy subsidies backed by *financial and technical support for energy-efficiency and RES* (e.g. backed by the ESKOM DSM scheme) • *Domestic emissions trading scheme*
Targeted economic and fiscal policy		• *Financial support for the optimisation and installation of energy efficient technologies linked to energy audits and management systems, e.g. as a part of the ESKOM DSM scheme*
Regulations and voluntary agreements	• Energy efficiency accord (voluntary agreement)	• Extension of the energy efficiency accord • Minimum energy efficiency standards (for energy using equipment as well as building permits for new industrial production facilities)
Information and know-how transfer	• Energy audits • Energy management systems	• Information and training of relevant actors
Research and technology transfer		• *RD&D scheme for energy efficient production technologies and methods*

The existing policy mix in the industrial sector has already a number of promising policy instruments. The framework is set by the energy efficiency strategy (which is linked to the general energy efficiency strategy), which aims at energy savings of about 14% until 2014. Specific measures include variable speed drives, efficient motors, compressed air management, efficient lighting, heating, ventilation and cooling as well as thermal savings (more efficient use and production of heat). Another important policy instrument is the energy efficiency accord, which includes the 37 large industries in South Africa. These industries have signed the Energy Efficiency Accord and established technical committees where they discuss how to fulfil the energy efficiency target.

For exploiting the ambitious potential of 41 $MtCO_2eq$ in the industrial sector, the following additional climate policies and measures are suggested.

Cross-cutting issues are the gradual phase out of subsidies for energy from fossil fuels and the potential introduction of a domestic emissions trading scheme.

The recent mix of policy instruments could be supplemented by direct financial support for introducing energy efficient technologies and production methods. Such an instrument should also be linked to other policy instruments such as the participation in energy audits or the introduction of energy management systems. Furthermore, additional policy instruments include information and training of relevant actors or a RD&D scheme for energy efficient production technologies and methods.

8.4 Options for a stronger involvement of South Africa in the international regime

South Africa has been constructive in the post-2012 negotiations, as evidenced by its proposal on "Sustainable Policies and Measures" (SD-PAMs). While it has indicated a willingness to take on a very loose type of commitment, South Africa is also one of the Parties to stress the responsibility of industrialised countries for the climate problem. This could be observed by its request for large and ambitious commitments by Annex I countries in AWG3. At AWG4, it called for mitigation through legally binding reductions by Annex I Parties and voluntary action by developing countries with technological and financial support.

8.4.1 Analysis

South Africa has the responsibility, capability and potential to make a contribution to the international effort to reducing emissions. In comparison to other countries, South Africa is at a relatively advanced development state with GDP/cap well above developing country average and still above world average. Per capita emissions are well above world average and in the range of those of Poland, Spain and Italy. South Africa would therefore be one of the first countries to move to an advanced stage in a multistage regime:

- *Responsibility*: South Africa's responsibility for climate change due to its historical emissions excluding LULUCF is slightly above world average. LULUCF emissions do not play a major role.
- *Capability*: South Africa's per capita income is above world average on a GDP PPP basis. But its human development index is just below average. This is an indication that the income is very unevenly distributed.
- *Potential:* South Africa disposes of a substantial mitigation potential. According to the figures from Phase II of the project, the no-regret potential to reduce 2020 emissions below BAU levels amounts to 57 Mt, the co-benefit potential to 110 Mt and the ambitious mitigation potential to 212 $MtCO_2eq$. These would be equal to a 9%, 18% or 35% reduction compared to BAU levels respectively and a +19%, +7% or -15% change compared to 2005 emissions levels.

South Africa is still a developing country, its emissions are high but development is very unevenly distributed. The electricity/coal sector is by far the sector with the largest emissions and also the highest capability. This sector is also highly developed and likely to be institutionally capable to handle an emission limitation or reduction target. At the same time, high levels of inequality and the history of Apartheid mean that the country still has to address some very basic needs of some parts of the population. Hence climate targets need to allow South Africa's socio-economic development to proceed in a sustainable manner.

Earlier analyses put South Africa also at a high level compared to other developing countries. Ott et al. (2004) classify South Africa as "rapidly industrialising country" implying an absolute limitation target (i.e. a 'growth cap' on emissions) if funding and technology are provided from Annex I countries. Others find that South Africa would have to accede to Annex I soon if emissions/capita or GDP/capita thresholds are applied, a little earlier for emissions/capita (Gupta 2003; Höhne et al. 2005).

South Africa disposes of some of the technical capacity necessary to quantify emissions and reductions. Comprehensive statistics exist in South Africa. Mainly economic, financial, social and energy indicators are included (Statistics South Africa 2006). In the National Communication detailed data are available for all gases and sectors for 1990 and 1994 (Government SA 2000). Apart from that no emission data have been officially published yet. National studies on the effect of policies to reduce emissions do exist. Winkler et al. (2005a, 2005b) assume South Africa to have a sound institutional infrastructure "to measure and

verify the implementation of energy efficiency interventions in industry". This includes industrial clients, the electric utility Eskom, energy service companies and four South African universities who are involved in measurement and verification. A National Energy Efficiency Agency was established under the Central Energy Fund in late 2005.

According to the World Bank (2006), one of the major challenges South Africa faces is the development of institutional mechanisms to enable the formulation, adoption and implementation of integrated national climate change policies. According to the National Communication (Government SA 2000) "an urgent need exists for the establishment and maintenance of a greenhouse gas emissions inventory database. An independent verification system to ensure that only verified data is included in a national emissions database needs to be developed and maintained."

8.4.2 Suggestions for a potential contribution

Given the amount of global emission reductions required to keep temperature change below 2°C and based on the above analysis, we suggest that it would be equitable and feasible for South Africa to commit to sectoral no-lose targets for the power production and industry sectors.

We propose two options for the level of stringency based on the assessment of what amount of reductions is necessary by 2020 to bring global emissions on a 2°C trajectory (see section 11):

The target could either be set at a stringent level correlated to the ambitious mitigation potential but implementation would have to be made contingent on the provision of financial and non-financial support from Annex I countries. The total target for both sectors would in this case amount to about 191 $MtCO_2eq$ annual emissions in 2020, about 36% below the BAU level.

Alternatively, the targets could be set at a lower level, for instance correlated to the co-benefit mitigation potential. The total target for both sectors would in this case amount to about 256 $MtCO_2eq$, about 14% below BAU levels. South Africa could then nevertheless implement ambitious policies and measures to overachieve the target and sell the resulting surplus on the carbon market. This alternative would require less direct financial and non-financial support from Annex I countries but more support through the carbon market and hence more stringent emission reduction targets for Annex I countries of 45% compared 1990 as opposed to 30% as assumed for the option above.

If targets are not politically feasible, a second-best option could be to implement sectoral or policy-based CDM projects in the power production and industry sectors. Sectoral CDM would probably be politically more acceptable for developing countries. However, the technical implementation of sectoral CDM and sectoral no-lose targets would probably be very similar and no-lose targets have a twofold advantage: first, there would be no need to assess the additionality of emission reductions, and second, no-lose targets open the opportunity to achieve net reductions, namely the difference between BAU and the target. Under the CDM, everything below BAU would be credited.

In addition, South Africa could commit to implementing a set of SD PAMs for the sectors not covered by the sectoral no-lose targets or sectoral CDM. South Africa would quantify the effect of the package of SD PAMs in advance. The total package of sectoral no-lose targets and SD PAMs should aim at mobilising the full ambitious mitigation potential. However, the implementation of these policies and measures would be conditional on additional international funding to cover the higher costs compared to business-as-usual development.

Due to missing capacity in these sectors, the emission reductions achieved through PAMs could probably only be roughly estimated. Therefore, no direct link is assumed between policies and the international carbon markets. Practical measures related to investment

needs could be linked to international funding, e.g. through the GEF or other international funds, but also to private sector CDM projects.

9. South Korea

9.1 South Korea in comparison to other countries

Table 26 provides different energy and emission indicators. The right column shows how South Korea performs compared to other countries. The figures illustrate that South Korea ranks very high among developing countries with respect to its state of development. Its GDP per capita and emissions per capita are well above that of most developing countries and above world average.

Table 26. Energy and emission indicators for South Korea

	Indicator	Value	Meter
Responsibility	Cumulative emissions 1900 to 2004 per capita per year	2.3 $tCO_2eq/cap./y$	
Capability	GDP per capita (2004)	19,400 US $ PPP 2000/cap.	
	Human development index 2002	0.888 (high)	
Potential	Past emission trend from 1990 to 2004	+73%	
	Emissions per capita (2003)	10.8 $tCO_2eq/cap.$	
	Emissions per GDP (2004)	558 tCO_2eq/MUS (2000)$	
	Emissions per kWh electricity (2003)	437 gCO_2/kWh	
	Energy efficiency in industry	High	
	Emissions in transport per capita (2003)	2.19 $tCO_2eq/cap.$	
	Emissions in households and services per capita (2003)	1.42 $tCO_2eq/cap.$	
	Emissions in agriculture per capita (2000)	0.25 $tCO_2eq/cap.$	
	Emissions in waste per capita (2000)	0.14 $tCO_2eq/cap.$	
	Emissions in land use change and forestry per capita (1990)	-0.56 $tCO_2eq/cap.$	

For detailed explanation of the meters and data sources see Appendix A.

South Korea's is in its state of development very close or even similar to some Annex I countries: Its population was almost stable in the last decade. Its electricity system is largely based on nuclear power, making emissions per kWh very low. Its industrial sector makes up a large share of its emissions, but it is one of the most efficient in the world. Transport and household emissions are high, agricultural emissions are not relevant.

South Korea is classified as country with a high human development index. Its GDP per capita lies well above world average and middle income countries average. It is in the range of the Czech Republic, Greece and Cyprus. After the establishment of the UNFCCC South Korea became member of the OECD and is therefore, similar to Mexico, a non-Annex I but OECD country.

Figure 19 shows the shares of South Korea's energy sources up to the year 2003. Oil is by far the most important energy source (49% in 2003). Coal (23%), nuclear (17%) also contribute considerably to total primary energy supply. Gas, renewables and waste only play a minor role.

South Korea's carbon intensity fell by 1.2% to 0.614 t carbon/toe per year between 1990 and 2001. A major reason for this was the shift from coal use to a higher share of natural gas and nuclear power. Methane emissions from fuel combustion were comparatively high in 1990 (715,700 t carbon) and declined by 65% by 2001 (Government South Korea 2003).

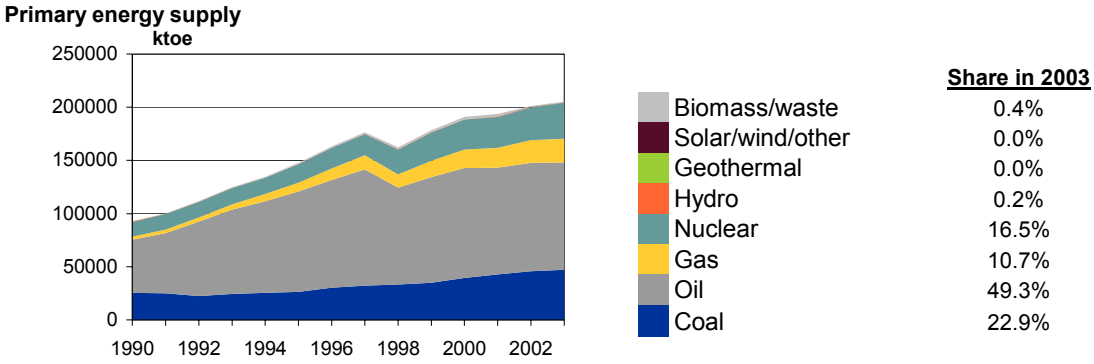


Figure 19. South Korea's primary energy supply between 1990 and 2003 (IEA 2005b)

9.2 Reference emissions and mitigation potential

Figure 20 below shows South Korea's greenhouse gas emissions under the business-as-usual scenario and all three reduction scenarios. Major sources for future data in South Korea are trend extrapolation of national and IEA statistics (IEA 2005a).

As illustrated in Figure 20, the reduction potential for South Korea is 13% (no-regret), 19% (co-benefit) and 42% (ambitious potential) below BAU. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the (1) industrial, (2) power and (3) transport sector. In the industrial sector, there exists an ambitious potential of 212 $MtCO_2eq$ in the year 2020. The ambitious potential in the power sector is estimated at 112 $MtCO_2eq$. In the transport sector, there is an ambitious potential of about 80 $MtCO_2eq$. The total ambitious potential in Korea is estimated at 443 $MtCO_2eq$ in the year 2020. A detailed overview of the potential per sector and scenario can be found in Appendix B.

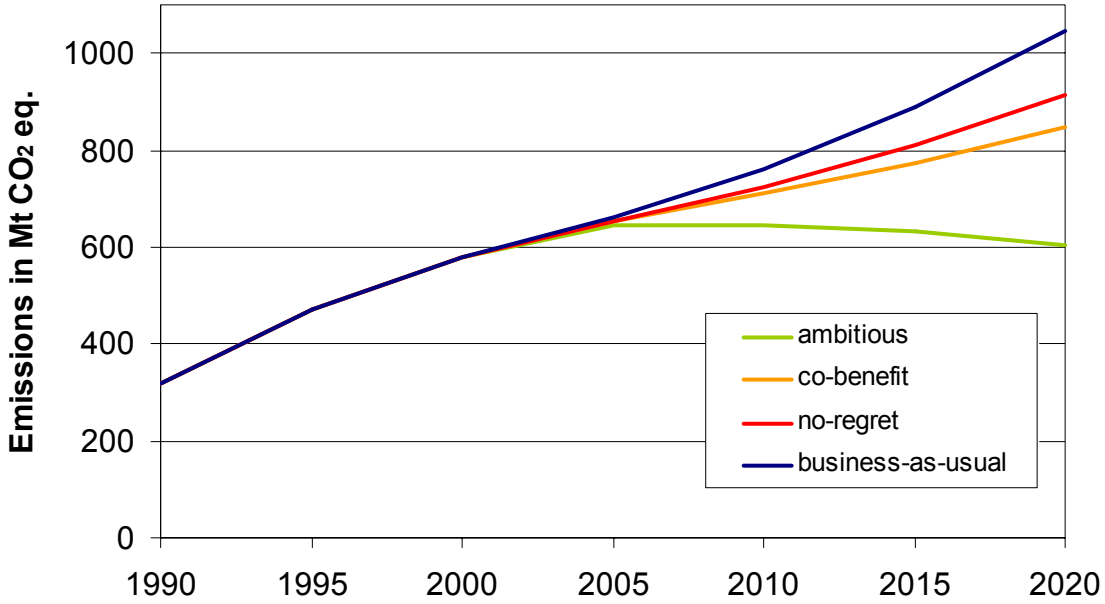


Figure 20. Scenarios for greenhouse gas emissions in South Korea between 1990 and 2020.

Figure 21 shows South Korea's total reduction potential on the sector level under the ambitious potential scenario compared to the business-as-usual scenario and the remaining emissions according to sectors.

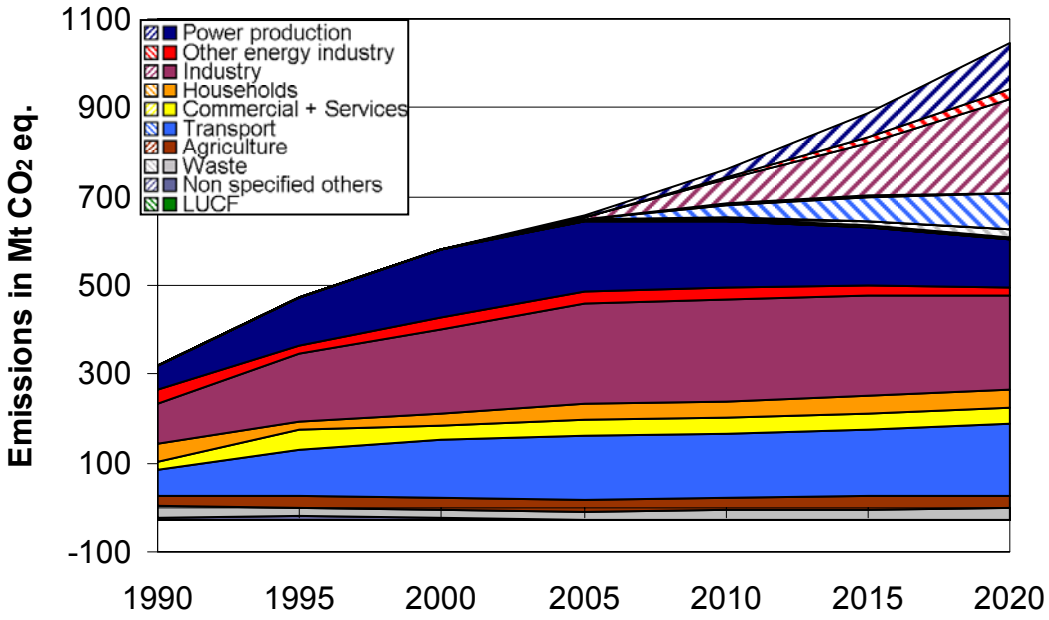


Figure 21. South Korea's emissions under the business-as-usual and the ambitious potential scenario on a sector basis between 1990 and 2020. Striped areas show the sectoral emission reduction potential under the ambitious potential scenario compared to the business-as-usual scenario. (Emissions from LUCF kept constant after 2003 due to data availability)

Most important findings for South Korea:

- South Korea's emissions are projected to increase by about 3% per year between 2000 and 2020 under the business-as-usual scenario.

- In 2000 most emissions result from industry (33%), power production (27%) and transport (22%) Under the business-as-usual scenario, the share is projected to be more or less constant although the importance of power production will decrease, while the share of industry will increase.
- South Korea has a high share of nuclear energy in the electricity mix, high efficiency, some use of combined heat and power generation and low distribution losses. Major reduction option is to move to renewable energy sources.
- South Korea's industry is already very efficient but is growing very fast. Moving to more use of renewable energy could compensate for the growth.
- In the transport sector reduction options are considerable. A shift to more natural gas and biomass use is one emission reduction option. Another element is to increase efficiency, especially in aviation and road transport, and a shift to increase the absolute amount of rail transport.
- Under the no-regret potential scenario reductions of 13% below BAU (38% above 2005 emissions) might be possible. Under the co-benefit potential scenario reductions of 19% below BAU (28% above 2005 emissions) could be feasible. Under the ambitious potential scenario, overall emission reductions of 42% below BAU (9% below 2005 emissions) might be possible.

9.3 Existing and possible further national climate policies

9.3.1 Overview of existing climate policies and measures

This section gives a general overview of existing climate policies and measures in the Republic of Korea. For this purpose, we distinguish between policies and measures targeting energy efficiency improvements, energy supply and other relevant sources of GHG emissions.

If not stated otherwise, the source for this section is the latest National Communication to the UNFCCC (Government South Korea 2003).

Korean climate policy has a strong focus on electric appliance energy-efficiency and the transport sector. The framework is set by the second comprehensive action plan, which consists of three parts. The first part includes the promotion of GHG reduction technologies and environmentally friendly technologies, the second part a strengthening of climate policies and measures and the third part increased public participation and cooperation. Furthermore, there are programmes promoting highly efficient products or energy-efficient appliances (e.g. energy labels and standards limiting stand-by power consumption to below 1 W).

