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# Quantifying emission reduction contributions by emerging economies

Summary



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# **Quantifying emission reduction contributions by emerging economies Summary**

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## Summary

### 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 half of 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.

This report provides a comparative analysis of greenhouse gas (GHG) emissions, including their national climate plans, of the major emitting developing countries Brazil, China, India, Mexico, South Africa and South Korea. It includes an overview of emissions and economic development, existing national climate change strategies, uses a consistent methodology for estimating emission reduction potential, costs of mitigation options, provides an estimate of the reductions to be achieved through the national climate plans and finally provides a comparison of the results to the allocation of emission rights according to different global effort-sharing approaches. In addition, the report discusses possible nationally appropriate mitigation actions (NAMAs) the six countries could take based on the analysis of mitigation options.

This report is an output of the project 'Proposals for quantifying emission reduction contributions by emerging economies' by Ecofys and the Wuppertal Institute for the Federal Environment Agency in Dessau. It builds upon earlier joint work "Proposals for contributions of emerging economies to the climate regime under the UNFCCC post 2012" published 2008.

The analysis for this report was completed before the UN climate summit in Copenhagen in December 2009. Hence, it predates the notification of NAMAs under the "Copenhagen Accord". However, the NAMAs discussed in this report and the NAMAs notified under the Copenhagen Accord operate at different levels. With the exception of Brazil, all the countries discussed in this report notified aggregate national targets under the Copenhagen Accord, either in terms of emission intensity targets or in terms of a reduction of national emissions below "business as usual." By contrast, this report discusses sector- or technology-specific NAMAs. The NAMAs discussed in this report can therefore be seen as possible ways of achieving the aggregate NAMAs notified under the Copenhagen Accord.

### 2. Methodology

The report covers four major aspects: estimating reference emissions and mitigation potential, estimating costs, comparing the outcomes with existing effort-sharing approaches, and discussing possible NAMAs as elements of comprehensive low-carbon development strategies.

#### **Estimating reference emissions and mitigation potential**

This report includes an update and further development of a bottom-up calculation tool (Höhne et al. 2008), which was designed to describe possible future emission

trends and reduction options for six emerging economies until 2020. The idea is to describe the future emission trends and emission reduction options in a consistent manner for Brazil, China, India, Mexico, South Africa and South Korea. We calculated five scenarios for all six 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 and related growth rates were taken from national studies. This was possible for Brazil, China, India and South Africa (Centro Clima et al. 2006; Chen et al. 2006; TERI and CCAP 2006; Winkler (ed.) 2007). Most of these studies include recent national policies up to the year 2005. Later policies are not considered because their level of implementation and the resulting impacts are often still unclear. For countries or sectors for which no detailed studies were available, patterns and growth-rate trends were usually assumed to be similar to those in previous years. These do not include the impact of additional policies. Consequently, this scenario may overestimate the 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 also call this scenario 'economic potential at costs below 0€/tCO<sub>2</sub>eq'. Given the economic net benefit achievable, it should be in the interest of each country to achieve this potential by using its own resources. The international community could, however, support implementation both by making technical contributions and by providing seed funding, e.g. for national revolving funds and by implementing policies and measures designed to overcome non-market barriers.

*Co-benefit:* Pathways under the co-benefit scenarios consider reduction options that are reasonable in terms of political aims other than GHG reduction. These also include reductions that incur some costs. A typical measure would be the increased use of renewable energy sources to enhance energy security and reduce dependency on importing fossil fuels or switching from diesel to gas in passenger transport (for reasons related to air quality). Recent policies such as those encouraging energy efficiency or setting 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 achieve 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 realise this scenario.

*Ambitious:* This scenario includes reduction options which can be implemented at extra net cost, while maintaining the same level of service. It includes reduction options that are technically feasible and would accelerate capital stock turnover, but would not lead to stranded investments. This potential can be achieved 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.

*National climate change plans:* This scenario includes our interpretation of the national climate change plans. At the time of analysis, all of the countries except South Korea had presented detailed climate change strategies or scenarios and in some cases other medium-term plans as well. But only Mexico and South Africa provided aggregated emission scenarios. Hence, we had to include all assumptions from these plans to generate such scenarios. However, it was difficult to quantify all plans and to

understand clearly from the plans what is additional to BAU. For South Korea we considered only preliminary summaries and an initial outline of possible targets published in August 2009. The final climate plan was published too late to be considered in this study.