A number of policies and measures targeting **energy efficiency** and **energy conservation** have been implemented in Korea. For the industrial sector, they include energy audits and voluntary agreements on reducing GHG emissions. Standards on building insulation and design, building certificates or energy labels target energy consumption in the residential and commercial sector. In the transport sector, a number of instruments aiming at reducing fuel consumption of vehicles have been implemented. They include e.g. the promotion of hybrid and compact cars, traffic and logistic management systems or a promotion of public transport. Furthermore, there is financial support for the expansion of energy service companies.

Policy instruments aiming at the **energy supply** in Korea include a programme targeting renewable energy by strengthening supply and demand, financial support for the expansion of district heating and cooling and regulation on increasing the share of gas and nuclear power in the energy mix.

A number of climate policies and measures targeting **other relevant sources of GHG emissions** have been implemented in Korea. Climate policy instruments targeting the waste

sector include a programme aiming at waste minimisation and recycling, the improvement of landfills, financial support for the utilisation of landfill gas, waste incineration or improved sewage and waste water treatment. For targeting GHG emissions in the agricultural sector, a programme on methane management and best farming practices as well as livestock management have been implemented.

9.3.2 Suggestions for additional climate policy instruments and measures

The following section analyses the existing climate policies and measures for sectors with the highest GHG emissions reduction potential in the Republic of Korea. Based on the sourcebook, we give suggestions for improving the existing mix of climate policy instruments and measures with additional policies and measures in order to exploit the full reduction GHG emissions reduction potential. The three sectors with the highest GHG emissions reduction potential between 2005 and 2020 (ambitious potential) are the (1) industrial, (2) power and (3) transport sector.

Climate policy measures and instruments where the country potentially needs assistance from Annex I countries are highlighted in *italic* in the following tables. Such instruments are mainly investment support or RD&D schemes. Chapter 2.3 presents more generally which category of policy instruments is considered appropriate for addressing the no-regret, co-benefits, and ambitious potential, respectively.

9.3.2.1 Industry

This section gives suggestions for improving the climate policy mix in the industrial.

Table 27: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the industrial sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy	• 3 year plan for energy audits of the energy intensive industry	
General economic and fiscal policy		• Gradual phase-out of direct and indirect energy subsidies and price control backed by *financial and technical support for energy-efficiency and RES* • Ecological finance reform • *Domestic emissions trading scheme*
Targeted economic and fiscal policy	• Low interest policy funds for energy efficient technologies linked to energy audits	• *Financial support for the optimisation and installation of energy efficient technologies linked to energy audits and management systems*
Regulations and voluntary agreements	• Voluntary agreements	• Minimum energy efficiency standards (for energy using equipment as well as building permits for new industrial production facilities)
Information and know-how transfer	• Energy audits	• Energy management systems • Information and training of relevant

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
		actors
Research and technology transfer		• *RD&D scheme for energy efficient production technologies and methods*

Climate policy in the industrial sector in Korea focuses on energy audits and low interest policy funds for implementing the options for energy efficiency detected during the energy audit. Furthermore, there are voluntary agreements with energy intensive companies on reducing GHG emissions

For exploiting the ambitious potential of 212 $MtCO_2eq$ in 2020 in the industrial sector, the following additional climate policies and measures are suggested.

Cross-cutting issues for realising the ambitious potential in the industrial sector are the gradual phase out of subsidies for energy from fossil fuels, an ecological finance reform and the potential introduction of a domestic emissions trading scheme.

The recent mix of policy instruments could be supplemented by direct financial support for introducing energy efficient technologies and production methods. Such an instrument should also be linked to other policy instruments such as the participation in energy audits or the introduction of energy management systems in companies. Furthermore, additional policy instruments include MEPS for energy using equipment and building permits for new industrial production facilities, information and training of relevant actors or a RD&D scheme for energy efficient production technologies and methods.

9.3.2.2 Power

This section outlines existing climate policies and measures in the Korean power sector. Suggestions for improving the existing climate policy mix are given in order to exploit the GHG emissions reduction potential.

Table 28: Overview of existing climate policies and measures and suggestions for improving the existing policy mix in the power and heat sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy	• Renewable energy programme aiming at the supply and demand side	• Renewable energy targets for heat and cold supply
General economic and fiscal policy		• Ecological finance reform • *Domestic emissions trading scheme* • Gradual phase-out of energy subsidies backed by *financial and technical support for energy-efficiency and RES*
Targeted economic and fiscal policy	• Financial support for renewable energy targeting demand (e.g. cost reduction measures, preserving margin from electricity transaction costs) • Financial support for renewable energy targeting supply (test	• Feed-in tariffs or electricity quota (green certificates) for RES and CHP • *Financial support for the installation of RES technologies for cold and heat* • *Investment support for*

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
	villages) • Financial support for district heating and cooling • Financial support for energy service companies	*improvements in the conversion efficiency of fossil fuel power plants (linked to MEPS, see below)*
Regulations and voluntary agreements	• Supply of gas and nuclear power	• Favourable regulations on grid access and power purchase agreements for RES and CHP plants • Create target for energy savings from DSM by utilities to 1% per year (compared against the baseline) • Accelerated building permission procedures for RES and CHP plants • Building codes with a mandatory share of RES for heat and cold • Dynamic minimum conversion efficiency standards, regularly updated • *"CCS-ready" obligation for new built power plants*
Information and know-how transfer		• Network of local actors • Demonstration and training on RES and CHP technologies targeting contractors, retails sales staff, architects and engineers
Research and technology transfer		• *RD&D schemes for accelerated development, technical improvement and market introduction of RES and CHP technologies for electricity, heat and cold, efficient fossil fuel power plants and for analysis of CCS* • Public and co-operative procurement of RES technologies

A number of additional climate policies and measures are suggested for strengthening the existing mix in the power sector in order to exploit the ambitious potential of 112 $MtCO_2eq$ in the year 2020.

The framework for realising further emission reduction potential in the power sector could be set by an ecological finance reform, a domestic emissions trading scheme and a gradual phase out of fossil fuel subsidies backed by technical and financial support for RES technologies and energy efficiency. This would contribute to levelling the playing field for RES and energy efficiency technologies. Saved subsidies for coal and other fossil fuels could be used for financing energy-efficiency and RES. In turn, improved energy-efficiency would contribute to lowering the energy costs for consumers and outweigh the higher costs of energy due to the phase-out of subsidies.

RES and CHP technologies for electricity could be supported by favourable feed-in tariffs, regulations on power purchasing and grid access, accelerated building permission

procedures, training of local actors, public or co-operative procurement as well as RD&D activities.

RES and CHP technologies for heat and cold could contribute to reducing fossil fuel and electricity consumption for these fields of application. Based on a target for heat and cold from RES, additional policy instruments like direct investment support, building codes with a mandatory share of RES for heating and cooling or training activities for relevant actors help to realise emission reduction potential in this field.

Additional policies and measures for promoting efficient fossil fuel power plants could be targeted financial policies such as investment support for power plants with a high conversion efficiency, regulation such as minimum standards for the conversion efficiency of new built plants or a RD&D scheme.

Requiring newly built fossil fuel power plants to be designed "capture ready" could bring CCS forward. This would also have indirect implications on energy prices and make energy from fossil fuels more expensive. Support and co-operation with Annex I countries will be needed in this field.

GHG emissions stemming from the power production sector can also be indirectly targeted. Climate policy instruments and measures aiming at improving energy end-use efficiency and energy conservation in households or the industry have an effect on the country's energy demand. Especially for the household sector, a number of climate policies and measures have already been implemented. They include building codes and certificates, financial support for energy efficient buildings, MEPS for electric domestic appliances and energy labelling. A more detailed discussion of additional policy instruments for improving energy end-use efficiency in the household and service sector can be found in the sourcebook.

9.3.2.3 Transport

This section gives suggestions for improving the mix of climate policy instruments in the transport sector.

Table 29: Overview over existing climate policies and measures and suggestions for improving the existing policy mix in the transport sector (Climate policy measures and instruments for which the country needs predominantly financial assistance from Annex I countries are highlighted in *italics*)

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
Framework policy		• Targets/quotas for biofuels
General economic and fiscal policy		• Tax exemptions for sustainable biofuels • Energy taxation on fuels • Phase-out of subsidies and tax exemptions for vehicle fuels • *Domestic emissions trading scheme*
Targeted economic and fiscal policy	• Financial support for low polluting, energy efficient vehicles • Promotion of compact and hybrid cars • Promotion of diesel engines	• Road fees, congestion charges • CO_2 differentiated vehicle taxation • Depreciation rules favouring energy efficient vehicles
Regulations and voluntary agreements	• Air quality preservation act • Idle running vehicles • Expansion of public transport	• Average specific emissions target for new vehicles • Dynamic MEPS for vehicles

Category of the policy instrument	Existing climate policies and measures	Suggestions for additional climate policies and measures
	• Transport system efficiency act	components • Tighter speed limits • Spatial planning favouring non-motorised and public transport • Integrated transport planning
Information and know-how transfer	• Logistic information network • Traffic demand management systems • Information campaigns targeting idle running vehicles	• Vehicle labelling • Driver training programmes • Promotion of public transport
Research and technology transfer	• RD&D on compact and hybrid cars as well as diesel engines	• *Research on sustainable transportation systems*

The ambitious potential of about 80 $MtCO_2eq$ in 2020 in the transport sector can be realised by introducing a number of additional climate policies and measures.

The existing mix of climate policy instruments and measures in the Korean transportation sector consists of a number of promising instruments. They include mainly targeted economic and fiscal policies (e.g. financial support for efficient and low polluting vehicles), regulations (e.g. emission standards) and information measures (e.g. traffic demand management systems).

Cross-cutting policy instruments are a phase out of subsidies and energy taxation on fuels as well as a domestic emissions trading scheme in the transport sector (connected to an average specific emission target).

Aiming at different fields of application (biofuels, individual motor car transport, air transport, public transport and freight transport), additional policy instruments could support the realisation of the ambitious potential. Policy instruments for targeting biofuels include a quota and tax exemptions. For targeting vehicles, a number of different policy instruments are available. Such policy instruments could be targeted economic and fiscal policies and measures such as road charges, CO_2-differentiated vehicle taxation or favourable depreciation rules for efficient vehicles. Standards could consist of average specific emission targets for new vehicles, dynamic MEPS for vehicle components, speed limits or integrated transport planning. Additional climate policy instruments of the category information and know how transfer could be vehicle labelling, driver training programmes or promotion of public transport. A shift from road-based to rail- or waterway-based transport can be induced by direct financial support such as tax reductions or subsidies.

9.4 Options for a stronger involvement of South Korea in the international regime

South Korea belongs not only to the G77/China but also to the Environmental Integrity Group. As South Korea is an OECD member and its GDP exceeds those of some countries with economies in transition, it is one of the first candidates for graduating from the group of non-Annex I countries and taking a comparable level of commitments as industrialised countries. South Korea has substantial capacities not only in economic terms but also in technical terms, as evidenced in its second National Communication. South Korea has not yet clearly presented its position on the future of the climate regime.

9.4.1 Analysis

South Korea's scores on the indicators responsibility, capability and potential are therefore among the highest of developing countries:

- *Responsibility*: South Korea's responsibility for climate change due to its emissions excluding LULUCF is at world average.
- *Capability*: South Korea's per capita income is well above world average and closer to Annex I average. Its human development index is at Annex I average.
- *Potential:* Despite the high efficiency of the South Korean economy and the large share of nuclear power in electricity production, the mitigation potential is substantial. According to the figures from Phase II of the project, the no-regret potential to reduce 2020 emissions below BAU levels amounts to 133 Mt, the co-benefit potential to 200 Mt and the ambitious mitigation potential to 443 $MtCO_2eq$. These would be equal to a 13%, 19% or 42% reduction compared to BAU levels respectively, and a +38%, +28% or -9% change compared to 1990 emissions levels.

Earlier analyses put South Korea also at a high level compared to other developing countries. Ott et al. (2004) classify South Korea as "newly industrialised country" implying an absolute limitation or reduction target with some funding provided from Annex II countries. Others find that South Korea would have to accede to Annex I very soon if emissions/capita or GDP/capita thresholds are applied (Höhne et al. 2005).

In addition, South Korea disposes of all the technical capacity necessary to quantify emissions and reductions. South Korea is at a very high level of development compared to the other countries considered in this report. Its policy-making is advanced. In the National Communication detailed data are available for all gases and sectors from 1990 to 2001 (Government South Korea 2003).

9.4.2 Suggestions for a potential contribution

Given the need for mobilising almost the full ambitious mitigation potential and based on the above analysis, we suggest that it would be equitable and feasible for South Korea to join Annex I and commit to an absolute and binding national emission limitation target. South Korea's target could be set at about a level correlated to the ambitious emission reduction potential, i.e. at about 604 $MtCO_2eq$ annual emissions in 2020. This would be equal to a 42% reduction compared to 2020 BAU levels and a 9% decrease compared to 2005 levels.

South Korea would be able to participate fully in international emissions trading under Article 17 of the Kyoto Protocol. Hosting JI projects but not CDM projects would be possible. No direct transfers of resources would be made to South Korea.

10. Resulting overall framework

In the previous chapters we have described the national circumstances of the six countries, the mitigation potential and a possible contribution to the international climate regime.

Table 30 includes a summary of the suggested contributions from the countries covered above ordered by decreasing overall stringency. Based on their respectively high and low levels of economic development, we propose that it would be equitable for South Korea to join Annex I and for India to commit to implementing Sustainable Development Policies and Measures. We present two options for Mexico, Brazil, South Africa and China.

In option A, Mexico, Brazil, South Africa and China would commit to national or sectoral no-lose targets to be set at the "ambitious level" but subject to financial support by Annex I countries outside of the carbon market. Together with a 30% reduction below 1990 levels for

Annex I countries, these contributions would allow to bring global emissions on a 2°C trajectory (see section 11).

An alternative framing (option B) could be envisaged that is equally stringent but is relying more on the carbon market as financing instrument and not on additional financial assistance. In this alternative framing Mexico, Brazil, South Africa and China would commit to no-lose targets in the same sectors at their co-benefit potential. To bring global emissions on a 2°C trajectory, the target for Annex I countries would then need to be 45% below 1990 in 2020, not 30%. The additional 15 percentage points could be met through further domestic reductions in Annex I and/or provide additional financial resources to developing countries through demand for credits from the no-lose targets. In this alternative, Annex I countries would provide technical assistance to remove non-market barriers, but not substantial additional resources outside of the carbon market to developing countries to directly reduce emissions.

Table 30. Summary of illustrative example contributions for 2020 ordered by decreasing overall stringency

Country	Type	Scope	Option A		Option B	
			Emission level	Financing	Emission level	Financing
South Korea	Absolute and binding national emission limitation target	All sectors	Well below BAU (e.g. 40%)	No additional financing	Well below BAU (e.g. 40%)	No additional financing
Mexico	Absolute no-lose emission target	All sectors	Well below BAU (e.g. 40%)	Conditional on financial support	Below BAU (co-benefit potential, e.g. 15%)	Technical assistance to reach co-benefit potential
Brazil	Absolute no-lose emission target	All sectors	Well below BAU (e.g. 15%)	Conditional on financial support	Below BAU (co-benefit potential, e.g. 6%)	Technical assistance to reach co-benefit potential
South Africa	Sectoral no-lose targets	Power production and industry sector	Well below BAU (e.g. 35%)	Conditional on financial support	Below BAU (co-benefit potential, e.g. 18%)	Technical assistance to reach co benefit potential
	Sustainable development policies and measures	Remaining sectors	Not quantified		Not quantified	
China	Sectoral no-lose targets	Power production, iron/steel and cement sectors	Well below BAU (e.g. 30%)	Conditional on financial support	Below BAU (co-benefit potential, e.g. 14%)	Technical assistance to reach co benefit potential
	Sustainable development policies and measures	Remaining sectors	Not quantified		Not quantified	
India	Sustainable development policies and measures	All sectors	Well below BAU	Conditional on financial support	Well below BAU	Conditional on financial support

We observe from the table a differentiation between the countries ranging from Annex I like commitments to moderate supported emission reductions. We also observe that the proposed reduction level varies between countries based on our analysis of mitigation potential.

11. Consistency with 2°C limit

The IPCC in its Fourth Assessment Report specifies the requirements of global emissions to be in line with global average temperature increase of 2°C: global emissions need to peak by 2015 and decline to 50 to 85% below 2000 levels by 2050 (IPCC 2007a). In this section we test whether the ambition level provided in this report is consistent with the 2°C limit.

Taken together, the reduction potential of all the considered countries, Brazil, China, India, Mexico, South Korea, South Africa, would amount to 9% (no-regret) 15% (co-benefit), and 31% (ambitious potential) compared to the BAU of these countries (excluding LUCF). Assuming a reduction of 30% below 1990 emissions by 2020 by Annex I countries, this would lead to global emissions of +41% above 1990 emissions (no-regret), +37% above 1990 emissions (co-benefit) and +27% above 1990 emissions (ambitious potential).

Figure 22 below on the left hand side shows global greenhouse gas emissions up to 2020 under the business-as-usual scenario split into Annex I and non-Annex I countries. The reduction potential identified here as “non-Annex I” includes only the potential identified in this report for the six countries for the ambitious scenario. Additional mitigation potential in non-Annex I countries other than the six analysed here would be available in addition. It will, however, be lower as the six countries cover more than 50% of the emissions of non-Annex I countries in 2020. Annex I countries are assumed to reduce emissions 30% below the 1990 level.

The right hand side of the picture shows possible emission paths that aim at limiting global average temperature increase to 2°C. To asses this we have made the following assumptions (for a detailed description of the methodology see Höhne and Blok 2006):

- In all cases it is assumed that anthropogenic CO_2 emissions from deforestation and afforestation are constant from 1990 to 2020 at 1 GtC. (Estimates for these emissions vary significantly between 0.5 and 2 GtC. Reference emissions are usually assumed to decline during the middle of the century.)
- After 2020 global CO_2 emissions (all sources and countries together) are assumed to decline so that CO_2 concentration in 2100 is below 400 ppmv: In a first phase after 2020, the *trend* in global CO_2 emissions is assumed to decline by 0.5 percentage points per year. In a second phase (as of 2030 to 2045) global CO_2 emissions decline by a constant percentage. In all cases, CO_2 concentration in 2020 is already at 400 to 415ppmv, rises further (430 to 455 ppmv in around 2040) and finally declines to reach 400 ppmv in 2100.
- The calculations are performed on the basis of CO_2 only. All other greenhouse gases are assumed to be reduced at the same rate. The CO_2 equivalent concentration in 2100 would be roughly 450 ppmv CO_2eq.

We present these global pathways for 5 cases:

- Starting from the BAU case in 2020, emissions would need to decline by about 10% per year after 2020 to keep the CO_2 concentration below 400 ppmv, making it virtually impossible to reach the 2° goal.

- In case Annex I countries reduced emissions by 30% by 2020 and the six considered non-Annex I countries followed their BAU, global CO_2 emissions would need to decline by 4.9% per year over several decades, still a very demanding task.
- If Annex I reduced by 30% and those six non-Annex I countries met their whole co-benefit potential, global emissions would need to decline by 4.3% per year.
- If Annex I reduced by 30% and those six non-Annex I were able to reduce emissions according to their ambitious potential as calculated here, global emissions would need to decline by 3.5 % per year.