### **Mitigation costs**

Our approach to estimating mitigation costs involves making an 'informed expert judgement': We examine marginal abatement cost curves (MAC curves) from various studies and then use expert judgments to derive our results. The advantage compared to just looking at the MAC curves lies in the fact that these are prone to study-related assumptions. The assumptions we made often differed tremendously from those made to construct the MAC curves we looked at. Overall, the approach is in line with the general approach in this paper: to present a transparent, simple, serious analysis of mitigation efforts in developing countries.

We used two sources of MAC curves. The first is the ECN MAC curve database. This curve is the result of a bottom-up analysis, in which MAC curves for developing countries from various sources were combined in one curve (Version April 2009). The second source we used is the SERPEC cost curve. This is a sectoral bottom-up cost curve for the EU27 that was developed by Ecofys. The full SERPEC report is published November 2009.

### **Sensitivity analysis on parameters and costs**

Due to major uncertainties in future developments and extrapolation of data we included a sensitivity analysis. This takes selected parameters to create two extreme cases: one leading to very high emissions (high case) and one leading to comparatively low emissions (low case).

The assumptions related to costs are particularly uncertain. As we used different sources, there is often more than one cost estimate available. In the cost sensitivity we used the upper and the lower cost estimate if this was available. If no range could be derived from the sources available we assumed a change of +30% (high case) and -30% (low case). The results are included in the country chapters.

### **Effort sharing**

We compare the mitigation scenarios developed here with emissions reductions required under global effort-sharing proposals that are consistent with stabilising GHG concentrations at 450 ppmv CO<sub>2</sub>eq. We used the Evolution of Commitments tool (EVOC) to quantify the required reductions under five different global effort-sharing approaches:

- Contraction and Convergence (C&C), where per-capita emissions converge at the same time for all countries
- Common but Differentiated Convergence (CDC), where per-capita emissions are reduced to a low level, earlier for developed and later for developing countries
- Greenhouse Development Rights (GDRs), where all countries reduce emissions below their reference emissions according to the principles of responsibility and capability
- Global Triptych, where all countries reduce emissions sectorally according to the same rules

- South-North Dialogue Proposal, where countries participate in different stages, developed countries earlier, developing countries later.

All approaches require developed countries to reduce their emissions by 20 to 60% by 2020 compared to 1990 level. The required reductions for the major developing countries are provided in the following sections.

### **Possible Elements of Low-Carbon Development Strategies**

Based on the analysis of emission reduction potential and related costs as outlined above, the report discusses possible elements of Low-Carbon Development Strategies (LCDS) for the six countries until 2020.

The report first discusses definitions and modalities for NAMAs and LCDS in general. Based on the discussions so far under the FCCC and within literature, the report suggests modalities for the development of NAMAs and LCDS as well as for measuring, reporting and verification. On this basis, the report discusses possible elements of LCDS for the six countries.

Regarding the level of ambition, the discussed elements of LCDS are based on the following two considerations:

- Where possible, the level of ambition is matched to the analysis of global effort sharing proposals as outlined above. This approach is taken where all effort sharing approaches show very similar results.
- In all other cases we considered that the countries should as a minimum aim at mobilising their co-benefit potential, as these measures would yield macro-economic benefits for their economies.

As a caveat it should be noted that most global effort sharing proposals suggest emission reduction targets for industrialized countries that go substantially beyond what most industrialized countries have offered so far. The suggested appropriate range is 25% to 40% below 1990 in 2020, while the current proposals add up to only 17% at the maximum and could be far less depending on the applied rules. It could therefore be argued that proposing developing countries to match their efforts to the allocations under the global effort sharing approaches would require industrialized countries to do the same.

### **3. National climate strategies**

We analysed the national climate strategies for the six countries in the study and drew the following conclusions.

**Brazil:** The national climate change plan covers all major sectors (energy, forestry and agriculture, industry, waste and transport). It provides a list of measures but the resulting reductions are only quantified for a few measures. The most important measure is the reduction of the deforestation rate, which we would judge as very ambitious. A significant number of measures are not quantifiable with the information provided. These include measures such as the possible establishment of a certification system for biofuels, further development of important programmes such as PROCEL (a programme designed to save energy) and CONPET (a programme designed to rationalise derivatives from oil and gas). In general, it was difficult to judge the overall impact of all such measures because they are often too vague and it is not clear which of the proposed measures are additional actions or are already included in the BAU.