Keeping in mind the uncertainties of the calculations, we still conclude from the figure the encouraging finding that global emission growth from 2010 to 2020 can be halted by implementing the ambitious scenario in the six non-Annex I countries. But after 2020, substantial further global reductions are necessary to stay below the 2°C limit.

We assumed here implicitly that emissions from land-use change and forestry would follow the same path as all other emissions after 2020. Including the specific mitigation potential of the LUCF sector, the reductions after 2020 for the other sectors could be relaxed a little. The reason is that most business-as-usual scenarios already describe a *decline* in LUCF emissions in the early half of the century.

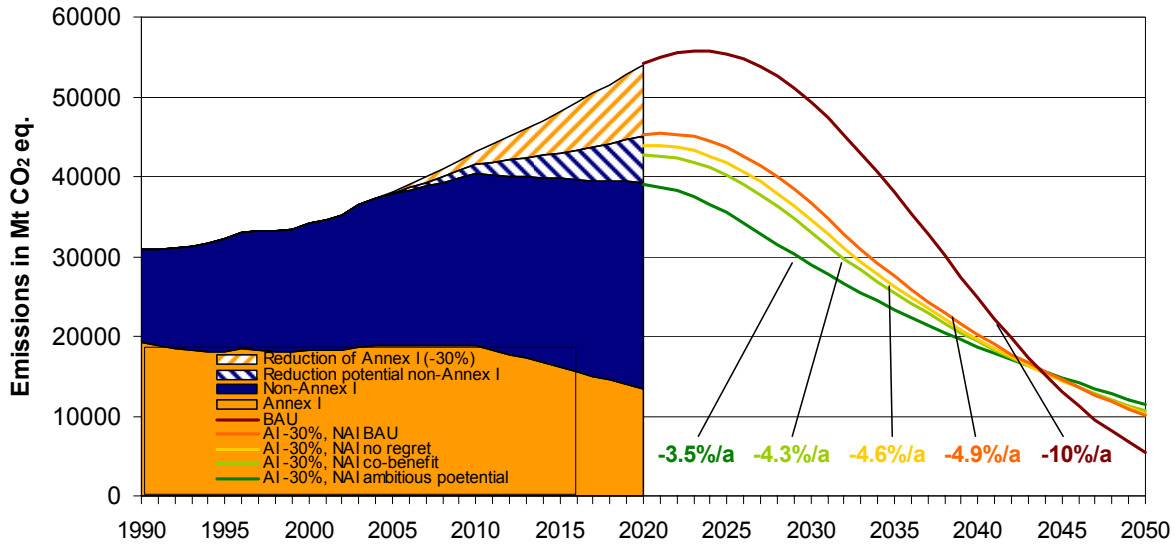


Figure 22. Global greenhouse gas emissions including reduction scenarios for Annex I (-30% domestic reductions compared to 1990 by 2020) and non-Annex I (ambitious potential reductions for Brazil, China, India, Mexico, South Africa and South Korea between 1990 and 2020). On the right hand side possible global reduction paths under all scenarios between 2020 and 2050 are provided to stay below the 2° limit in the long term.

It is difficult to compare these findings to the IPCC Fourth Assessment Report (IPCC 2007b, figure SPM 6) as the IPCC referrers to 2030 and does not distinguish among countries. However, the report identifies an average reduction potential of about 13 $GtCO_2eq$ for the group of non-OECD countries (including Brazil, China, India, and South Africa) and of about 6 $GtCO_2eq$ for the group of OECD countries (including Mexico and South Korea) at costs below 100 USD per tCO_2eq These figures exclude transport and forestry. Transport would add another 2.5 $GtCO_2eq$ reduction potential on the global level. The ranges between minimum and maximum figures are huge and could add or subtract about 50% of the overall potential. Nevertheless, the results show that our estimates are roughly in line with the IPCC findings.

A study commissioned by Vattenfall assumes that the 2° limit can be met with emission reduction measures up to 40€/$GtCO_2eq$ on the global level (Vattenfall 2007). In the Vattenfall study this leads to about 11$GtCO_2eq$ emission reduction by 2020. This includes forestry and a high share of negative costs in the building sector. Country details are only available for China and therefore difficult to compare to our estimates. We assume at least a global reduction by 15 $GtCO_2eq$ related to higher financial efforts. We excluded LUCF and did not make assumptions on the building stock due to insufficient data in the considered countries. Other crucial assumptions are discount rates, future technology development, future development of emissions and conversion of 2° temperature increase into a global emission stabilisation level.

12. Support for enhanced mitigation action

The previous sections highlighted the need for financial support for enhanced mitigation action in the six developing countries. Substantial financial resources are necessary to make the required changes. This chapter further examines the potential role of existing mechanisms to provide the necessary resources to enhance the efforts to limit and reduce emissions and to take on the proposed commitment.

12.1 Financial support for non-Annex I countries

Financial support for a switch to low- and no-carbon technologies is a key element to enhance the participation of non-Annex I countries in the climate regime. This sub-section presents an overview of policies and measures that require financial support, based on Work Package III of this project. It analyses the pros and cons of existing instruments to provide financial support under the climate regime, and examines ways to provide the level of support necessary to enhance the participation of all six Parties. The analysis is, however, not confined to these countries but also largely applicable to other developing countries. Originally, this section was intended to devise a strategy for mobilising financial resources to realise the no-regret, co-benefit, and ambitious potential identified in Parts II and III. Due to the limited information available, however, this section can to a large extent only provide general suggestions that touch upon the role of international financial support to realise the mitigation potential.

12.1.1 Policies and measures that require financial support (by country and by sector)

Based on Part II, Part III identified additional domestic policies and measures in the three sectors with the highest emission reduction potential of each country. It also suggested that the following policies and measures could strengthen the existing policies and measures but require financial support for realisation (see Table 31). Providing adequate financial support for the policies and measures will greatly enhance the chances of participation by the six countries in a future mitigation regime. It should be noted that some of the measures identified in Part III under the heading of “non-financial support”, such as capacity building, research and development etc., also require financial resources.

Table 31. Additional policies and measures that require financial support for realisation

	Sector	Financial support
Brazil	Power	Phase-out of direct and indirect energy subsidies or energy price control backed by financial support for improving energy end-use efficiency
		Installation of RES technologies
		Investment support for improvements in the conversion efficiency of fossil fuel power plants
	Transportation	Switching from road-based to rail-or waterway based transportation in the transportation sector connected to an improved regulatory and financial framework which reduces risks and fosters investments
China	Power	Investment support for improvements in the conversion efficiency of fossil fuel power plants
		Installation of RES technologies
	Industry	Optimisation and installation of energy efficient technologies linked to energy audits and management systems
India	Power	Phase-out of direct and indirect energy subsidies or energy price control backed by financial support for improving energy end-use efficiency
		Installation of RES technologies
		Investment support for improvements in the conversion efficiency of fossil fuel power plants
	Industry	Optimisation and installation of energy efficiency technologies linked to energy audits and management systems
Mexico	Power	Phase-out of direct and indirect energy subsidies or energy price control backed by financial support for improving energy end-use efficiency
		Installation of RES technologies
		Investment support for improvements in the conversion efficiency of fossil fuel power plants
	Industry	Optimisation and installation of energy efficiency technologies linked to energy audits and management systems
South Africa	Power	Phase-out of direct and indirect energy subsidies or energy price control backed by financial support for improving energy end-use efficiency
		Installation of RES technologies
		Investment support for improvements in the conversion efficiency of fossil fuel power plants
	Industry	Optimisation and installation of energy efficiency technologies linked to energy audits and management systems
South Korea	Power	Installation of RES technologies
	Industry	Investment support for improvements in the conversion efficiency of fossil fuel power plants

12.1.2 Existing instruments in the international climate regime to provide financial support

Under the international climate regime there are two main instruments, namely financial mechanisms and the CDM, to provide financial support for projects to limit and reduce GHG emissions in non-Annex I parties. In order to examine the potential role of the two instruments and the way to improve the current instruments for realising the potential identified in Parts II and III, we compare the instruments in terms of the size of the funds, the donors, funded activities, requirements, procedure and timing of payments. The results are summarised in Table 32.

The size of the funds: While 1 billion USD will be provided through the financial mechanisms under the climate change convention in the framework of the GEF's fourth replenishment (2006-2010) (GEF 2006, p. 3), the CDM may mobilise more than 24 billion USD by 2012, given that 2.4 Gt of emissions will be reduced through the current pipeline of CDM projects that have been registered or are at the validation stage and assuming a CER price of 10 USD. Both GEF and CDM financing usually leverage total investments or co-financing that are 4-6 times higher (UNFCCC 2007, pp. 140, 164).

Donors: While the resources for the financial mechanisms are in general public money provided by the governments of Annex II parties, in the case of the CDM they are provided non only by government but also by the private sector in Annex I parties where companies can use CERs to comply with national climate policy obligations.

Funded activities: While the CDM provides resources only for projects to directly reduce GHG emissions (hard-type projects), the financial mechanisms provide also resources for infrastructure development necessary to implement the climate convention (soft-type projects), including the development of National Communications.

Requirements: Both the CDM and the financial mechanisms require baseline setting: The CDM requires that projects are "additional" and the financial mechanisms only pay for the "incremental costs". The two instruments are thus not different in terms of providing financial support for hard-type projects that were identified in Phase III. The financial mechanisms, however, cover the full costs of establishing infrastructure necessary to implement the climate convention because they are incremental.

Procedure: CDM projects follow a rather complex procedure from the approvals by host and investment Parties over validation by independent experts to registration by the CDM Executive Board. The procedure of the financial mechanisms is less complex than that of the CDM. However, in the case of the financial mechanisms the responsibility to submit project proposals and acquire GEF approval lies with the non-Annex I Parties, while the responsibility to proceed the CDM projects lies with project developers.

Timing of payments: Under the financial mechanisms, parts of the resources are provided upfront and the rest is provided during the implementation of projects. Under the CDM, some economic actors are willing to provide part of the carbon finance upfront, but the dominant business model is payment on delivery. Since projects typically require upfront financing for implementation, this feature of the CDM market seriously inhibits project development.

Table 32. Comparison of existing instruments in the international climate regime to provide financial support

	Financial Mechanisms	CDM
The size of the funds	1 billion USD through the GEF's fourth replenishment (2006-2010), in total 15 billion USD since it started.	more than 24 billion by 2012 (2.4 Gt of emission reductions (pipeline of CDM projects) * 10 USD
Donors	Governments of Annex II Parties	Governments + the private sector in Annex I parties
Funded activities	Directly reduce GHG emissions (Hard-type) + infrastructure development necessary to implement the climate convention, e.g. NATCOM (soft-type)	Projects to directly reduce GHG emissions (hard-type projects)
Requirements	"Incremental costs"	"Additionality"
Procedure	Less complex than that of the CDM but the responsibility to submit project proposals and acquire GEF approval lies with the non-Annex I Parties.	A rather complex procedure from the approvals by host and investor Parties over validation by independent experts to registration by the CDM Executive Board.

Timing of payments	Part of the resources is provided upfront and the rest is provided during the implementation of projects	The dominant business model is payment on delivery

The above comparison illustrates the following points.

First, resources currently provided by the financial mechanisms are too small compared to the secretariat's estimate that additional investment and financial flows of 200-210 billion USD will be required in 2030 for mitigation (UNFCCC 2007, pp. 100-102). The CDM has potential to make up for the gap. It should be noted, however, that the resources provided through the CDM highly depends on Annex I reductions. Bringing global emissions on a 2°C trajectory on the one hand and creating the necessary demand for carbon credits on the other would necessitate Annex I reduction targets in the range of minus 45%.

Second, the CDM also has other limits due to its tendency to focus on projects with large reduction potential as only those provide incentives for private project developers. The financial mechanisms are thus – at least for the time being – more appropriate to address the needs of many non-Annex I Parties to provide financial resources for smaller projects.

Third, the financial mechanisms are perhaps better equipped to mobilise resources for realising the co-benefit potential. This is because the GEF promotes activities in other defined areas of global environmental concern, i.e. international waters and ozone depletion (Matz 2002, p. 504). Moreover, UNEP, one of the implementing agencies of the GEF, takes the responsibility for project consistency with existing environmental treaties. Of course, projects to realise co-benefit potential can be funded also through the CDM. The co-benefit does, however, not increase the attractiveness of the CDM for private project developers.

Fourth, the implementation of non-financial support needs financial resources. The financial mechanisms have their merits in this regard because they mobilise resources for establishing the infrastructure necessary to implement the obligations stipulated in the climate change convention in a relatively easy manner. Therefore, they may be utilised to provide financial resources for non-financial support measures. A particularly good example of how to provide financial resources for policies to promote renewable energy in developing countries is presented in Box 1 on support for feed-in tariffs.

And last, both the CDM and the financial mechanisms have one deficiency because in principle they do not provide resources to projects that realise no-regret potential – due to the requirements of additionality and incremental costs. While it is possible in principle under the CDM to demonstrate additionality by proving that non-economic barriers would prevent project implementation under business-as-usual, the low number of energy efficiency projects highlights the problems encountered in practice with this approach.

Based on the above analysis, we suggest to first restructure the financial mechanisms as explained in 12.3. Second, it is recommended to enhance bi-national, regional, and multi-national cooperation in order to provide more public funds for no-regret potential and for non-financial support and, third, to mobilise more private funds in order to realise no-regret and co-benefit potential.

In order to devise a specific proposal for restructuring the financial mechanisms, for mobilising public and private funds, and for tabling a specific proposal on the best mix of tools for realising mitigation potential, more in-depth research in the following areas is required:

- First, a more detailed analysis on reduction potential realised by each policy and cost analysis for introducing and implementing each policy in the six countries;
- Second, consideration of other multi-lateral funds and ODA for having a comprehensive view of financing scheme as this study focussed its analysis on the financing scheme embedded in the UNFCCC;

- Third, a detailed analysis on the problems that existing public and private funds encounter in order to clarify the areas that the financial mechanisms, the CDM, and the other financing scheme can best target.

Box 1: Feed-in tariffs

Feed-in tariffs have proven to be the most successful instrument to promote renewable energy. First introduced in Denmark and Germany, the instrument has found its way into many countries' legislation. Even Uganda has successfully implemented a modified feed-in system, where the difference between the market price and the stipulated tariff is not passed on to the consumer but paid by the state. In the case of North-South cooperation, Annex II countries would not pay the difference to the market price, but the difference between the feed-in tariff and the long-run marginal production costs of fossil fuel power plants that would be the alternative in the grid area that is served. This would avoid funding national energy subsidies.

There have already been studies on the transferability of the German experience to China (Beschberger and Reiche 2006). More in-depth studies would be advisable. It should be pointed out, however, that the national framework and playing field for renewables must be well prepared before any financial instrument like CDM or Annex II country payments can be successfully applied (Sterk et al. 2007a).

The promotion of feed-in laws in non-Annex I countries would contribute to the economic and social development, also in terms of employment, of the region or country concerned, thus contributing to sustainable development. Supporting a feed-in system in non-Annex I countries could thus prove to be one of the most promising ways to promote low-carbon or no-carbon development. This measure could be implemented bilaterally as well as multilaterally. It would also allow easy monitoring and control, since only the power actually fed into the grid by renewable energy sources would be eligible for funding by Annex II countries.

12.2 Additional support options for enhanced mitigation action: non-financial support

Financial support is a vital element for any comprehensive climate strategy, but its efficiency and effectiveness is greatly enhanced if it is supported by other means of cooperation and support.

Non-Annex I countries could benefit greatly from enhanced non-financial support. Exchange of knowledge and cooperation in research and development are potentially effective instruments of introducing and disseminating new technologies and political instruments (de Coninck et al. 2007). This form of technology cooperation has been employed outside of the climate regime, e.g. in the "Methane to Markets Partnership" (M2M), the "Carbon Sequestration Leadership Forum" (CSLF) and the "International Partnership for the Hydrogen Economy" (IPHE). It has, however, not yet played an adequate role in the context of the FCCC and the Kyoto Protocol.

It is important that the cooperation in RD&D activities starts at an early stage in the development of a technology because at a later stage the thorny issue of Intellectual Property Rights (IPRs) often prevents common approaches. If, however, cooperation starts early, new technologies can become common goods. These efforts should therefore be part of the larger technology deal between Annex I and non-Annex I countries (12.3).

In general and for all countries, RD&D schemes are recommended for the accelerated development, technical improvement and market introduction of RES and CHP technologies for electricity, heat and cold, efficient fossil fuel power plants and in most countries for the

analysis of CCS technologies. Other promising joint RD&D activities are schemes for energy efficient production technologies and methods and on sustainable transportation systems.

In addition to these general recommendations, there are special recommendations for each country:

- Many RD&D activities in Brazil have taken place in order to foster the switch from gas to bioethanol, especially in the context of the national alcohol programme for the transport sector (Proalcool). Cooperation in this field would probably benefit Germany/Europe as much as vice versa.
- China has shown immense interest in joint activities regarding RD&D and has even proposed the establishment of a ”Multilateral Technology Acquisition Fund” (MTAF) that could buy IPRs for low- and no-carbon technologies. On the other hand, China herself has put in place restrictions on importing wind power equipment. Joint schemes for cooperation in RD&D regarding wind power therefore appear to be particularly promising. In view of the heavy reliance on coal in the power sector, the analysis of CCS technologies is particularly important.
- India has not yet shown a similar interest in technology cooperation as has China. Nevertheless there is considerable potential for mutually beneficial exchanges of ideas and concepts. This concerns the development and deployment of RES technologies (especially wind, solar and biomass) and especially the outdated energy infrastructure. Considering India’s heavy reliance on coal, there is great potential for cooperation in efficient power generation technology and CCS.
- Mexico is an advanced developing country, in some respects comparable to Annex I countries and technology cooperation can be of mutual benefit. It has a long tradition of advanced energy efficiency standards, which could provide a basis for joint research in this area. Due to the heavy reliance of Mexico on oil and gas in the power sector, there is considerable potential in RD&D cooperation concerning efficient oil and gas fuelled power plants.
- South Africa is an advanced developing country with a heavy reliance on coal in electricity generation. Therefore, joint RD&D in coal technology (support for improvements in the conversion efficiency of fossil fuel power plants) and CCS appear to be a particular attractive option. There is considerable potential for RES technologies, therefore RD&D schemes for accelerated development, technical improvement and market introduction of RES technologies for electricity, heat and cold should be considered.
- In terms of economic development and GHG emissions, South Korea resembles an Annex I country. Cooperation on RD&D thus also takes the form of industrialised country cooperation, e.g. in the context of the OECD and the IEA. Recommended are RD&D schemes for accelerated development, technical improvement and market introduction of RES and CHP technologies for electricity, heat and cold, efficient fossil fuel power plants and for the analysis of CCS technologies.

All six countries analysed in this report would furthermore benefit from cooperation in standard setting and the creation of technology mandates. This form of international technology cooperation comprises the agreement of energy efficiency standards, mandates for technologies like renewable energy or the introduction of economic incentives for the deployment of certain technologies (e.g. subsidies for RES or tax incentives). There is furthermore substantial benefit in sharing the experiences of the EU and Germany in the establishment of an ETS or an ecological finance reform.

12.3 A technology alliance with the emerging economies

The negotiations in Bali have impressively confirmed the analysis that technology cooperation with financial support between Annex I and non-Annex I countries will assume a

prominent role in the negotiations on a post-2012 agreement. Technology cooperation was pushed centre stage by non-Annex I countries very early and remained there until the end. Developing countries, especially the emerging economies, expect considerable support for choosing a low-carbon and no-carbon economic development. Articles 4.3 and 4.5 of the UNFCCC represent the legal justification for this demand. A substantial offer for cooperation in technology development and deployment could thus play a vital role for effective negotiations towards COP15/CMP5 to be held in 2009 in Copenhagen (Ott 2007a; 2007b).

The challenge and at the same time the opportunity for an enhanced participation of non-Annex I countries, lies in developing an integrated system for the development and deployment of innovative technologies. This should combine high efficiency with the capacity to gradually develop and improve because it should be designed in such a way as to allow the future integration of non-Annex I countries in a GHG control regime.

The negotiations on a new mandate for the Expert Group on Technology Transfer (EGTT) provide some important insights for potential building blocks of such a strategy. One indication for the direction is the substitution of the term “technology transfer” by the term “technology development and deployment”. Whereas the former term connotes a one-directional flow of knowledge and technologies from North to South, the latter expression carries a notion of a mutually beneficial exchange and cooperation.

The pressure for enhanced cooperation on technology comes first and foremost from China, which already in 2000 recommended the establishment of a “Mechanism for Technology Transfer“ (FCCC/SBSTA/2000/MISC.4). Recently, China recommended the establishment of a “Multilateral Technology Acquisition Fund” (MTAF). This fund should provide the financial resources to buy intellectual property rights (IPRs) and thus allow a more rapid deployment of environmentally sound technologies in non-Annex I countries.

In Bali it quickly became apparent that technology cooperation is one of the most important conditions for developing countries to take on substantial commitments in any future post-2012 framework. Through the longest negotiations in the COP history, Parties finally reached an agreement on the Bali Action Plan which mentions that “mitigation actions by developing country Parties supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner.“ (Ott et al. 2008)

In view of these developments, Annex I countries should take a positive and proactive stance on the future role of technology and financing. This is because, first, the results of the IPCC-AR4 command rapid and decisive reductions on a global scale if the global mean temperature rise is to stay below 2°C. Second, this urgency has provided non-Annex I countries – and especially the largest and most advanced of them – with quite enhanced negotiation power: Integrating these countries in the global climate regime has moved from being desirable to being an absolute necessity.

A close collaboration between Europe and the larger non-Annex I countries is essential for effective negotiations (Oberthür and Ott 1999). However, this presupposes an agreement on the basic terms of cooperation. And it cannot be expected that the first step towards such a deal will come from non-Annex I countries – this must come from the European Union (Ott 2007b; 2007a). An offer of integrated technology cooperation in the context of a new climate alliance could present such a first step. It can combine the interest of the EU in integrating the larger economies of the non-Annex I countries in a control regime with the interest of the emerging economies in new and cleaner technologies.

Such an offer should comprise **cooperation** in the research, development and deployment (RD&D) of low- and no-carbon technologies, the **elaboration of common standards** and – as its core – a substantial **commitment to financing** the switch to low- and no-carbon technologies.

It has become apparent that the switch to low- and no-carbon technologies will require much higher financial volumes – estimates of the finances required range from Euro 20-30 billion in the Stern Review (Stern 2006) to US$ 200-210 billion in 2030 according to the UNFCCC

Secretariat (2007). In the long term, innovative ways will have to be found to generate financial means of this magnitude – like the taxation of air traffic or issuing special drawing rights, which could both generate about US$ 10-15 billion. In the short and medium term, however, such a fund will probably have to be financed with public money of Annex II countries (Ott 2007a). Taking part of the means generated by auctioning the emission rights under the European Emissions Trading system would already provide a considerable part of the means required.

Such a fund should therefore be the central element of such an offer, which should be modelled on the Montreal Protocol Fund. The Multilateral Fund for the Implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer (1987), established in 1990, is one of the reasons for the astounding success of the Montreal Protocol in protecting the ozone layer. Operational from 1991, the Multilateral Fund has received contributions totalling US$ 2.2 billion and supported about 5.500 projects in 144 developing countries resulting in the phase-out of several hundred thousand tonnes of ozone depleting substances (http://www.multilateralfund.org). An important element in the success of this fund is the Executive Committee, which consists of seven developing and seven industrialised countries with a voting structure designed to ensure that neither donors nor recipients are able to dominate the body (double majority voting). This fund therefore provides a useful blueprint for financing technology alternatives to fossil fuels as well. If this fund was supposed to be established under the GEF, it's institutional set-up should nevertheless be modelled on the Montreal Protocol's fund – the decisions taken in Nairobi 2006 relating to the governing structure of the Adaptation Fund already point into this direction (Sterk et al. 2007). Parties agreed at CMP3 in Bali that the newly established Adaptation Fund Board shall consist of 16 members, with two representatives from each of the five UN regional groups, one from SIDS, one from the LDCs, two others from Annex I parties as well as two representatives of non-Annex I parties. Decisions of the Board shall be taken by consensus; if no consensus can be reached, a two-thirds majority applies. This design for the Adaptation Fund provides a workable model for a post-2012 mitigation fund.

In addition to the fund, the Montreal Protocol employed a second innovative feature in order to replace outdated technology – the Technology and Economic Assessment Panel (TEAP). These panels were established by the Meeting of the Parties in order to provide and exchange the latest information on new technologies. The members were chosen according to their expertise and were supposed to act in their personal capacity, most of them came from industry and they were engineers rather than managers. With these design features the TEAP managed to incite the spirit of competition among the members from industry in order to come up with the latest technology (Ott 1998).

Box 2: Elements of a proposal for a technology alliance

Elements of a proposal for a technology alliance:

- cooperation in the research, development and deployment (RD&D) of low- and no-carbon technologies
- elaboration of common standards
- substantial commitment to financing the switch to low- and no-carbon technologies
    - governance modelled after Montreal Protocol Fund
    - Technology and Economic Assessment Panels
- commitment for financing adaptation to climate change
    - focus on technologies that have co-benefits in terms of mitigation

This new technology cooperation must be placed within the context of the carbon markets because these emerging markets are providing the background for all activities in the fight against climate change. In the North-South context the CDM is of particular importance. Certainly, the CDM cannot substitute the specialised means of cooperation in technology development and deployment and non-Annex I countries are emphasising that the CDM cannot be seen as an implementation of Article 4.5 (SBSTA 2000). It can, however, considerably improve the conditions for technological innovation and the deployment of innovative technologies in developing countries.

The offer of such a new technology alliance could provide a vital push for the post-2012 negotiations. Greatly enhanced cooperation in technology development and deployment could easily be expanded to include technologies for adaptation to the inevitable consequences of climate change. This would provide a positive incentive for the poorer developing countries (not considered otherwise in this report) that are not expected to undertake mitigation activities but are looking for ways to improve their resilience to climate impacts.

Even if all emissions were stopped today, global warming would continue well into the future – the atmosphere is already "loaded" with an additional 0.7°C that will materialise in the course of the next 20-30 years. Already today some negative consequences of climate change are observed in many regions of the world. According to preliminary estimates by the World Bank the yearly cost to "climate-proof" development in low-income countries would be in the range of US$ 10-40 billion. This estimate was made before the last IPCC report and might have to be revised upwards. Although only an estimate, the World Bank figure indicates the magnitude of the problem and the urgent need for additional resources to be mobilised.

In the face of these challenges the efforts so far are inadequate. All in all, the financial means designated for adaptation under the GEF amount to less than one percent of the sum required. It is thus imperative to make an adequate offer for funding adaptation measures and capacity building. The interdependency of mitigation and adaptation will require some form of streamlining in any case: On the one hand, mitigation activities will have to be checked against possible impacts of climate change (like changing rainfall patterns). On the other hand, adaptation technologies should be "climate proof" as well, thus supporting not only the resilience of a country against climate change but also contributing to foster increased independence from fossil fuels and the accompanying emissions.

Such an integrated offer of financing mitigation and adaptation activities by the EU would be an expression of the openness for new and creative ways to counteract the climate crisis. This challenge requires giving up traditional forms of diplomacy that are based on narrow notions of national interest (Sachs and Ott 2007). A true partnership with the new actors from non-Annex I countries must be part of this new approach.

For the European Union, this would open up new horizons in the global arena. First, this strategy would confirm the EU as being the global leader on climate policy. Second, this would support the Lisbon strategy of turning the Union into a highly creative and competitive area. Third, this would greatly improve relations with developing countries, especially the emerging economies, thereby strengthening the geopolitical weight of the Union. And fourth, this would counteract the strategy of the US to deflect from the multilateral process by offering technology cooperation. Offering concrete and substantial support by creating a technology alliance with the South will ensure that the initiative lies again with the EU and will keep the emerging economies firmly in the multilateral UNFCCC climate regime.

13. Synthesis and conclusions

This report provides a detailed overview of the national circumstances, emission levels, mitigation potential and policies and measures for the major developing countries Brazil,

China, India, Mexico, South Africa and South Korea. These countries account for more than 50% of non-Annex I parties' emissions. The report further proposes enhanced mitigation activities for these countries and elements of international financial and non-financial support for realising these contributions.

Participation by these developing countries in a future international climate regime is often called for, but it is usually unclear how and how much these countries should participate, what kind of support they need and in which sectors. This project aim to provide a more detailed view on these six countries to understand how they could best make a contribution to the regime and how they could best be supported in limiting their greenhouse gas emissions.

The project was completed in 4 phases:

- In the first phase, we provided a literature review of the issues at hand: An overview of which types of commitments have been proposed for emerging developing countries in the literature, a first overview of policies implemented by Brazil, China, India, Mexico, South Africa and South Korea that have an effect on greenhouse gas emissions, and an overview of the literature that calculates emission reduction potential and reduction costs.
- In a second phase, we developed a bottom-up spreadsheet calculation model to describe past and possible future emission trends and reduction options in a consistent format for Brazil, China, India, Mexico, South Africa and South Korea.
- In the third phase, we outlined and analysed the existing mix of climate policy instruments and measures (based on phase I and a review by experts from the different countries) in the sectors with the highest GHG emission reduction potential of the respective country (based on the findings from phase II).
- In the fourth phase, we transferred the findings of phases II and III into the international arena. To this end, we suggested potential contributions to the mitigation of climate change by the six countries and outlined financial and non-financial support necessary to enhance the efforts of the emerging economies in limiting and reducing greenhouse gas emissions, based on the options and potential identified in phase II and the measures identified in phase III. We concluded with the proposal for a technology alliance with the emerging economies. The analysis concentrates on support in the context of the UNFCCC and the Kyoto Protocol. It was based on the principles of ecological adequacy (keeping global temperature increase below 2°C) and differentiation between the countries based on their national circumstances.

The tool developed in this project allows comparing mitigation potential across major developing countries in a comparable manner for individual sectors, which is currently not available. As in any model, the results depend on the input assumptions. However, this tool allows using the same input assumptions for all countries to compare the results.

The no-regret and co-benefit mitigation potential in the six developing countries is substantial according to our analysis. It is in the interest of these countries to achieve the reductions that are possible at no net costs (9% below reference) and reductions with a co-benefit other than climate (together 17% below reference). International support may be necessary to remove the barriers that currently prevent these reductions to occur.

Additional reduction potential is available that allows to put these countries on a path that is consistent with 2°C. Most countries, except South Korea, would need financial assistance to realise this mitigation potential.

In all six countries there are already significant policies and measures in place that lead to mitigation of GHG emissions. Examples are binding targets and financial support for expanding the use of renewable energy, demand-side management, energy audits and voluntary agreements on increasing energy efficiency, promoting public transport and consumption or emission standards for vehicles.

The existing policy packages in the six countries can be individually supplemented by additional policies to realise the mitigation potential. The type and design of the policies largely depend on the current circumstances and emission profile of the country. Major components are reducing energy subsidies and taxing fossil fuels while at the same time compensating consumers by supporting them in saving energy, feed-in tariffs for electricity from renewable sources, direct financial support for cool and heat from renewable sources as well as energy efficiency measures, demand-side management by utilities, efficiency standards for buildings and equipment, stronger support for public transport and integrated transport planning.

The proposals for the international climate regime were based on an assessment of what level of effort is needed to reach the 2°C target. It emerges that if Annex I countries reduce their domestic emissions by 2020 by 30% below 1990 levels (i.e. without purchases from the carbon market), which is ambitious, still almost the full ambitious potential in the six countries considered here needs to be mobilised to stop emission growth within the next decade.

Based on this finding, we developed two options:

- Domestic reductions of 30% for Annex I countries as well as ambitious net contributions from non-Annex I countries. These contributions would be made possible by substantial direct financial and technical assistance from Annex I to cover the higher costs compared to the BAU scenario.
- Less ambitious contributions from non-Annex I countries at the level of their co-benefit potential. To bring global emissions on a 2°C trajectory, the target for Annex I countries would then need to be 45% below 1990 in 2020, not 30%. The additional 15 percentage points could be met through further domestic reductions in Annex I and/or be used to mobilise the ambitious potential in non-Annex I through the carbon market.

Based on their respective levels of economic development, the proposals for the contributions from the individual countries range from Annex I-like commitments to moderate supported emission reductions.

As once again confirmed by the most recent climate summit in Bali, commensurate levels of financial and technical support from industrialised countries are the *conditio sine qua non* for increased mitigation action by developing countries. As the Bali Action Plan illustrates, technology cooperation and financing are prerequisites for developing countries to consider mitigation commitments in the negotiations for the post 2012 regime.

Hence, industrialised countries should take a positive and proactive stance on the future role of technology. This is because, first, the results of the fourth assessment report of the IPCC command rapid and decisive reductions on a global scale if the global mean temperature rise is to stay below 2°C. Second, this urgency has provided developing countries – and especially the largest and most advanced of them – with quite enhanced negotiation power: Integrating these countries in the global climate regime has moved from being desirable to being an absolute necessity.

An offer of integrated technology cooperation with substantial financial support in the context of a new technology alliance could present a first step. Greatly enhanced cooperation in technology development and deployment could also easily be expanded to include technologies for adaptation to the inevitable consequences of climate change, another key priority for developing countries. Such an offer would be an expression of the openness for new and creative ways to counteract the climate crisis. This challenge requires giving up traditional forms of diplomacy that are based on narrow notions of national interest. A true partnership with the newly emerging actors from non-Annex I countries must be part of this new approach.

References

Arquit Niederberger, Anne, Conrad U. Brunner, Kejun Jiang and Ying Chen. (2006, to be published). *Energy efficiency in China. The Business Case for Mining an Untapped Resource.* Draft

Beschberger, Mischa and Danyel Reiche. (2006). *Good Environmental Governance for Renewable Energies – The Example of Germany – Lessons for China?* Wissenschaftszentrum Berlin für Sozialforschung (WZB). http://www.worldfuturecouncil.org/fileadmin/user_upload/Miguel/Good_Env_Gov.pdf.

Brouns, Bernd, Stefan Lechtenböhmer and Jochen Luhmann (Eds.). (2005). *Kyoto plus – Strategies for Global Climate Policy in the 21st Century*. Annual Report 2004/2005. Wuppertal: Wuppertal Institute. http://www.wupperinst.org/download/BBR-SL-JL-kyotoplus-en.pdf (07.03.2006).

Centro Clima, (Center for Integrated Studies on Climate Change and the Environment at the Institute for Research and Postgraduate Studies of Engineering at the Federal University of Rio de Janeiro (COPPE/UFRJ)), Thelma Kurg, Magda Alparecida de Lima, Luiz Gustavo Barioni, Geralde Martha and Haroldo Machado Filho. (2006). *Greenhouse gas mitigation in Brazil: Scenarios and opportunities through 2025.* Washington DC: Center for Clean Air Policy (CCAP). http://www.ccap.org/.

Chandler, W., R. Schaeffer, Z. Dadi, P.R. Shukla, F. Tudela, O. Davidson and S. Alpan-Atamer. (2002). *Climate Change Mitigation in Developing Countries: Brazil, China, India, Mexico, South Africa, and Turkey.* Pew Center on Global Climate Change. http://www.pnl.gov/aisu/pubs/eemw/papers.htm.

Chen, Jining, Can Wang, Ke Wang, Wenija Cai, Ying Zhang and Yuan Cao. (2006). *Greenhouse gas mitigation in China: Scenarios and opportunities through 2030.* Washington DC: Tsinghua University of China, Center for Clean Air Policy (CCAP). http://www.ccap.org/.

Club de Madrid and United Nations Foundation. (2007). *A Proposal of Global Leadership for Climate Action.*

de Coninck, H.C., C. Fischer, R.G. Newell and T. Ueno. (2007). *International Technology-Oriented Agreements to address climate change.* Discussion Paper (RFF DP 06 50), No. ECN-E--07-002. Petten: ECN (Energy Research Center of the Netherlands), RFF (Resources for the Future). http://www.ecn.nl/publications/default.aspx?nr=ECN-E--07-002.

DEAT. (2004). A national climate change response strategy. Pretoria.

Deutscher Bundestag (Ed.). (2002). *Endbericht*. Bundestagsdrucksache 14/9400. Berlin: Deutscher Bundestag (Enquete-Kommission „Nachhaltige Energieversorgung unter den Bedingungen der Globalisierung und Liberalisierung“).

DME. (2003). *White paper on renewable energy.* Pretoria: Department of Minerals and Energy. http://unfccc.int/files/meetings/seminar/application/pdf/sem_sup1_south_africa.pdf.

DME. (2005). *Energy efficiency strategy of the Republic of South Africa.* Pretoria: Department of Minerals and Energy. http://www.dme.gov.za/energy/pdf/ee_strategy_05.pdf.

EDRC. (2003). *Sustainable development and climate change in South Africa. Two case studies for the development and climate change project.* Cape Town, South Africa: Energy & Development Research Centre, University of Cape Town. Developent and climate change project. http://www.developmentfirst.org/Studies/SouthAfricaCountryStudies.pdf.

Fenhann, Joergen and Adrian Lema. (2008, Updated 8 January 2007). *CDM Pipeline Overview.* http://www.cdmpipeline.org.

GEF. (1993). *Implementing the FCCC, Incremental Costs and the Role of the GEF.* Working Paper 4. Global Environment Facility.

GEF. (2006). *GEF Resource Allocation Framework: Indicative Resource Allocations for GEF-4 for the Biodiversity and Climate change Focal Areas.* Global Environment Facility.

Government China. (2004). *The People's Republic of China initial national communication on climate change. Executive Summary.* Beijing, China: Government of the People's Republic of China. http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php.

Government China. (2005). *The renewable energy law.* Beijing: Government of China. www.renewableenergyaccess.com/assets/download/China_RE_Law_05.doc.

Government Mexico. (1997). *Mexico. First national communication for the United Nations Framework Convention on Climate Change.* Mexico City: Government of Mexico. http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php.