**China:** China's national climate change strategy includes some quantified emission reduction measures, each with its emission reduction potential. An overall baseline

and mitigation scenario is not provided. The Chinese National Action Plan on Climate Change does not mandate any additional mitigation actions, but summarizes the efforts undertaken in different policy areas which have a mitigating effect on greenhouse gases. Consequently, it is sometimes unclear which of the proposed measures are additional actions or already existing. It is very hard to quantify the mitigating effects of measures for which numerical data is not provided, such as spending on research and development and emission reductions in sectors with many decentralized sources (e. g. the building and transport sectors).

**India:** The national climate plan provides eight 'national missions' in key areas. It provides several measures but only a few of them are quantified in terms of resulting emission reductions. However, detailed targets for the electricity sector are contained in the 11<sup>th</sup> five-year plan. Most of the measures in the climate plan are rather general, e.g. promoting public transport or switching fuels in industry. The plan does not provide an overall baseline and mitigation scenario. Consequently, it is sometimes unclear which of the proposed measures are additional actions or already existing. The comprehensiveness and detail of the plan corresponds with India's state of development: it focuses on development and lacks quantified options.

**Mexico:** Mexico has a very detailed national plan up to 2012. It provides measures with their effects on emissions. Even though the resulting emission reductions are not very ambitious in the short term, the plan is in line with an overall strategy to reduce emissions by 50% until 2050, which assumes moderate reductions in early years and more ambitious reductions later on.

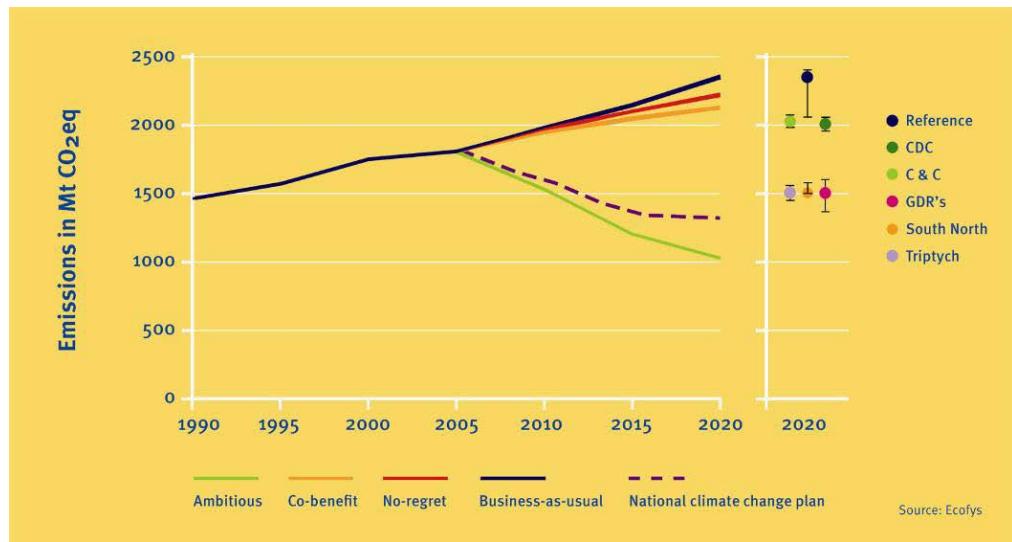
**South Africa:** South Africa has provided a comprehensive study on long-term mitigation pathways and options up to 2050. This, however, does not provide concrete plans which of the measures to implement. Emissions from coal are a major source of GHG emissions and these are currently not directly covered by the measures implemented.

**South Korea:** South Korea has announced three possible options for emission reduction targets by 2020 (a reduction to 8% above the 2005 emission level, stabilisation at the 2005 emission level or reduction to 4% below the 2005 emission level). South Korea recently provided a climate change strategy. However, it was published too late to be included in this report.

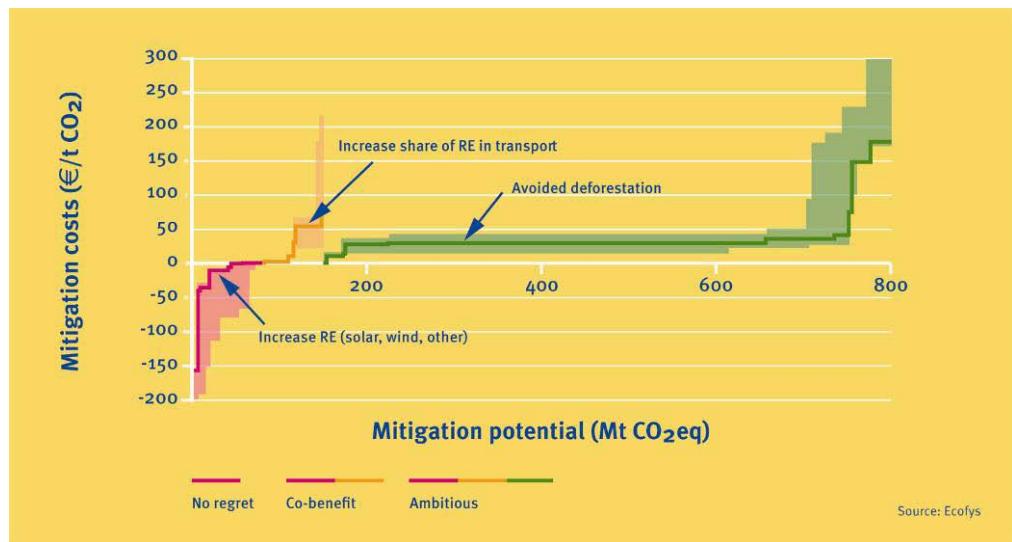
#### 4. Results

The following figures provide the emission scenarios (left), and the allocations that are compatible with stabilising GHG concentrations at 450 ppmv CO<sub>2</sub>eq according to the various global effort-sharing approaches (right).

## Brazil



**Figure 1 Emission scenarios with allowances according to a range of global effort-sharing approaches in 2020 for Brazil**



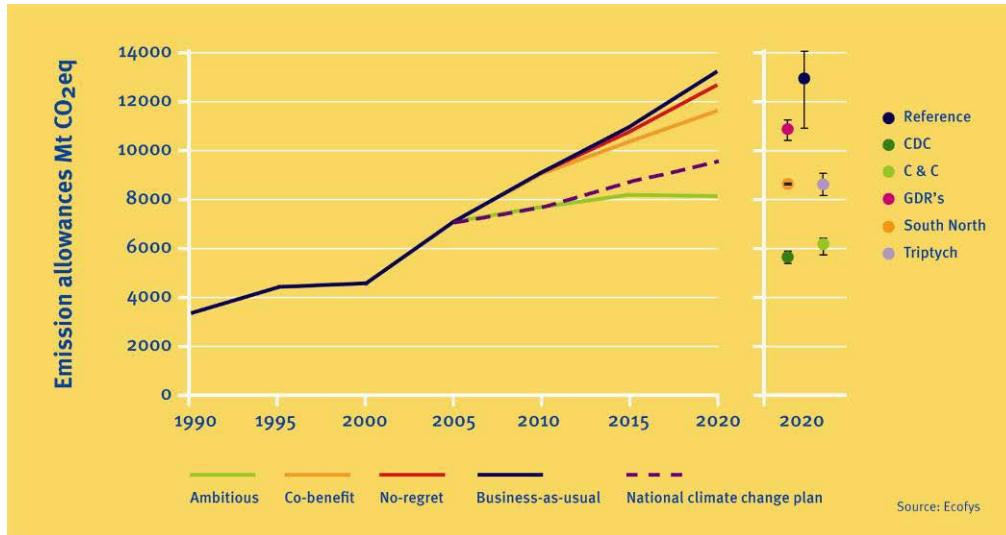
**Figure 2 Indicative mitigation costs for emission scenarios 2020 for Brazil**

The three sectors with the highest GHG emission reduction potential between 2005 and 2020 under the ambitious potential are the LUCF, transport and the power sector.