Government Mexico. (2001). *México. 2a Communicatión Nacional ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático. [2nd national communication for the United*

Nations Framework Convention on Climate Change]. Mexico City: Government of Mexico. http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php. [Summary in English.]
Government SA. (2000). *Initial national communication under the United Nations Framework Convention on Climate Change.* Pretoria: Government of the Republic of South Africa. http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php.
Government South Korea. (2003). *Second national communication of the Republic of Korea under the United Nations Framework Convention on Climate Change.* Seoul: Government of the Republic of Korea. http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php.
Gupta, J. (2003). Engaging Developing Countries in Climate Change: KISS and Make-Up! In Michel, D. (Ed.), *Beyond Kyoto: Meeting the Long-Term Challenge of Global Climate Change*: the Johns Hopkins University Center for Transatlantic relations, Transatlantic Dialogue on Climate Change.
Höhne, Niklas and Kornelis Blok. (2006). The impact of the Kyoto Protocol on climate stabilization. In *What is next after the Kyoto Protocol? Assessment of options for international climate policy post 2012.* Amsterdam, The Netherlands: Techne Press. http://www.technepress.nl/publications.php?id=13.
Höhne, Niklas, Dian Phylipsen and Sara Moltmann. (2006). *Factors underpinning future action.* Cologne: Ecofys Germany. http://www.fiacc.net/data/Factors_underpinning_future_action.pdf.
Höhne, Niklas, Dian Phylipsen, Simone Ullrich and Kornelis Blok. (2005). *Options for the second commitment period of the Kyoto Protocol, research report for the German Federal Environmental Agency.* Climate Change 02/05, ISSN 1611-8855. Berlin: ECOFYS GmbH. http://www.umweltdaten.de/publikationen/fpdf-l/2847.pdf.
IBGE. (2006). *Database of the IBGE.* The Brazilian Institute of Geography and Statistics, Ministério do Planejamento, Orçamento e Gestão. http://www.ibge.gov.br/english/.
IEA. (2005a). *CO_2 Emissions from Fuel Combustion (2005 edition)*. Paris, France: International Energy Agency. http://data.iea.org/ieastore/co2_main.asp.
IEA. (2005b). *Energy balances.* CD database. Paris: International Energy Agency.
IEA. (2006). *CO_2 Emissions from Fuel Combustion (2006 edition)*. International Energy Agency. http://www.iea.org/w/bookshop/add.aspx?id=36.
Inclan-Gallardo, Ubaldo. (2004). *Current status and perspectives for renewable energy in Mexico.* Presentation of the Secretaría de Energía http://www.cec.org/files/PDF/ECONOMY/Pres-Inclan-RenEnergyMeeting_en.pdf.
IPCC. (2006). *IPCC guidelines for national greenhouse gas inventories*. Cambridge, UK: Cambridge University Press.
IPCC. (2007a). *Climate Change 2007. Mitigation of climate change.* IPCC Assessment Reports. Geneva, Switzerland: Working Group III, IPCC Secretariat (International Panel on Climate Change). http://www.ipcc.ch.
IPCC. (2007b). *Climate Change 2007. Mitigation of climate change. Summary for policymakers.*, IPCC Assessment Reports. Geneva, Switzerland: Working Group III, IPCC Secretariat (International Panel on Climate Change). http://www.ipcc.ch/ipccreports/ar4-wg3.htm.
IREDA. (2006). *Homepage of IREDA.* Retrieved July, 2006. Indian Renewable Energy Development Agency Limited. http://www.iredaltd.com/.
Jiang, Keijun, Ju Hui and Lin Eda. (2003). *Country study: China.* Beijing, China: The development and climate project. http://www.developmentfirst.org/Studies/ChinaCountryStudy.pdf.
La Rovere, Emilio Lèbre and Claudia do Valle Costa. (2005). *SSN 2. The SouthSouthNorth (SSN) Project. Mitigation report for Brazil.* www.southsouthnorth.org.
Margolis, Robert and Daniel Kammen. (1999). Underinvestment the Energy Technology and Policy Challenge. *Science, 285* (5428), 690-692.
Marland, G., T.A. Boden and R. J. Andres. (2003). Global, Regional, and National Fossil Fuel CO_2 Emissions. In Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy (Ed.), *Trends: A Compendium of Data on Global Change*. Oak Ridge, Tennesse., U.S.A. Available online at: http://cdiac.esd.ornl.gov/trends/emis/meth_reg.htm.
Matz, Nele. (2002). Environmental Financing: Function and Coherence of Financial Mechanisms in International Environmental Agreement. *Max Planck Yearbook of United Nations Law, 6*, 472-534.
MCT. (2004). *Brazil's initial national communication under the United Nations Framework Convention on Climate Change.* Brasilia: Ministry for Science and Technology, Government of Brazil. http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php.
Meinshausen, Malte. (2005). *On the risk of overshooting 2°C.* Paper presented at the Scientific Symposium “Avoiding Dangerous Climate Change”, MetOffice, Exeter, 1-3 February 2005. http://www.stabilisation2005.com/.

Michaelowa, Axel and Pallav Purohit. (2007). *Additionality determination of Indian CDM projects. Can Indian CDM project developers outwit the CDM Executive Board?* Paper published under Climate Strategies
MME. (2006). *Homepage of the MME.* Ministério de Minas e Energia, Govnerment of Brazil. http://www.mme.gov.br/.
MNES. (2005). *New and renewable energy policy statement 2005.* Draft II. New Delhi, India: Ministry of Non-conventional Energy Sources. http://mnes.nic.in/Rene%202005_new.pdf.
MoEF. (1992). *Policy statement for abatement of pollution.* NO. H. 11013(2)/90-CPW. New Delhi: Ministry of Environment & Forests, Government of India. http://www.envfor.nic.in/divisions/cpoll/psap.pdf.
MoEF. (2004). *India's initial national communication to the United Nations Framework Convention on Climate Change.* New Delhi: Ministry of Environment & Forests, Government of India.
MOSPI. (2006). *Database of the Central Statistical Organisation.* Ministry of Statistics and Programme Implementation, Government of India. http://mospi.nic.in.
MPNG. (2006). *Homepage of the MPNG.* Ministry of Petroleum & Natural Gas, Government of India. http://petroleum.nic.in/.
Mwakasonda, S. and H. Winkler. (2005). Carbon capture and storage in South Africa. In R. Bradley, K. A. Baumert (Ed.), *Growing in the greenhouse: Protecting the climate by putting development first* (pp. 94-109). Washington DC: World Resources Institute.
NBS. (2006). *Statistical data.* National Bureau of Statistics of China. http://www.stats.gov.cn/english/index.htm.
NDRC. (2004). *China medium and long term energy conservation plan.* Beijing: National Development and Reform Commission. http://www.beconchina.org/energy_saving.htm.
NDRC. (2006). *The outline of the eleventh five-year plan. For national economic & social development of the People's Republic of China.* Profile. Beijing: National Development and Reform Commission. http://ghs.ndrc.gov.cn/15ghgy/t20060529_70793.htm.
Oberthür, Sebastian and Hermann E. Ott. (1999). *The Kyoto Protocol - International Climate Policy for the 21st Century*. Berlin, Germany: Springer.
Ott, H E., H. Winkler, B. Brouns, S. Kartha, M. Mace, S. Huq, Y. Kameyama, A.P. Sari, J. Pan, Y. Sokona, P.M. Bhandari, A. Kassenberg, E.L. La Rovere and A. Rahman. (2004). *South-North dialogue on equity in the greenhouse. A proposal for an adequate and equitable global climate agreement.* S. Eschborn, Gesellschaft für Technische Zusammenarbeit. http://www.wupperinst.org/uploads/tx_wiprojekt/1085_proposal.pdf.
Ott, Herman E. (1998). *Umweltregime im Völkerrecht. Eine Untersuchung über neue Formen internationaler institutionalisierter Kooperation am Beispiel der Verträge zum Schutz der Ozonschicht und zur Kontrolle grenzüberschreitender Abfallverbringungen.* Baden-Baden:
Ott, Hermann E. (2007a). *Climate Policy Post-2012 – A Roadmap. The Global Governance of Climate Change.* Discussion paper. Stockholm: Tällberg Foundation. http://www.wupperinst.org/uploads/tx_wibeitrag/Ott_Taellberg_Post-2012.pdf.
Ott, Hermann E. . (2007b). *Internationale Klimapolitik 2020. Herausforderung für die deutsche (Umwelt-) Außenpolitik.* Reihe „Kompass 2020“. Berlin: Friedrich-Ebert-Stiftung. http://library.fes.de/pdf-files/iez/04691.pdf.
Ott, Hermann E., Wolfgang Sterk and Rie Watanabe. (2008). The Bali Roadmap - New Horizons for Global Climate Policy? *Climate Policy, 1/2008*.
Parliament SA. (2000). *Gas Act.* Pretoria: Parliament of the Republic of South Africa. www.info.gov.za/gazette/acts/2001/a48-01.pdf.
Peiyan, Zeng. (2005). *Keynote Remarks*. Speech of the Vice Premier, State Council, P.R. China. Paper presented at the Beijing International Renewable Energy Conference 2005, 7 November 2005, Beijing. http://www.birec2005.cn/news_show.asp?ClassId=21&id=34.
Philibert, Cedric. (2000). How could emissions trading benefit developing countries. *Energy Policy, 28* (13), 947-956. http://www.sciencedirect.com/science/article/B6V2W-40YYFVT-4/1/a96f4c7e89fb0d4d67360f7dc525368d.
Riksgränsen. (2007). *Chairman's Summary.* Paper presented at the The Midnight Sun Dialogue on Climate Change, 11-14 June 2007, Riksgränsen. http://www.sweden.gov.se/sb/d/8757.
RSA. (2006). South Africa's Country Report to the Fourteenth Session of the United Nations Commission on Sustainable Development (CSD 14) first session of the second implementation cycle (2006-2007). Pretoria: Department of Environmental Affairs & Tourism.
Sachs, Wolfgang and Hermann E. Ott. (2007). A New Foreign Policy Agenda. Environmental Politics is Resource Politics is Peace Politics. *Internationale Politik. Journal of the German Council on Foreign Relations (IP-Global Edition), 8* (1/2007), 16-22.
SBSTA. (2000). *Development and Transfer of Technology, Status of the Consultative Process (Decision 4/CP.4)*. Subsidiary Body for Scientific and Technological Advice (SBSTA). Paper

presented at the Thirteenth session, 11.-15.11.2000, Lyon. http://unfccc.int/resource/docs/2000/sbsta/misc04.pdf.
Schneider, Lambert. (2007). *Is the CDM fulfilling its environmental and sustainable development objective? An evaluation of the CDM and options for improvement.* Berlin: Öko-Institut.
SEMARNAT. (2001). *National Program of Environment and Natural Resources 2001-2006.* Mexico City, Mexico: Secretariat of the Environment and Natural Resources. http://portal.semarnat.gob.mx/english/PMA.pdf.
Shukla, P.R., R. Nair, M. Kapshe, A.Garg, S. Balasubramaniam, D. Menon and K.K. Sharma. (2003). *Development and climate. An assessment for India.* Draft. Ahmedabad: Indian Institute of Management (IIM). Developement and climate project. http://developmentfirst.org/india/report/fullreport.pdf.
Statistics South Africa. (2006). *StatsOnline.* Statistics South Africa. http://www.statssa.gov.za/.
Sterk, Wolfgang, Carmen Dienst, Sven Harmeling and Dietmar Schüwer. (2007a). *Renewable Energy and the Clean Development Mechanism. Potential, Barriers and Ways Forward. A Guide for Policy-Makers.* Berlin: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit.
Sterk, Wolfgang, Hermann E. Ott, Rie Watanabe and Bettina Wittneben. (2007b). The Nairobi Climate Change Summit (COP 12 – MOP 2): Taking a Deep Breath before Negotiating Post-2012 Targets? *Journal for European Environmental & Planning Law (JEEPL), 2/2007*, 139-148. .
Stern, Nicholas. (2006). *Stern Review: The Economics of Climate Change.* London: HM Treasury UK.
Sussman, Frances, Ned Helme, Emilio Lébre La Rovere, Sergio Jauregui, Jose Eduardo Sanhueza, Jose Alberto Garibaldi and Jake Schmidt. (2006). *Barriers to increasing clean energy investment and consumption in Latin America and the Caribbean.* Washington D.C., USA: Center for Clean Air Policy. http://www.ccap.org/international/IADB%20Clean%20Energy%20Barriers_CCAP_3-29-06.pdf.
TERI, CCAP. (2006). *Greenhouse Gas Mitigation in India: Scenarios and Opportunities through 2031.* The Energy and Resources Institute (TERI), The Center for Clean Air Policy (CCAP), New Delhi, India. http://www.ccap.org/international/Final%20India%20Report%20(Dec%202006).pdf
UN. (2004). *World Population Prospects: the 2004 revision.* United Nations Department for Economic and Social Information and Policy Analysis, New York, USA.
UNDP. (2004). *Human development report 2004.* New York, USA: United Nations Development Programme. http://hdr.undp.org/reports/global/2004/?CFID=1426232&CFTOKEN=10027022.
UNFCCC. (2007). *Background paper on analysis of existing and planned investment and financial flows relevant to the development of effective and appropriate international response to climate change.* United Nations Convention Climate Change (UNFCCC). http://unfccc.int/files/cooperation_and_support/financial_mechanism/application/pdf/background_paper.pdf.
USEPA. (2006a). *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990 – 2020.* Appendix A-D. Washington, D.C., USA: United States Environmental Protection Agency. http://www.epa.gov/nonco2/econ-inv/international.html.
USEPA. (2006b). *Global Mitigation of Non-CO_2 Greenhouse Gases.* Washington, D.C., USA: United States Environmental Protection Agency. http://www.epa.gov/nonco2/econ-inv/international.html.
Van Aardenne, J.A., F.J. Dentener, J.G.J. Olivier, C.G.M. Klein Goldewijk and J. Lelieveld. (2001). A 1 x 1 degree resolution dataset of historical anthropogenic trace gas emissions for the period 1890-1990. *Global Biogeochemical Cycles, 15(4)*, 909-928.
van Vuuren, D., Z. Fengqi, B. de Vries, J. Kejun, C. Graveland and L. Yun. (2003). *Energy and emission scenarios for China in the 21st century. Exploration of baseline development and mitigation options.* RIVM report, No. 410002001/2001. Bilthoven, the Netherlands: RIVM. http://www.rivm.nl/bibliotheek/rapporten/410002001.pdf.
Vattenfall. (2007). *Curbing climate change: Moving towards a low carbon society.* Stockholm, Sweden: Vattenfall. http://www.vattenfall.com/www/ccc/ccc/index.jsp.
Winkler, H., T. Alfstad and M. Howells. (2005a). *South African Energy Policies for Sustainable Development.* Phase 2, final report. Cape Town: Energy Research Centre, University of Cape Town. http://www.erc.uct.ac.za/recentpub.htm.
Winkler, H., M. Howells and K. Baumert. (2005b). *Sustainable development policies and measures. Institutional uissues and electrical efficiency in South-Africa.* Washington DC: Center for Clean Air Policy (CCAP).
Winkler, H., R. Spalding-Fecher, S. Mwakasonda and O. Davidson. (2002). Sustainable development policies and measures: starting from development to tackle climate change. In Baumert, K.A., O. Blanchard, S. Llose and J.F. Perkaus (Eds.), *Building on the Kyoto Protocol: Options for protecting the climate* (pp. 61-87). Washington DC: WRI. http://www.erc.uct.ac.za/harald.htm

Winkler, Harald (Ed.). (2006). *Energy policies for sustainable development in South Africa: Options for the future*. Cape Town, South Africa: Energy Research Centre, University of Cape Town. http://www.erc.uct.ac.za/recentpub.htm.

Wittneben, Bettina, Wolfgang Sterk, Hermann E. Ott and Bernd Brouns. (2006). The Montreal Climate Summit: Starting the Kyoto Business and Preparing for post-2012 The Kyoto Protocol's First Meeting of the Parties (MOP 1) and COP 11 of the UNFCCC. *Journal for European Environmental and Planning Law (JEEPL), 2/2006*, 90-100. .

World Bank. (2005). *World Bank Development indicators 2005*. Oxford University Press, New York, USA. http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20523710~menuPK:232599~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html.

World Bank. (2006). *Clean energy and development: Towards an investment framework.* Washington: The World Bank. http://siteresources.worldbank.org/DEVCOMMINT/Documentation/20890696/DC2006-0002(E)-CleanEnergy.pdf.

WRI. (2006). *CAIT - Climate Analysis Indicators Tool.* World Resource Institute. http://cait.wri.org/.

Yamin, Farhana and Joanna Depledge. (2004). *The International Climate Change Regime. A Guide to Rules, institutions and Procedures*. Cambrigde: Cambridge University Press.

Appendix A Description of performance meters

The country studies include tables with country specific indicators and related performance meters. These meters compare the country's performance to that of other countries for each of the four indicators. In general, the borders between the colours represent the non-Annex I average, world average and Annex I average (see Figure 23). As there are always small countries that are outliers at the top or bottom of the range (e.g. per capita emissions of Trinidad and Tobago are extremely high) we selected the upper boundary of the meter to exclude the top 2.5% of the population. Similarly the lower boundary excluded the bottom 2.5% of population. Hence, the full range of the meter includes 95% of the population. The indicators are out of this range for some countries (5% of the population). Values for the meters are given in Table 33.

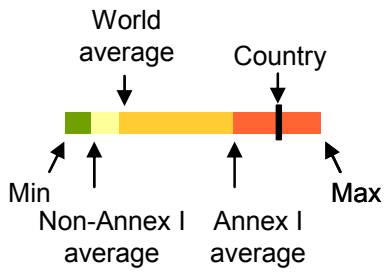


Figure 23. Calibration of performance meters

Table 33. Calibration of the meters

Indicator	Unit	Minimum excl. 2.5% lowest population	Non-Annex I average	World average	Annex I average	Maximum excl. 2.5% highest population
GHG emissions/cap	tCO_2eq/cap.	0.48	3.10	5.38	14.62	24.65
GDP PPP/cap	Ths US$/cap.	0.85	4.61	8.58	24.82	37.27
Human development Index (HDI)		0.365	0.647	0.690	0.899	0.941
GHG emissions/GDP	$kgCO_2eq$/US$	0.28	0.67	0.63	0.59	1.74
Cumulative emissions 1900 to 2004 per capita per year	tCO_2eq/cap./y	0.21	1.09	2.61	8.93	17.73
Emissions per kWh	$kgCO_2eq$ per kWh	0.01	*0.92*	0.71	*0.61*	1.37
Emissions from transport per capita	tCO_2eq	0.03	0.34	0.89	3.13	6.51
Emissions from households and services per capita	tCO_2eq	0.01	0.25	0.57	1.85	2.98
Emissions from agriculture per capita	tCO_2eq	0.22	0.84	0.88	1.10	3.22
Emissions from waste per capita	tCO_2eq	0.02	0.15	0.21	0.43	0.69
Emissions from land use change and forestry per capita	tCO_2eq	-2.69	*0.62*	0.31	*-0.96*	8.92

Data sources: GDP according to World Bank (2005), Emissions from various sources including submissions to the UNFCCC, IEA (2005a) and USEPA (2006a), population according to the UN (2004), HDI according to UNDP (2004), own calculations as compiled in Höhne et al. 2006. Cumulative emissions from are cumulative GWP weighted. CO_2 emissions are taken from Marland et al. 2003 and exclude land-use change and forestry. CH_4 and N_2O emissions are derived from national emissions for 1990 extended backward using the regional growth rates of Van Aardenne et al. 2001. The cumulative emissions are divided by the current population. Emissions/kWh are from IEA 2005a.