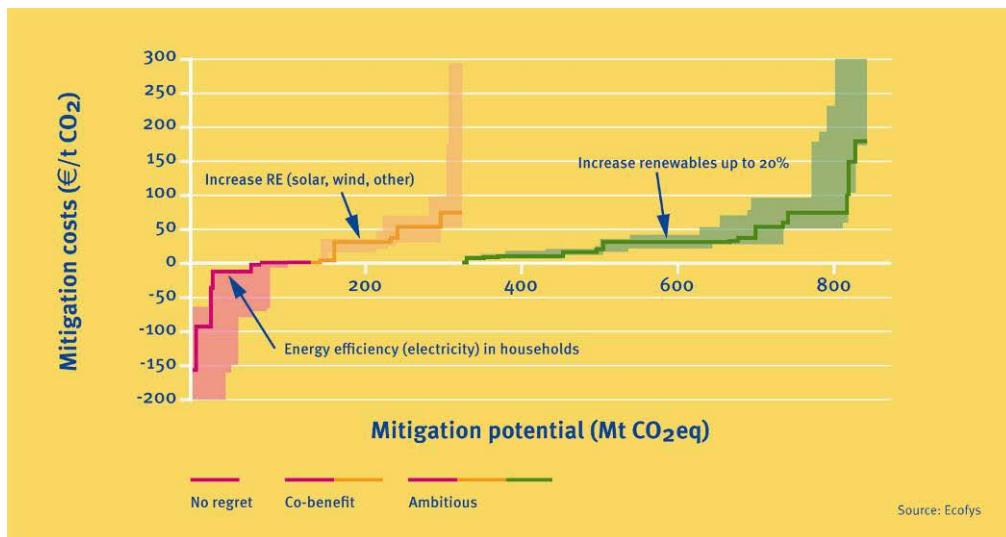
Under the no-regret scenario reductions of 5% below BAU (22% above 2005 emissions) are possible. Under the co-benefit scenario reductions of 9% below BAU (17% above 2005 emissions) are feasible. Under the ambitious scenario reductions of 37% below BAU (20% below 2005 emissions) are possible. According to our interpretation of Brazil's national climate change plan reductions of 25% below BAU (4% below 2005 emissions) are possible, but depend strongly on achieving the ambitious deforestation goal.

If Brazil can achieve its ambitious reductions in deforestation as planned, then its national plan is in line with the emission level of the global effort-sharing approaches that are based on GDP. Sharing allowances on the basis of per-capita emissions (which exclude emissions from forestry) would lead to less stringent reduction requirements.

## China



**Figure 3 Emission scenarios with allowances according to a range of global effort-sharing approaches for China**



**Figure 4 Indicative mitigation costs for emission scenarios in 2020 for China**

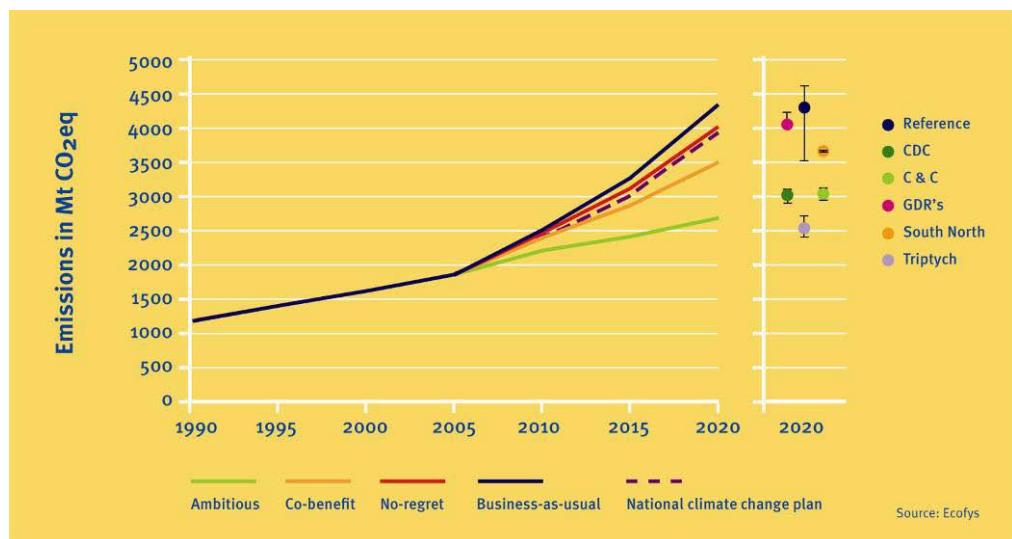
The three sectors with the highest GHG emission reduction potential between 2005 and 2020 under the ambitious scenario are the power, industry and the other energy industry sector.

Under the no-regret scenario reductions of 4% below BAU (80% above 2005 emissions) are possible. Under the co-benefit scenario reductions of 12% below BAU

(65% above 2005 emissions) are feasible. Under the ambitious scenario reductions of 39% below BAU (15% above 2005 emissions) are possible. According to our interpretation of China's national climate change plan reductions of 28% below BAU (36% above 2005 emissions) are possible.

According to our interpretation, China's national plan is quite ambitious in several respects. It includes measures with substantial costs and is more ambitious than our co-benefit scenario. It is also more ambitious compared to the results of the Greenhouse Development Rights approach that judges China's responsibility and capability as low. It is in line with the Triptych approach, which looks at sectoral reduction opportunities. Only approaches based on per-capita emissions would require more ambitious reductions than those in China's national plan.

## India

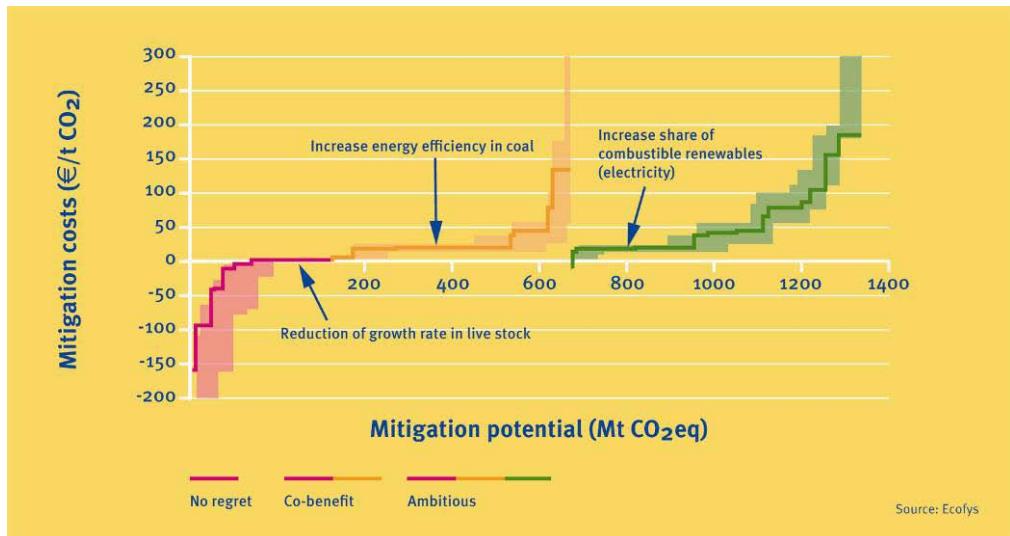


**Figure 5 Emission scenarios with allowances according to a range of global effort-sharing approaches in 2020 for India**

The three sectors with the most important GHG emission reduction potential between 2005 and 2020 under the ambitious scenario are the power, transport and the industry sector.

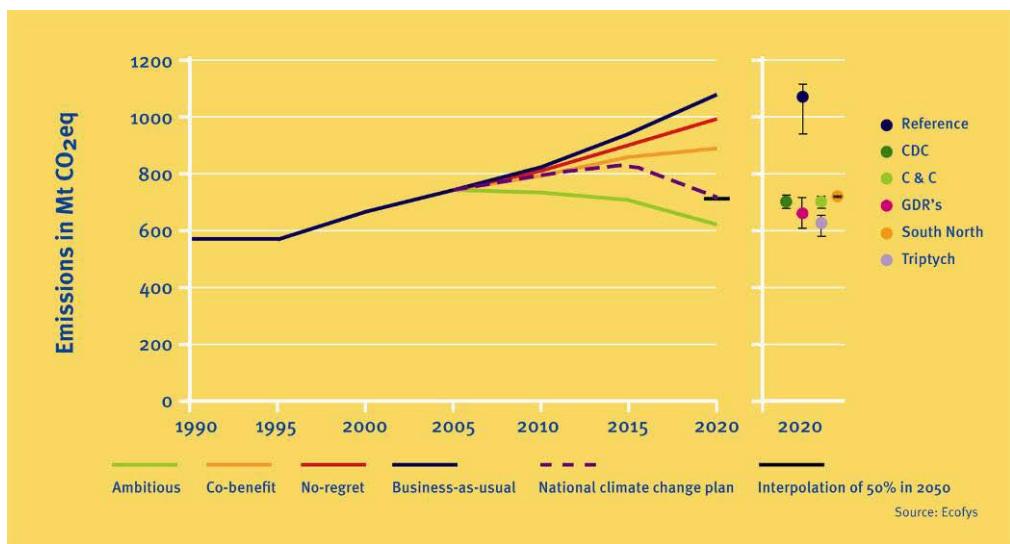
Under the no-regret scenario reductions of 7% below BAU (121% above 2005 emissions) are possible. Under the co-benefit scenario reductions of 20% below BAU (92% above 2005 emissions) are feasible. Under the ambitious scenario reductions of 39% below BAU (46% above 2005 emissions) are possible. According to our interpretation of India's national climate change plan reductions of 9% below BAU (117% above 2005 emissions) are possible.