Usually the Annex I average is above the world average and the non-Annex I average is below the world average. When this is not the case, values are shown here in *italics* and the order of Annex I and non-Annex I averages (and the corresponding colours) in the meters are swapped.

Appendix B Overview of scenario results

Table 34. Overview of scenario results per country

	1990	2005	2020									
	BAU [Mt]	BAU [Mt]	BAU [Mt]	No-regret [Mt]	Reduction below BAU [Mt]	Reduction below BAU [%]	Co-benefit [Mt]	Reduction below BAU [Mt]	Reduction below BAU [%]	Ambitious potential [Mt]	Reduction below BAU [Mt]	Reduction below BAU [%]
Brazil												
Power production	19	39	160	123	37	23%	123	37	23%	40	120	75%
Other energy industry	9	12	20	17	3	13%	14	6	29%	11	9	44%
Industry	84	140	250	239	11	4%	239	11	4%	190	59	24%
Iron & Steel (CO2)	*12*	*22*	*38*	*33*	*5*	*14%*	*33*	*5*	*14%*	*30*	*8*	*21%*
Cement (CO2)	*17*	*23*	*38*	*33*	*5*	*13%*	*33*	*5*	*13%*	*31*	*7*	*18%*
Pulp & Paper (CO2)	*2*	*4*	*7*	*7*	*0*	*0%*	*7*	*0*	*0%*	*4*	*3*	*40%*
Rest (CO2)	*43*	*78*	*139*	*139*	*0*	*0%*	*139*	*0*	*0%*	*121*	*18*	*13%*
Households	14	18	25	25	0	0%	25	0	0%	25	0	0%
Commercial + Service	2	4	6	6	0	0%	6	0	0%	6	0	0%
Transport	101	169	320	285	35	11%	208	112	35%	156	164	51%
Agriculture	436	607	755	741	14	2%	741	14	2%	703	52	7%
Waste	35	43	72	68	4	6%	68	4	6%	50	22	30%
Non specified others	1	0	0	0	0	0%	0	0	0%	0	0	0%
LUCF	1957	1373	1373	1373	0	0%	1373	0	0%	1373	0	0%
Total	**2660**	**2408**	**2983**	**2879**	**104**	**3%**	**2796**	**187**	**6%**	**2555**	**429**	**14%**
China												
Power production	778	2013	3037	2897	140	5%	2562	474	16%	1715	1322	44%
Other energy industry	176	472	857	762	95	11%	676	181	21%	593	264	31%
Industry	1017	1621	2015	1600	415	21%	1600	415	21%	1245	770	38%
Iron & Steel (CO2)	*173*	*346*	*471*	*364*	*107*	*23%*	*364*	*107*	*23%*	*342*	*129*	*27%*
Cement (CO2)	*182*	*782*	*1011*	*751*	*259*	*26%*	*751*	*259*	*26%*	*697*	*314*	*31%*
Pulp & Paper (CO2)	*31*	*28*	*54*	*40*	*14*	*26%*	*40*	*14*	*26%*	*17*	*37*	*69%*
Rest (CO2)	*602*	*334*	*294*	*264*	*30*	*10%*	*264*	*30*	*10%*	*177*	*117*	*40%*
Households	349	251	328	328	0	0%	328	0	0%	328	0	0%
Commercial + Service	38	66	162	162	0	0%	162	0	0%	162	0	0%
Transport	132	369	986	861	125	13%	726	260	26%	591	395	40%
Agriculture	984	1209	1507	1509	-2	0%	1509	-2	0%	1412	95	6%
Waste	152	174	260	260	0	0%	260	0	0%	202	59	23%
Non specified others	40	18	20	20	0	0%	20	0	0%	20	0	0%
LUCF	224	-47	-47	-47	0	0%	-47	0	0%	-47	0	0%
Total	**3910**	**6171**	**9153**	**8376**	**777**	**8%**	**7811**	**1342**	**15%**	**6223**	**2930**	**32%**
India												
Power production	305	670	1068	960	109	10%	714	355	33%	422	647	61%
Other energy industry	26	41	93	86	8	8%	75	18	20%	63	30	32%
Industry	208	376	958	811	147	15%	811	147	15%	713	245	26%
Iron & Steel (CO2)	*52*	*115*	*408*	*338*	*70*	*17%*	*338*	*70*	*17%*	*314*	*94*	*23%*
Cement (CO2)	*44*	*85*	*263*	*190*	*73*	*28%*	*190*	*73*	*28%*	*190*	*73*	*28%*
Pulp & Paper (CO2)	*7*	*8*	*21*	*18*	*4*	*18%*	*18*	*4*	*18%*	*11*	*10*	*47%*
Rest (CO2)	*100*	*152*	*248*	*248*	*0*	*0%*	*248*	*0*	*0%*	*192*	*56*	*23%*
Households	61	99	139	139	0	0%	139	0	0%	139	0	0%
Commercial + Service	15	12	18	18	0	0%	18	0	0%	18	0	0%
Transport	102	144	496	445	50	10%	349	147	30%	265	231	47%
Agriculture	330	403	579	478	101	17%	478	101	17%	435	144	25%
Waste	94	124	199	199	0	0%	199	0	0%	165	34	17%
Non specified others	0	1	1	1	0	0%	1	0	0%	1	0	0%
LUCF	-34	-40	-40	-40	0	0%	-40	0	0%	-40	0	0%
Total	**1110**	**1835**	**3518**	**3102**	**416**	**12%**	**2742**	**775**	**22%**	**2182**	**1336**	**38%**
Mexico												
Power production	112	203	295	265	30	10%	234	61	21%	109	186	63%
Other energy industry	19	27	38	30	8	20%	25	13	33%	15	23	61%
Industry	92	81	104	87	17	16%	87	17	16%	62	41	40%
Iron & Steel (CO2)	*12*	*9*	*9*	*7*	*2*	*24%*	*7*	*2*	*24%*	*6*	*3*	*32%*
Cement (CO2)	*15*	*23*	*42*	*28*	*14*	*33%*	*28*	*14*	*33%*	*28*	*14*	*34%*
Pulp & Paper (CO2)	*3*	*1*	*2*	*2*	*0*	*9%*	*2*	*0*	*9%*	*1*	*1*	*38%*
Rest (CO2)	*59*	*39*	*34*	*34*	*0*	*1%*	*34*	*0*	*1%*	*25*	*10*	*28%*
Households	19	24	32	32	0	0%	32	0	0%	32	0	0%
Commercial + Service	3	4	4	4	0	0%	4	0	0%	4	0	0%
Transport	111	160	255	236	19	7%	187	68	27%	144	111	43%
Agriculture	72	84	108	99	9	8%	99	9	8%	87	21	19%
Waste	37	48	80	80	0	0%	80	0	0%	48	31	39%
Non specified others	0	0	0	0	0	0%	0	0	0%	0	0	0%
LUCF	136	136	136	136	0	0%	136	0	0%	136	0	0%
Total	**605**	**770**	**1055**	**973**	**82**	**8%**	**882**	**173**	**16%**	**638**	**417**	**39%**
South Africa												
Power production	153	187	202	194	8	4%	172	30	15%	135	67	33%
Other energy industry	58	49	70	61	10	14%	50	21	29%	41	29	41%
Industry	76	71	97	84	13	13%	84	13	13%	56	41	42%
Iron & Steel (CO2)	*29*	*14*	*15*	*11*	*3*	*23%*	*11*	*3*	*23%*	*8*	*7*	*48%*
Cement (CO2)	*7*	*12*	*24*	*14*	*9*	*39%*	*14*	*9*	*39%*	*14*	*10*	*42%*
Pulp & Paper (CO2)	*0*	*0*	*0*	*0*	*0*	*13%*	*0*	*0*	*13%*	*0*	*0*	*13%*
Rest (CO2)	*37*	*36*	*39*	*39*	*0*	*0%*	*39*	*0*	*0%*	*31*	*8*	*20%*
Households	8	12	15	15	0	0%	15	0	0%	15	0	0%
Commercial + Service	4	7	9	9	0	0%	9	0	0%	9	0	0%
Transport	37	59	93	84	9	10%	67	26	28%	51	42	45%
Agriculture	47	46	71	54	17	24%	54	17	24%	57	14	20%
Waste	18	22	41	41	0	0%	41	0	0%	23	17	43%
Non specified others	1	0	0	0	0	0%	0	0	0%	0	0	0%
LUCF	1	2	2	2	0	0%	2	0	0%	2	0	0%
Total	**404**	**458**	**602**	**545**	**57**	**9%**	**492**	**110**	**18%**	**389**	**212**	**35%**
South Korea												
Power production	60	170	223	203	20	9%	168	55	25%	111	112	50%
Other energy industry	24	17	29	24	5	17%	22	6	23%	17	12	41%
Industry	88	235	420	338	82	20%	338	82	20%	209	212	50%
Iron & Steel (CO2)	*3*	*16*	*13*	*11*	*1*	*11%*	*11*	*1*	*11%*	*9*	*4*	*30%*
Cement (CO2)	*25*	*36*	*35*	*22*	*12*	*36%*	*22*	*12*	*36%*	*22*	*13*	*36%*
Pulp & Paper (CO2)	*3*	*4*	*4*	*4*	*0*	*9%*	*4*	*0*	*9%*	*2*	*2*	*51%*
Rest (CO2)	*49*	*151*	*316*	*250*	*66*	*21%*	*250*	*66*	*21%*	*168*	*147*	*47%*
Households	41	34	41	41	0	0%	41	0	0%	41	0	0%
Commercial + Service	22	36	40	40	0	0%	40	0	0%	36	4	9%
Transport	55	0	242	221	21	9%	194	48	20%	162	80	33%
Agriculture	23	27	31	30	1	3%	30	1	3%	30	1	2%
Waste	29	16	42	42	0	0%	42	0	0%	24	18	43%
Non specified others	3	4	4	0	4	100%	0	4	100%	0	4	100%
LUCF	-26	-26	-26	-26	0	0%	-26	0	0%	-26	0	0%
Total	**320**	**660**	**1047**	**914**	**133**	**13%**	**846**	**200**	**19%**	**604**	**443**	**42%**
Total	**9009**	**12301**	**18358**	**16790**	**1568**	**9%**	**15570**	**2788**	**15%**	**12591**	**5767**	**31%**

Appendix C Overview of good practice policy packages

1 Introduction

1.1 Objectives of this paper

The objective of work package (WP) 3 (section X.3. of each country chapter) is to develop packages of policies, measures, and instruments able to realise the GHG mitigation potential identified in WP 2 (section X.2 of each country chapter) of the project for six emerging economies (Brazil, China, India, Mexico, South Africa, and South Korea).

The analysis in work package 3 is grouped into three steps:

- In the first step, a sourcebook for policy packages for several GHG emitting sectors (and sub sectors if appropriate) is being developed. This sectoral sourcebook is based on an analysis of most recent policy proposals e.g. by the IPCC, IEA and others on current state-of-the-art policies and measures for the respective sector. It is presented in a systematic way that reflects the different groups of policies as well as the different potential categories.
- The second step (country by country analysis) reflects for the sectors with the highest GHG mitigation potential (top-three sectors) in each of the six countries the policies already in place, those that would need to be improved or strengthened, and those policies that are missing in order to harness the full potential identified in WP 2. The sourcebook serves as background for this analysis.
- The third step analyses for each policy group, sector and country, which policies can be pursued on a national basis, and for which potential international support or international cooperation might be necessary. It serves thus as an input to work package 4.

This paper presents the results of the first step, i.e., the sourcebook for policy packages.

1.2 Sectors analysed

A Sourcebook is being developed based on most recent policy proposals for the following sectors:

- Cross-sectoral climate and energy policy instruments
- Power plants and heat production
- Industry
- Residential and commercial sector
- Transport sector
- Waste
- Agriculture

1.3 Categories of policies and measures

To be effective, climate policy strategies must take into account the complex interplay of barriers, which usually requires a package of well-designed and mutually supportive policy instruments. It will be necessary to package different policies and measures into target group- and sector-specific market transformation programmes adequately addressing the different actors in a certain sector or sub-sector on a specific field of action (e.g. renewable

energy for electricity production, energy end-use efficiency in buildings, …). These packages together will strengthen incentives and overcome barriers for all actors in the particular field[5]. For the sectoral policy sourcebook, the policies and measures are grouped into a number of categories in order to provide a more systematic overview of the range of instruments.

In general, we distinguish between five groups of policies and measures. These policy instruments target different types of GHG reduction potential such as the no-regret potential (individual benefits outweigh individual costs of GHG reduction options), the co-benefits potential (societal benefits approximately equal societal costs) and the ambitious potential (societal costs are bigger than societal benefits). The following policies can significantly contribute to exploiting the achievable GHG reduction potential by addressing various barriers through giving economic incentives, reducing transaction efforts for market actors, or setting standards:

- **A) General economic and fiscal policies and measures** are having an impact on GHG emission reductions by providing for the right price signals in the markets and economic sectors by altering price ratios: energy/CO_2 taxation, emissions trading, sustainable subsidy reform.
  Through internalising external costs or benefits and making them visible to the different actors, the no-regret and co-benefits potential for GHG reductions are targeted. In particular, the gap between both targets will be reduced, because the no-regret potential will be increased in size: better price signals are leading to higher individual benefits. Only if market actors expect further increases in energy or GHG (certificate) prices, such policies may also lead to early adoption of parts of the ambitious potential. These policies and measures are often cross-cutting to the sectoral approach but sometimes also sector-specific.

- **B) Targeted economic and fiscal policies and measures** support the search for, or implementation of the sector- and technology-specific potential, such as subsidies for energy analyses (energy audits) or investment, feed-in tariffs for electricity from renewable energy sources or from cogeneration of heat and power, or certificate schemes for energy savings or electricity from renewable energy sources. Besides the no-regret potential, these policy instruments aim at the co-benefits and ambitious potential for GHG reduction options, since they directly aim at specific fields of application, sectors or technologies.
  They either overcome barriers related to lack of information that impede the utilisation even of the cost-effective no-regret potential, or (partly) compensate investors for costs resulting from the GHG reduction activity. Such costs can be search costs (in the cases of the no-regret and co-benefits potential) or investment costs. The latter can be too high from the individual perspective but attractive from the societal perspective, i.e. in cases of a co-benefits potential; the justification for targeted financial support in such cases is to make it attractive for individuals to pursue the co-benefits potential that have a net benefit for society. However, experience shows that financial support for investments often has the biggest effect through creating awareness of the existence and the (net) benefits of GHG mitigation options, rather than through investors making a detailed calculation of their costs and benefits.
  In a case of an ambitious potential, investment costs would even be too high from the societal perspective in the short run. In such cases, targeted investment support may still be justified to address the ambitious potential, if in the long run the potential is expected to become cost-effective due to technology learning curves.

- **C) Standards and voluntary agreements** make specific technologies or measures mandatory or the default for actors and transform markets by the non-availability of certain products. Depending on their strength, these policies bear the potential for a full

[5] This study, however, only provides the framework for this. Concrete tailoring of policy packages and including their evaluation and if necessary adaptation is the task of the respective countries.

exploitation of the co-benefits and ambitious potential. In many cases, however, considerations regarding the ability of suppliers to adapt their product ranges or the cost-effectiveness for investors limit these policies to the no-regret or co-benefits potential. They reduce transaction costs and information barriers. However, such policies can only be introduced for technologies that are easy to standardise.

Standards and voluntary agreements can also create obligations to improve or exchange existing production processes or technologies, apart from the market-based incentives or disincentives provided by the economic and fiscal measures. Regulations on the use of planning procedures, e.g. in the transport sector, are also included here. Such obligations and regulations intend to widen the technology focus of public and market actors and, thereby, both to overcome information barriers and to create a level playing field. They, too, are instruments to improve the utilisation of the no-regret and co-benefits potential. Voluntary agreements are best to use when the number of market actors is relatively small, while legal standards are more widely applicable.

The following policies are more of a supportive character and should be combined with targeted policies and measures (i.e., categories B) and C)) in order to realise significant GHG reductions:

- **D) Information, know-how transfer and education** improve the knowledge basis of actors, thereby reducing transaction costs and increasing availability and uptake of climate-friendly technologies and solutions. This category also includes the necessary institutions for the know-how transfer as well as specific services that are provided for emission reduction, such as energy analyses (audits) and specialised consultancy, which can play an important role in increasing knowledge and capacity of actors and sectors. All in all, this category of policies and measures is mainly targeting a better exploitation of no-regrets and, partly, co-benefits potential. Reduced transaction costs may also increase the size of both types of potential relative to the overall (ambitious mitigation) potential.
- **E) Research and technology transfer** in order to develop new technologies for GHG mitigation and to make these technologies available. This can also be supported by demand pull through public or private targeted procurement, or through co-operative procurement.

  These types of policies will thus increase the size of the overall GHG mitigation potential, and will convert part of the ambitious potential into co-benefits or even no-regret potential.

For each of the sectors analysed, first of all, technology areas or subsectors with a significant potential for reduction of GHG emissions have been identified based on WP 2 results and existing literature (e.g. IPCC 2007; Deutscher Bundestag 2002). For each of these areas and subsectors, a package of policies and measures from the above five categories that can be considered good practice was identified. This is based, again, on the literature as well as on the Wuppertal Institute's expertise. Usually, one to three policy instruments in the package are considered to be principal instruments. These are often targeted policies and measures from categories B) or C) that have shown to be effective in practice either in OECD countries or in emerging economies, but also often includes a sustainable reform of energy subsidies that still exist in some emerging economies.

1.4 Introduction to the presentation of the results

In the following, the sourcebook is presented in the form of tables organised by sector and by the five groups of policies and measures. The **principal instruments** in each package are highlighted in **bold**.

2 Good practice policy instruments

2.1 Cross-sectoral climate policy instruments

2.1.1 Introduction

The cross-sectoral climate policy instruments include policies and measures, which set the framework for sector specific instruments aiming at a **reduction of GHG emissions stemming from fossil fuels and other sources**, **efficient use of energy** and the **application of renewable energy sources**. For this purpose, the selected policy instruments target different sectors, technologies and fields of application.

2.1.2 Sourcebook overview

The following table provides an overview of cross-sectoral climate policies and measures.