The reductions under India's national plan are in line with the results of the effort-sharing approaches that judge India's responsibility and capability as low. They place the required effort in the range of the no-regret and co-benefit scenarios. Approaches that are based on sectoral considerations or only per-capita emissions would require (much) more ambitious reductions.



**Figure 6 Indicative mitigation costs for emission scenarios in 2020 for India**

## Mexico

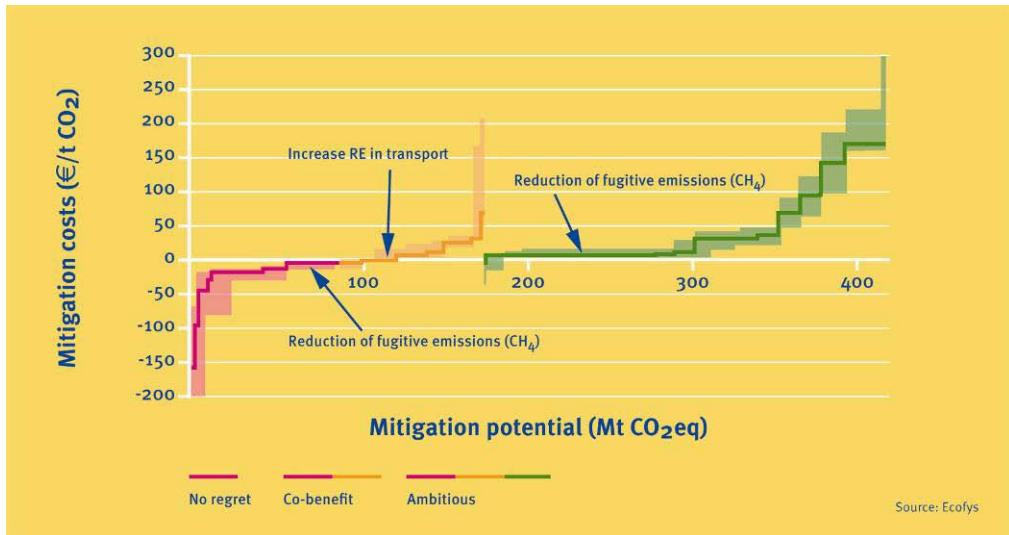


**Figure 7 Emission scenarios with allowances according to a range of global effort-sharing approaches in 2020 for Mexico**

The three sectors with the highest GHG emission reduction potential between 2005 and 2020 under the ambitious scenario are energy industry (oil and gas sector), transport and the power production sector.

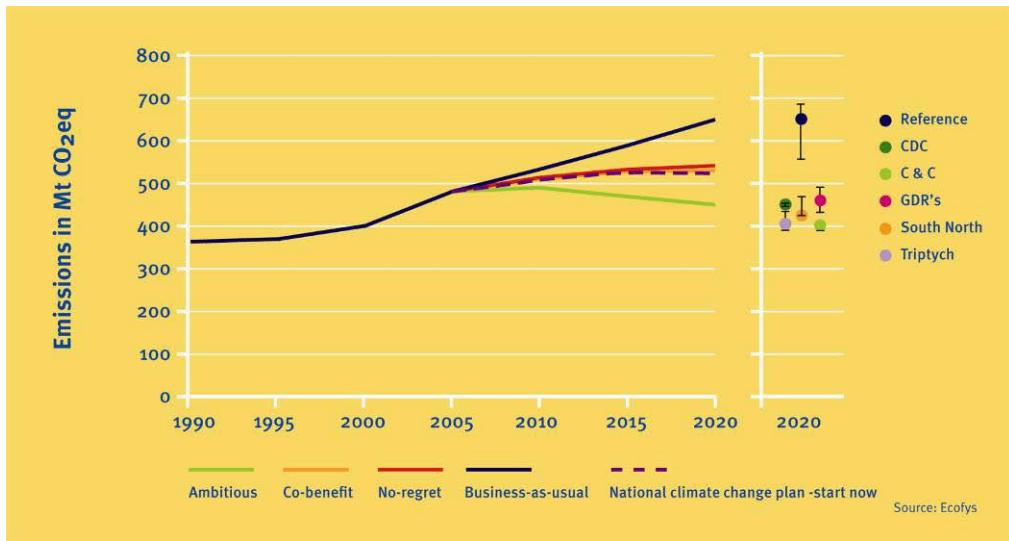
Under the no-regret scenario reductions of 8% below BAU (34% above 2005 emissions) are possible. Under the co-benefit scenario reductions of 18% below BAU (20% above 2005 emissions) are feasible. Under the ambitious scenario reductions of 43% below BAU (16% below 2005 emissions) are possible. According to our interpretation of Mexico's national climate change plan, reductions of 34% below BAU (3% below 2005 emissions) are possible. The plan contains significantly higher reductions than in the co-benefit scenario.