Table 35. Packages of cross-sectoral climate policies and measures

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
Reduction of fossil-fuel and other GHG emissions	**Emissions trading scheme** Joint implementation(JI), Clean Development Mechanism (CDM), Green Investment Schemes(GIS) **Gradual phase-out of energy subsidies/ Ecological finance reform**	Low carbon fund Investment support for specific GHG emissions reduction projects	**Overall GHG emissions reduction targets (e.g. minus 20% compared to baseline by 2020)** Framework for sectoral voluntary agreements Framework for technology specific voluntary agreements Framework for a fuel switch to non- or lower carbon fuel (e.g. Swedish strategy to substitute oil by 2020)	Framework for capacity building	RD&D on non or low carbon technologies, processes and methods Framework for eco-efficient public procurement and co-operative procurement schemes
Efficient use of energy	**Emissions trading scheme** **Gradual phase-out of energy subsidies/ Ecological finance reform**: Energy taxation on fossil fuels and electricity Reduction of tax exemptions, subsidies and other support of	**Energy efficiency fund** Alternatively or complementary: **Obligations** for energy suppliers or grid operators **to save energy**, with or without a White certificates scheme	Overall quantitative energy efficiency targets (at least 1 % per year vs. baseline in end-use efficiency; 1.5 % per year vs. baseline in primary energy) Framework for requirements on energy end-	Framework for energy labelling of appliances, buildings, vehicles, etc. Framework for energy auditing Framework for energy efficiency benchmarks Framework for capacity building	RD&D on energy efficiency technologies Framework for energy-efficient public procurement and co-operative procurement schemes

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
	fossil fuels Efficient organisation of electricity and gas markets Incentive-based regulation of electricity and gas transmission grids		use efficiency and energy services Framework for Eco design requirements/ MEPS for energy using products Framework for energy performance requirements of new and refurbished buildings		
Use of renewable energy sources	**Gradual phase-out of energy subsidies**	**Framework for feed-in tariffs** Alternatively: green certificates scheme	Overall quantitative renewable energy sources targets Framework for the use of renewable energy in transport and for the supply of electricity and heat	Framework for capacity building	RD&D on RES technologies Framework for public procurement and co-operative procurement schemes

2.1.3 Explanation for the choice of the policy instruments and packages

Principal cross-sectoral policy instruments for the **reduction of GHG emissions stemming from fossil fuels and other sources** are:

- overall quantitative emission reduction targets which are setting the framework for further action and allow monitoring the achievement of the targets; such targets should aim at the achievement of the no-regret and co-benefits potential, i.e. a reduction of about -30% by 2020 compared to the baseline; depending on external financial assistance, the targets could also include a part of the ambitious potential;
- policies to make the co-benefits potential financially attractive for market actors, i.e., increase the size of the no-regret potential. These policies include an emissions trading scheme as well as the gradual phase-out of energy subsidies, where these exist, and an ecological finance reform internalising the external costs connected to GHG emissions.
- These principal instruments should be supported by, e.g. frameworks for other targeted activities aiming at reducing GHG emissions.

Reducing other taxes (e.g. on labour or the general VAT) can compensate the poor and small businesses for the gradual phase-out of energy subsidies. However, financial and other assistance for reducing consumption of purchased energy through energy end-use efficiency and renewable energy are even more effective in such compensation, since they further increase the no-regret potential.

Important cross-sectoral policy instruments targeting the **efficient use of energy** include an energy efficiency fund financing general and targeted information, such as energy analyses

(energy audits), and supporting investments in energy efficiency technologies and activities. It may be funded from the government money saved through the gradual phase-out of energy subsidies. Both policy instruments therefore serve to move the size of the no-regret potential closer to that of the co-benefits potential, while the energy efficiency fund is also a general framework for organising and funding packages of targeted policies and measures that tackle all barriers simultaneously. After energy subsidies have been removed, an emissions trading scheme (for industry sectors) and an ecological finance reform internalising the external costs connected to the consumption of energy are important policies for fully tapping the co-benefits potential of energy efficiency.

Supporting cross-sectoral policy instruments for energy efficiency could be, e.g. overall quantitative energy efficiency targets (at least 1 % per year vs. baseline in end-use efficiency; 1.5 % per year vs. baseline in primary energy, justified by the large but underutilised ambitious potential of energy efficiency) as well as legal frameworks for, e.g. labelling of energy consuming technologies, information campaigns, energy audits, energy performance requirements, or RD&D on energy efficiency technologies. Where the latter are appropriate will be discussed in the respective chapters of this paper.

A framework for feed-in tariffs for **renewable energy sources** is considered the main policy instrument in this sector leading to an accelerated market penetration of renewable energy technologies for generating electricity. Experience from many countries, including, e.g. India, has proven the effectiveness of adequate feed-in tariffs. For heat and cold from renewable energy sources, the main instrument is the gradual phase-out of energy subsidies. Only if subsidies for fossil fuels or electricity no longer distort the market, it will be possible to use the potential of renewable energy that is already economic for society. These principal instruments can be supported be e.g. overall quantitative renewable energy sources targets, RD&D on renewable energy technologies, or favourable planning regulations.

2.2 Power plants and heat production

2.2.1 Introduction

The sector power plants and heat production includes **combined heat and power production** (CHP) at different scales (small-scale, medium-sized and large-scale), **renewable energy sources for electricity** as well as **heat and cold production**, **efficient fossil fuel power plants** and **carbon capture and storage** (CCS). Policy instruments targeting the different sub sectors aim at bringing technologies with low or no GHG emissions on the market, using fuel in a more efficient manner and inducing a fuel switch.

2.2.2 Sourcebook overview

In the following table, an overview of climate policy instruments targeting power plants and heat production is given.

Table 36. Packages of climate policy instruments in the sector heat and power production

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
Small-scale CHP (< 2 MW el)		**Financially attractive feed-in tariffs** defined by legislation, alternatively: bonus system Investment support, e.g. grants, soft loans Subsidies for decentralised district heating networks	**Favourable regulations** on technical and market conditions for the purchasing of CHP electricity by grid companies Favourable planning regulations for CHP and district heating	Demonstration and training on small-scale CHP technologies and their application for installation contractors, retail sales staff, architects and engineers Network of local actors	RD&D scheme for accelerated development, technical improvement and market introduction Public procurement and co-operative procurement
Medium-sized CHP		**Financially attractive feed-in tariffs** defined by legislation, alternatively: bonus system Financial incentives for the construction of new CHP plants and early replacement of inefficient plants Subsidies for district heating networks and linking industrial cogeneration facilities with neighbouring heat consumers	**Favourable planning and grid connection regulations** for CHP and district heating	Demonstration and Training on medium-sized CHP technologies and their application for installation contractors, retail sales staff, architects and engineers Network of local actors	RD&D scheme for accelerated development, technical improvement and market introduction
Large-scale CHP (> 100 MW el)	**Domestic emissions trading**, JI, CDM, GIS	Financial incentives for the construction of new CHP plants and early replacement of inefficient plants Subsidies for district heating networks, linking industrial cogeneration facilities with neighbouring heat consumers	Quantitative targets for power from large-scale CHP (CHP quota) **Favourable planning and grid connection** regulations for CHP and district heating		RD&D scheme for accelerated development, technical improvement and market introduction
Renewable energy sources (RES) for electricity	JI, CDM, GIS	**Favourable feed-in tariffs** defined by legislation Alternatively: Renewable electricity quota for electricity suppliers and	Favourable regulations on grid access and power purchase agreements Accelerated building permission procedures for	Demonstration and Training on RES technologies and their application for installation contractors, retail sales staff, architects and	RD&D scheme for accelerated development, technical improvement and market introduction Public procurement and

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
		green certificates	RES plants	engineers Network of local actors	co-operative procurement
Renewable energy sources for heat and cold	**Gradual phase-out of energy subsidies** JI, CDM, GIS	**Financial support for installation of RES technologies**, e.g. soft loans or direct investment grants	**Building codes** with a mandatory share of RES for heating and cooling	Demonstration and Training on RES technologies and their application for installation contractors, retail sales staff, architects and engineers Network of local actors	RD&D scheme for accelerated development, technical improvement and market introduction Public procurement and co-operative procurement
Efficient fossil fuel power plants	**Domestic emissions trading** JI, CDM, GIS Energy taxation of fuels	Investment support (e.g. soft loans or direct investment grants) linked to MEPS	Dynamic minimum conversion efficiency standards, regularly updated		RD&D scheme for accelerated development, technical improvement and market introduction
CCS	**Domestic emissions trading** Energy taxation of fuels		Obligation for CCS technology in new built power plants		RD&D scheme for accelerated development, technical improvement and market introduction

2.2.3 Explanation for the choice of the policy instruments and packages

Combined heat and power production (CHP) should be targeted by principally with feed-in tariffs for electricity, because they are providing economic planning reliability for investors, and by favourable regulations on planning issues, grid connection as well as technical and market conditions such as the purchasing of electricity from such plants by grid companies. Such issues regarding regulation ease the installation of CHP plants. For large-scale CHP plants, a well-designed domestic emissions trading scheme is also an important instrument since it encourages the efficient use of energy. Supporting instruments could be networks of regional actors (especially for small and medium-sized plants), demonstration and training on small- and medium-sized CHP technologies, financial support for the refurbishment or early replacement of old, and installation of new CHP plants, as well as favourable planning conditions and subsidies for district heating networks linking CHP plants with heat sinks. It will depend on the level of the feed-in tariffs or other targeted economic instruments, to which extend the no-regret, co-benefits, or even ambitious potential of CHP can be exploited.

The principal policy instrument supporting **renewable energy sources for electricity** are feed-in tariffs defined by legislation, providing economic planning reliability to investors. Again, it will depend on the level of the feed-in tariffs or other targeted economic instruments, to which extend the no-regret, co-benefits, or even ambitious potential of CHP can be exploited. This instrument should be complemented by favourable regulations regarding planning issues, connection to the grid, or obligations for grid companies to purchase that electricity. Further instruments strengthening the effect of feed-in tariffs are RD&D on

renewable energy sources for electricity, networks of local actors or accelerated building permission procedures.

Renewable energy sources for heat and cold should be targeted with building codes which request a mandatory share of heat and/or cold from renewable sources, as well as a combination of financial support for the installation of such technologies which awards going beyond the mandatory share of renewables, and the gradual phase-out of energy subsidies. The latter two instruments lift the no-regret potential towards the level of the co-benefits potential or maybe beyond, depending on the level of financial support. The mandatory share of heat and/or cold from renewable sources may usually be used to tap the co-benefits potential but might in principle also go into the ambitious potential. These principal policy instruments could be supported by e.g. RD&D activities, networks of local actors, or public and co-operative procurement to accelerate market introduction and technology learning.

Domestic emissions trading is seen as the principal policy instrument for targeting **efficient fossil fuel power plants** by giving GHG emissions from fossil fuels a price. This assumes a smaller number of large economic actors basing their investment decisions on rational economic choices. Supporting policy instruments in this sector could be energy taxation of fuels, dynamic minimum conversion standards, which are regularly updated, investment support, or RD&D activities.

Carbon capture and storage (CCS) is still an emerging and costly technology and has not been demonstrated on a large scale yet. The principal policy instrument for bringing this technology forward is a domestic emissions trading since it gives GHG emissions from fossil fuels a price and, thus, makes investments in CCS profitable. However, this technology should be supported by RD&D activities in order to further develop the technology and reduce the GHG abatement costs.

2.3 Industry

2.3.1 Introduction

Policy instruments for the industry sector include cross-cutting instruments as well as policy instruments targeting different fields of application such as process heat, process drives, specific production processes, cross-sectoral energy use and building shell including heating, ventilation and air conditioning (HVAC).

2.3.2 Sourcebook overview

In the following, an overview of climate policies and measures in the industry sector is given.

Table 37. Packages of climate policy instruments in the industry sector

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
Cross-cutting		**Package implementation and financing framework:** government or energy efficiency funds or obligation for energy companies/WC	Framework for individual voluntary agreements		
Process heat	**Emissions trading scheme**	**Financial support** for the installation and optimisation of energy-efficient	**Individual voluntary agreements** on reducing energy	**Energy audits** Benchmarking Regional	Public procurement, co-operative

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
		provision of process heat or a fuel switch to non- or low carbon fossil fuels, e.g. soft loans, grants; particularly for measures covered by the voluntary agreements and developed as results of energy audits	consumption or GHG emissions	networks of actors	procurement
Process drives	Energy taxation on electricity	**Financial support** for the installation and optimisation of energy-efficient drives, e.g. soft loans, grants	Dynamic MEPS, regularly updated **Individual voluntary agreements** on reducing energy consumption	**Energy audits** Benchmarking **Regional networks of actors**	Public procurement and co-operative procurement
Specific production processes	**Emissions trading scheme**		**Obligations to implement the best available technology (BAT)** Alternatively: Individual voluntary agreements on reducing GHG emissions Integration of GHG emission issues into permits for plant operation	**Energy audits** Benchmarking Information and training on benefits of new technology/ solutions Regional networks of actors	RD&D on energy-efficient production processes
Cross-sectoral electricity uses (compressed air, cooling, lighting, some pumping)		**Financial support** for the installation and optimisation of specific energy-efficient cross-cutting technologies	Dynamic MEPS regularly updated Individual voluntary agreements on reducing energy consumption	**Energy audits and management** Information and training on benefits of new technology/ solutions **Regional networks of actors**	Public procurement and co-operative procurement
Building shell and heating, ventialtion and air-conditioning (HVAC)	**Gradual phase-out of energy subsidies/** Energy taxation on heating fuels and electricity	**Financial support** for refurbishment towards low energy (or even passive) buildings and HVAC/lighting system optimisation to accelerate market penetration	Dynamic MEPS, regularly updated and with implementation control	**Energy audits/ analyses** Building certificates Information and training on benefits of new technology/ solutions **Regional**	RD&D on low energy/passive/ bioclimatic refurbishment concepts in existing buildings

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
				networks of actors	

2.3.3 Explanation for the choice of policy instruments and packages

The principal **cross-cutting** policy instrument in the industry sector is the financing framework for GHG reduction measures in the different fields of application. Financing support for measures facilitating individual action is essential for realising the GHG reduction potential and could come from government, an energy efficiency fund or white certificates. It should be complemented by a framework for voluntary agreements on concrete action with individual companies.

GHG emissions from **process heat** should mainly be targeted through a mix of instruments for (1) detection of possibilities for energy saving opportunities (energy audits), (2) creation of internal commitment and structures for implementation by industry companies through individual voluntary agreements on reducing GHG emissions, (3) targeted financial incentives through investment support for low GHG emissions technologies, and (4) general economic incentives through a domestic emissions trading scheme. The financial incentives are considered necessary to achieve the commitment and the actual implementation of the potential energy efficiency actions. Instruments (1) through (3) mainly target the no-regret potential, while instrument (4) also targets the co-benefits potential. However, depending on the size of the financial support, instrument (3) could also target the co-benefits and ambitious potential.

These policy instruments could be supported by benchmarks for GHG emissions making a comparison with other companies possible and easing compliance with voluntary agreements, regional networks of actors bundling knowledge regarding GHG emissions reduction opportunities and stimulating action through peers leading by good example, and public/co-operative procurement. The latter is assisting market introduction and break-through of innovative technologies, and can thus convert some of the ambitious potential into a co-benefits or no-regret potential. The other two are mainly assisting in tapping the no-regret potential.

Process drives should be targeted through the principal instruments of (1) energy audits showing saving potential, (2) networks of local actors bundling knowledge and expertise, (3) individual voluntary agreements for reducing energy consumption of motor drives, and (4) financial support for installing energy efficient process drives. The intervention logic for these policies and measures and their role in targeting the different types of potential have been described in the section on process heat.

Regarding **specific production processes**, principal policy instruments include (1) a domestic emissions trading scheme giving price signals, (2) obligations to implement the best available technology (alternatively: voluntary agreements), and (3) energy audits showing saving options. These policy instruments could e.g. be supported by RD&D on production processes with low GHG emissions, benchmarks for ranking a company's production process as well as information and training on new technologies and networks of local actors in order to spread knowledge on how to realise GHG reduction options. In this area, it is possible to work with obligations instead of targeted financial incentives, since the number of sites and companies is quite small and therefore possible to control. An example is the Best Available Technology (BAT) as part of the Integrated Pollution Prevention and Control (IPPC) regulation in the EU.

Principle policy instruments for targeting **cross-sectoral electricity uses** (including compressed air, cooling, lightning, some pumping) include financial support for energy-efficient cross-cutting technologies, energy audits and management for detecting and realising saving options, and a network of local actors bundling knowledge on energy efficiency. The intervention logic for these policies and measures and their role in targeting the different types of potential have been described in the section on process heat. Dynamic minimum energy efficiency standards or voluntary agreements for standard equipment as well as public/co-operative procurement could support these policy instruments.

Building shell and HVAC could be addressed by the principal policy instruments of (1) financial support for refurbishment towards a lower heating demand and for energy efficient building technologies in order to accelerate the market penetration of low energy buildings, combined with (2) energy audits/analyses of buildings for detecting saving options, (3) the gradual phase-out of energy subsidies where these exist, and (4) networks of local actors. This again provides for a combination of information (2) and targeted incentive (1) instruments with a general instrument to provide a level economic playing field (3). It is complemented by an instrument to strengthen knowledge on the supply-side of energy-efficient technology (4). The potential targeted by instruments (1) to (3) have been mentioned elsewhere; the networks of local actors also mainly target no-regret options. Energy taxation on heating fuels and electricity, dynamic minimum energy efficiency standards for buildings, information measures such as building certificates or information and training on energy efficient technologies as well as RD&D on energy efficient buildings could support the principal policy instruments in this subsector.

2.4 Residential and commercial sector

2.4.1 Introduction

Policy instruments for the residential and commercial sector aim at reducing GHG emissions connected to new and existing buildings (shell, HVAC and lightning), white goods as well as ICT and home electronics. Changing the behaviour and increasing the penetration of the market with energy efficient technologies are the targets of such policy instruments.

2.4.2 Sourcebook overview

In the following table, an overview of climate policy instruments in the household sector is given.

Table 38. Packages of climate policy instruments in the household and commercial sector

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
New buildings – Shell, HVAC and lighting	**Gradual phase-out of energy subsidies/** Energy taxation on heating fuels and electricity	Financial support for new-built low energy/passive/ bioclimatic buildings to accelerate market introduction Package implementation and financing framework: government or energy efficiency funds or obligation for energy companies/WC	**Dynamic MEPS**, regularly updated and with implementation control: Residential: shell and heating; Commercial: shell, HVAC and lighting	Building certificates Information and training on benefits of new technology/ solutions Regional networks of actors	RD&D on low energy/passive/ bioclimatic building concepts

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
Existing buildings – Shell, HVAC and lighting	**Gradual phase-out of energy subsidies/** Energy taxation on heating fuels and electricity	**Financial support** for refurbishment towards low energy (or even passive) buildings and HVAC/lighting system optimisation to accelerate market penetration **Package implementation and financing framework:** government or energy efficiency funds or obligation for energy companies/WC	Dynamic MEPS, regularly updated and with implementation control: Residential: shell and heating; Commercial: shell, HVAC and lighting	**Energy audits/ analyses** Building certificates Information and training on benefits of new technology/ solutions **Regional networks of actors**	RD&D on low energy/passive/ bioclimatic refurbishment concepts in existing buildings
White goods	**Gradual phase-out of energy subsidies/** Energy taxation on electricity	**Temporary financial support** for energy-efficient cold appliances to accelerate market introduction Package implementation and financing framework: government or energy efficiency funds or obligation for energy companies/White certificates scheme	**Dynamic MEPS**, regularly updated	**Energy labelling** with energy efficiency classes Targeted information campaigns	Public procurement and co-operative procurement
ICT and home electronics	Gradual phase-out of energy subsidies/ Energy taxation on electricity		**Dynamic MEPS**, regularly updated, for limiting both standby (to below 1 Watt) and on-mode consumption Alternatively: Voluntary agreements on stand-by losses and minimum standards	Energy labelling for on-mode consumption if possible (e.g. TVs) Targeted information campaigns	**Public procurement** and co-operative procurement

2.4.3 Explanation for the choice of the policy instruments and packages

New buildings including building shell, HVAC and commercial **lighting** should be targeted with dynamic minimum energy efficiency standards (MEPS), which are regularly updated (hence dynamic) and for which compliance is controlled. Such MEPS reduce the search and transaction costs for market actors, prescribe a cost-effective level of energy efficiency, and come at a relatively low cost for the government. Supporting policy instruments could be (1) the gradual phase-out of energy subsidies or energy taxation on heating fuels and electricity where these exist, giving appropriate price signals and bringing

the no-regret potential to their fair level, (2) financial support for innovative low energy buildings using much less energy than required by the MEPS, to accelerate market introduction (financed through government from the saved energy subsidies, energy efficiency fund or white certificates) and thereby to assist in making the MEPS and the no-regret potential dynamic, (3) information measures such as building certificates, information and training of planners, architects or installation contractors in order to spread knowledge on low energy building technologies and solutions, and (4) RD&D on most innovative low energy building concepts to increase the ambitious potential.

The principal policy instruments for targeting **existing buildings including building shell, HVAC and** commercial **lighting** are (1) financial support in order to increase the number of refurbishments and accelerate the market penetration of energy-efficient HVAC and lighting systems, in combination with (2) the gradual phase-out of energy subsidies where these exist, (3) energy audits for detecting the energy saving potential as well as (4) networks of local actors. The intervention logic for these policies and measures and their role in targeting the different types of potential have been described in the section on industrial building shell and HVAC in chapter 1.4. Similar to the case of new buildings, these instruments should be supported by energy taxation, building certificates, information and training of different actors, RD&D on refurbishment concepts and energy efficiency technologies for buildings, as well as minimum energy efficiency standards for refurbishments that are done anyway. Since it is not possible in practice to force building owners to take action and refurbish their existing buildings, the combination of the information instruments (energy audits and building certificates) with the targeted financial support is paramount here.

White goods should be targeted with a package including (1) energy labelling, which is providing information to the consumer and setting the framework for other policy instruments by setting up energy efficiency classes, (2) dynamic minimum energy performance standards (MEPS) for appliances in order to take the worst performing appliances out of the market, (3) the gradual phase-out of energy subsidies where these exist, and (4) temporary financial support for the most energy-efficient cold appliances in order to accelerate market introduction (financed through government from the saved energy subsidies, or an energy efficiency fund, or obligations for energy companies, or a white certificates scheme). Supporting instruments could be energy taxation of electricity, targeted information campaigns in order to inform different actors about energy saving options, benefits, and labels, and public/co-operative procurement accelerating the market introduction of the most energy-efficient appliances. The intervention logic behind this package has been described, e.g. by ECU (1997) and Michelsen (2005). Energy Labelling and MEPS have been introduced not only in many OECD countries but also in many emerging economies and developing countries. Thailand was one of the first emerging economy countries to introduce such an energy label.

ICT and home electronics should be addressed by the principal policy instruments of dynamic minimum energy efficiency standards targeting stand-by and on-mode consumption, which are regularly updated in order to take the worst performing appliances out of the market, as well as public/co-operative procurement in order to accelerate the market penetration of the most energy efficient appliances. These policy instruments could be supported by the gradual phase-out of energy subsidies or energy taxation on electricity, energy labelling for on-mode consumption, and targeted information campaigns informing about e.g. stand-by losses in order to raise the awareness of the different actors. Since the cost of saving energy in ICT technology is usually quite low, all of these instruments mainly target the no-regrets potential. Since the savings on energy costs that can be made on single appliances are quite small, it is not useful to work with financial incentives and in most cases also not with labelling, but simply to require progress in energy efficiency through the dynamic MEPS.

2.5 Transport sector

2.5.1 Introduction

Climate policy instruments for reducing GHG emissions in the transportation sector target at **sustainable biofuels**, **individual motor car traffic**, **air traffic**, **public transport** and **freight transportation**. These policy instruments aim at reducing GHG emissions from transportation through bringing energy-efficient technologies and low-carbon fuels on the market, inducing a modal shift, and changing the behaviour of travellers.

2.5.2 Sourcebook overview

This table presents policy instruments in the transportation sector.

Table 39. Packages of climate policy instruments in the transportation sector

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
Sustainable biofuels	**Tax exemptions for sustainable biofuels**		Alternative to tax exemptions: biofuel quotas **Environmental and social production standards**		RD&D on new biofuels
Individual motor car transport	**Energy taxation on fuels** Alternatively: emission trading scheme Phase-out of subsidies and tax exemptions for petrol, diesel and other vehicle fuels except sustainable biofuels	Road fees, congestion charges, etc. CO_2 differentiated vehicle taxation (reduced levels for most energy-efficient cars) and **depreciation rules** (reduced or nor depreciation for less energy-efficient cars) Financial incentives to make use of car-sharing/car-pooling and public transport (modal shift)	**Average specific emission target** (fleet target) for new cars Alternatively: Voluntary agreements with manufactures on an average emission target for new and old cars Dynamic MEPS for car components (e.g. air conditioning, tyres), regularly updated Speed limits Regulations on spatial planning favouring non-motorised and public transport Restrictions on car use in city centres or on specific car free days	Vehicle labelling Traffic management systems Driver training programmes Information and motivation for car-sharing/car-pooling and public transport (modal shift) Promotion campaigns for efficient travel planning Promotion of intermodal transit (park and ride)	RD&D on efficient and low emission technologies Public procurement of energy-efficient cars

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
Air transport	**Emissions trading scheme in the aviation sector** Energy taxation on kerosene Alternatively: increased landing fees or ticket taxes Phase-out of subsidies and tax exemptions for kerosene	Value-added tax for international travel Route pricing	**Average specific emission target (fleet target)**	Air traffic management systems	RD&D on efficient and low emission technologies
Public transport		**Financial support** of public transport (reduced user fees, public investments in infrastructure)	Restrictions on individual transport (e.g. parking restrictions, road pricing, congestion charges) Integrated transport planning	Promotion of public transport	RD&D on innovative public transport systems
Freight transport	**Energy taxation on petrol** Alternatively: emission trading scheme Phase-out of subsidies and tax exemptions for truck fuels	Financial incentives to shift freight transport from road to rail Road fees for heavy vehicles	**Average specific emission target (fleet target) for new and old lorries** Alternatively: Voluntary agreements with manufactures on an average emission target for new and old lorries Dynamic MEPS for lorry components, regularly updated Speed limits	Promotion of improving the logistic management Vehicle labelling Traffic management systems Driver training programmes Promotion of intermodal transport (combined transport on road, rail and/or waterways)	RD&D on efficient technologies

2.5.3 Explanation for the choice of the policy instruments and packages

An increased market penetration of **biofuels** can be reached through the principal policy instrument of tax exemptions for biofuels (or introducing taxation on fossil fuels for the first time) in order to make them competitive. The boom for biofuel production in countries such as Brazil can be explained by tax exemptions for ethanol in Brazil, Germany, or the USA have proven the effectiveness of such a policy. However, this policy instrument must be coupled with environmental and social production standards in order to secure that biofuels are produced in a sustainable way. RD&D on new biofuels could support an accelerated market penetration.

Individual motor car transport should be targeted in three ways: (A) improving fuel efficiency of new and existing cars, (B) improved use of existing cars, and (C) encouraging modal shifts. Route (A) is best addressed by the principal climate policy instruments of (1) a mandatory fleet average specific emission target for new cars in order to accelerate the introduction of energy-efficient vehicles on the market, (2) an energy taxation on fuels, which will also have an impact on the behaviour of car users (B), and (3) depreciation rules for vehicles differentiated according to GHG emissions – with the highest depreciation allowed for the most fuel-efficient vehicles and no depreciation for vehicles consuming more than a threshold (e.g. 170 g/km for cars).

There are a number of supporting policy instruments available in order to strengthen the principal instruments outlined above. These instruments include financial incentives such as the phase-out of subsidies and tax exemptions for fuels, road fees, vehicle taxation differentiated according to GHG emissions, financial support to make use of car-sharing or car-pooling, legislative instruments such as dynamic minimum energy efficiency standards for car components, speed limits (B) or restrictions on car use in cities (C). Supporting information measures could be vehicle labelling in order to categorise vehicles according to energy efficiency classes (A) or information measures aiming at altering the behaviour of drivers like traffic management systems (B), driver training programs (B) or promotion of modal shifts (C). Finally, RD&D measures on efficient and low emissions technologies or public/co-operative procurement of energy efficient cars could accelerate the market transition.

Most of these instruments, again, tackle the no-regret potential, while energy taxation aims to bring the no-regret potential closer to the co-benefits potential, and RD&D is intended to increase the ambitious potential. Public/co-operative procurement can also use a part of the ambitious potential and partly turn it into a co-benefits or no-regret potential, if market break-through can be accelerated.

Principle climate policy instruments for targeting **air transport** could be an emissions trading scheme in the aviation sector for internalising the external costs of air transport, and an average specific emission target for new planes in order to take the worst performing planes out of the market. These instruments appear appropriate since the number of actors, both on the side of carriers and on the side of airplane producers, is relatively small. They could be supported by energy taxation on kerosene, a phase out of subsidies for kerosene, a value-added tax for international travel, route pricing, air traffic management systems in order to reduce unnecessary air traffic, and RD&D on efficient and low emission technologies.

Public transport should be targeted through the principal policy instrument of financial support (e.g. reduced user fees and public investments in an improved infrastructure) in order to set incentives for an increased use of this mode of transportation. Supporting instruments could be restrictions on individual transport (e.g. parking restrictions or congestion charge), integrated transport planning, promotion of public transport as well as RD&D on innovative public transport systems.

Freight transportation should be targeted through the principal policy instruments of fuel taxation, which could lead to a more efficient use of lorries and a shift towards transportation on rail or waterways as well as an average specific emission target for new lorries, which could result in a higher penetration of the market with low GHG emission lorries. A number of supporting instruments are available, which are aiming at reducing GHG emissions in the freight sector. Financial instruments aiming at changing the behaviour include a phase-out of subsidies and tax exemptions for truck fuels, financial support to switch from road to rail based transport, and road fees for heavy vehicles. Legislative instruments include dynamic minimum energy efficiency standards for lorry components and speed limits. Various information measures such as vehicle labelling, information campaigns, traffic management systems or driver training programs could support the principal policy instruments. Finally, RD&D on efficient freight transportation technologies and solutions is also important. The roles of all these policies and measures are similar to those presented for individual car transport.

2.6 Waste

2.6.1 Introduction

Policy instruments in the waste sector could be divided into instruments targeting **household waste** on the one side and **industrial waste** on the other side. Waste prevention, reuse, recycling and minimising GHG gases from land-filled waste are the main targets of these policy instruments.

2.6.2 Sourcebook overview

Policy instruments in the waste sector are presented in the following table.

Table 40. Packages of climate policy instruments in the waste sector

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
Household waste		Deposit system for reusable packaging Favourable feed-in tariffs for electricity from landfill gas and/or waste incineration	**Quotas for reusable packaging** Recycling quotas for packaging waste Extended producer responsibility scheme for packaging (e.g. green dot) **Mandatory waste treatment** (mechanical, biological and/or thermal) Mandatory source separation **Obligations to capture landfill gas**	Information and motivation on waste prevention, minimisation and reuse Information on kerbside recycling	RD&D on waste preventing and minimising packaging
Industrial waste	**Waste tax based on environmental impact**	Deposit systems for reusable packaging Favourable feed-in tariffs for electricity from landfill gas and/or waste incineration	**Quotas for reusable packaging** **Recycling quotas** Alternatively: Voluntary agreements to prevent, minimise and re-use waste Extended producer responsibility scheme for	Information and motivation on waste prevention and minimisation Benchmarks on waste from specific production processes Waste audits Environmental management systems	RD&D on waste preventing and minimising technologies and production processes

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
			packaging (e.g. green dot) **Mandatory waste treatment** (mechanical, biological and/or thermal) **Obligations to capture landfill gas**		

2.6.3 Explanation for the choice of the policy instruments and packages

Principle climate policy instruments for targeting **household waste** include quotas for reusable packaging in order to prevent or minimise the occurrence of waste, mandatory waste treatment for further minimising the amount of waste as well as obligations to capture landfill gas in order to deal with GHG emissions. Supporting instruments could be a deposit system for reusable packaging, favourable feed-in tariffs for electricity from landfill gas and/or waste incineration, recycling quotas for packaging waste, an extended producer responsibility scheme for packaging or mandatory source separation. Supporting information measures include information and motivation for waste prevention, minimisation and reuse as well as information on kerbside collection. Finally, RD&D on e.g. waste minimising packaging could also support the principal policy instruments.

Industrial waste is targeted by principal climate policy instruments like a waste tax based on environmental impact in order to give financial incentives for waste prevention or minimising the amount of waste, quotas for reusable packaging and recycling as well as mandatory waste treatment and obligations to capture landfill gas. Supporting policy instruments include – besides the policy instruments, which are also targeting household waste – waste audits, environmental management systems, benchmarking as well as RD&D on waste preventing and minimising production processes.

2.7 Agriculture

2.7.1 Introduction

Climate policy instruments targeting the agricultural sector could be divided into instruments targeting **soil**, **nutrients** and **livestock**. These policy instruments mainly aim at reducing GHG emissions through changing land use patterns, farming techniques and the political framework.

2.7.2 Sourcebook overview

An overview over climate policy instruments for the agricultural sector is given in the following table.

Table 41. Packages of climate policy instruments for the agricultural sector

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer

Object of PAMs	General economic and fiscal PAMs	Targeted economic and fiscal PAMs	Standards and voluntary agreements	Information, know-how transfer and education	Research and technology transfer
Soil		Financial support for removing environmentally sensitive land from agricultural production	Requirements for conservation of agricultural land (e.g. protection from erosion) Requirements for wetland protection	Information and technical assistance for conservation measures (e.g. soil or wetland conservation)	RD&D on sustainable land-use
Nutrients	Ecological finance and subsidy reform in the agricultural sector (e.g. shift from production based support measures to direct area payments in arable production)	Financial support for sustainable agricultural production methods (e.g. organic farming, improvement of nutrient management)	Standards on fertiliser application	Information and training on good practice sustainable agricultural production methods Information and training on efficient fertiliser application (e.g. database supporting the development of nutrient management plans or crop nutrient budgets) GPS supported agricultural production methods	RD&D on sustainable agricultural production methods RD&D on fertilisers with low N_2O emissions
Livestock		Financial support for manure handling Favourable feed-in tariffs for electricity from biogas produced from manure	Standards for livestock feeding and manure handling	Information and training on good practices in livestock feeding and manure handling	RD&D on options to decrease CH_4 emissions from livestock

2.7.3 Explanation for the choice of the policy instruments and packages

Climate policy instruments targeting GHG emissions from **soil** include financial incentives for protecting sensitive soil, requirements for soil and wetland conservation, information and assistance on soil protection as well as RD&D on sustainable land use.

The efficient use of **nutrients** could be targeted through an ecological finance and subsidy reform in the agricultural sector, financial support for sustainable farming techniques, standards on fertiliser application or information on efficient fertiliser use.

GHG emissions from **livestock** should be targeted by policy instruments such as financial support for manure handling, favourable feed-in tariffs for electricity from biogas produced from manure, standards for livestock feeding and manure handling, information on such issues as well as RD&D on options to decrease GHG emissions from livestock.

References

Deutscher Bundestag (Enquete-Kommission „Nachhaltige Energieversorgung unter den Bedingungen der Globalisierung und Liberalisierung“, Hrsg.) 2002: Endbericht, Bundestagsdrucksache 14/9400, Berlin

ECU (Energy and Environment Programme, Environmental Change Unit, University of Oxford) 1997: DECADE, Transforming the UK Cold Market, 1997, Brenda Boardman et al., Oxford

IPCC (Intergovernmental Panel on Climate Change) 2007: Fourth Assessment Report, Working Group III: Mitigation

Michelsen, Christian 2005: Exploring policy space: Interactions between policy instruments on household energy efficiency, The case of domestic cold appliances in Germany, IIIEE Master’s Theses 2005: 11, Lund

Appendix D Abbreviations

AF	Adaptation Fund
AI	Annex I
AR4	Fourth Assessment Report of the IPCC
Art.	Article (*Artikel*)
AWG	Ad-hoc Working Group (on further commitments for Annex I parties)
BAU	Business-as-usual (scenario)
BIP	Gross domestic product (*Bruttoinlansprodukt*)
BRZ	Brazil
C	Carbon
CCS	Carbon capture and storage
CDM	Clean development mechanism
CH_4	Methane
CHN	China
CHP	Combined heat and power production
CO_2	Carbon dioxide
CONPET	Brazil's National Programme for the Rational Use of Natural Gas and Oil Products (*Programa Nacional da Racionalização do Uso dos Derivados do Petróleo e do Gás Natural*)
COP	Conference of the parties
DSM	Demand side management
EEI	Energy Efficiency Index
EGTT	Expert Group on Technology Transfer
ETS	Emissions Trading System
EU	European Union
FCCC	Framework Convention on Climate Change
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse gas
GIS	Green investment scheme
Gt	Giga tonnes, 10^9 tonnes
GWh	Giga watt hours, 10^9 watt hours
HDI	Human development index (developed by the United Nations)
HVAC	Heating, ventilation and air conditioning
ICT	Information and communication technology
IND	India
IPCC	International Panel on Climate Change
IPR	Intellectual property rights
JI	Joint implementation
KOR	South Korea
KP	Kyoto Protocol
KWK	Combined heat and power, CHP (*Kraft-Wärme-Kopplung*)
LDCF	Least Developing Countries Fund
LUCF	Land-use change and forestry

LULUCF	Land-use, land-use change and forestry
MEPS	Minimum energy performance standards
Mrd.	Billion (*Milliarde(n)*), 10^9
Mt	Mega tonnes, 10^6 tonnes
CO_2äquiv, CO_2eq	Carbon dioxide equivalents (*Kohlenstoffdioxidäquivalente*)
N_2O	Nitrous oxide
NAI	Non-Annex I
OECD	Organisation for Economic Co-operation and Development
PAMs	Policies and measures
ppm, ppmv	parts per million, parts per million by volume
PPP	Purchasing power parity
PROÁLCOOL	Brazil's National Alcohol Programme (*Programa Nacional do Àlcoo*l)
PROCEL	Brazil's National Electrical Conservation Programme (*Programa Nacional de Conservação de Energia Eléctrica*)
PROINFA	Brazil's Programme for Alternative Sources of Energy (*Progorama de Incentivo às Fontes Alternatives de Energiea Elétrica*)
PRONAR	Brazil's National Air Quality Control Programme (*Programa Nacional de Controle da Qualidade do Ar*)
RD&D	Research, development and demonstration
RES	Renewable energy sources
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCCF	Special Climate Change Fund
SD PAMs	Sustainable development policies and measures
THG	Greenhouse gas (*Treibhausgas*)
UNFCCC	United Nations Framework Convention on Climate Change
USD	US Dollar, US$
WC	White certificates scheme
WP	Work package
ZAF	South Africa