The ambitions in Mexico's national plan are well in line with all of the effort-sharing approaches analysed here. Although the effort-sharing approaches are based on very different principles, their results are very similar. These approaches assign relatively high responsibility and capability to Mexico.



**Figure 8 Indicative mitigation costs for emission scenarios in 2020 for Mexico**

## South Africa

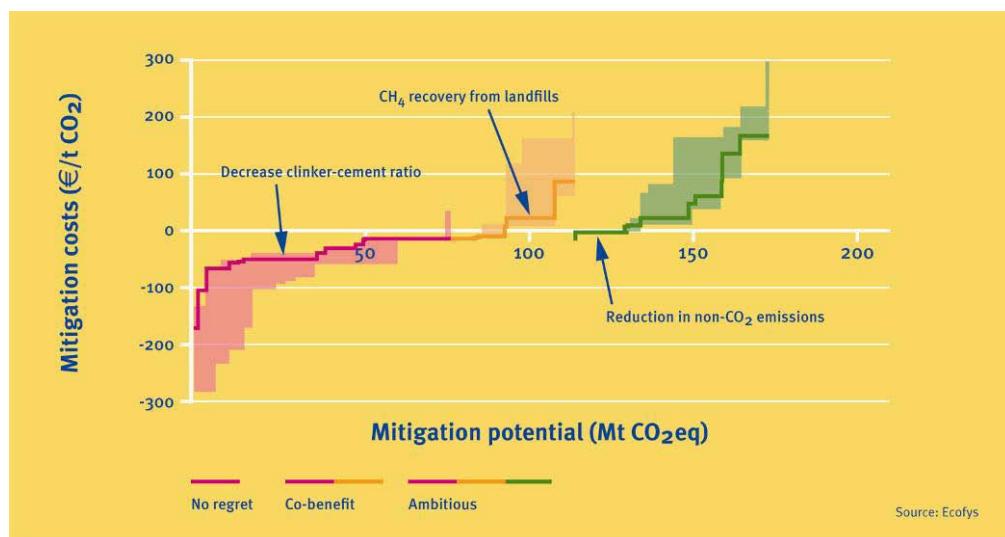


**Figure 9 Emission scenarios with allowances according to a range of global effort-sharing approaches in 2020 for South Africa**

The three sectors with the highest GHG emission reduction potential between 2005 and 2020 under the ambitious scenario are the power, the industry and the other energy industry (coal, oil and gas) sector.

Under the no-regret scenario reductions of 16% below BAU (12% above 2005 emissions) are possible. The no-regret potential is relatively high compared to other countries. Under the co-benefit scenario reductions of 18% below BAU (10% above 2005 emissions) are feasible. Under the ambitious scenario reductions of 30% below BAU (7% below 2005 emissions) are possible. According to South Africa's national climate change plan, reductions of 19% below BAU (9% above 2005 emissions) are possible.

The ambition level of South Africa's plan is unclear. Our interpretation of South Africa's 'start now' scenario results in emissions that are higher than all of the effort-sharing approaches analysed here. Although based on very different principles, the results of the effort-sharing approaches for South Africa are very similar. These approaches assign relatively high responsibility and capability to South Africa.



**Figure 10 Indicative mitigation costs for emission scenarios in 2020 for South Africa**

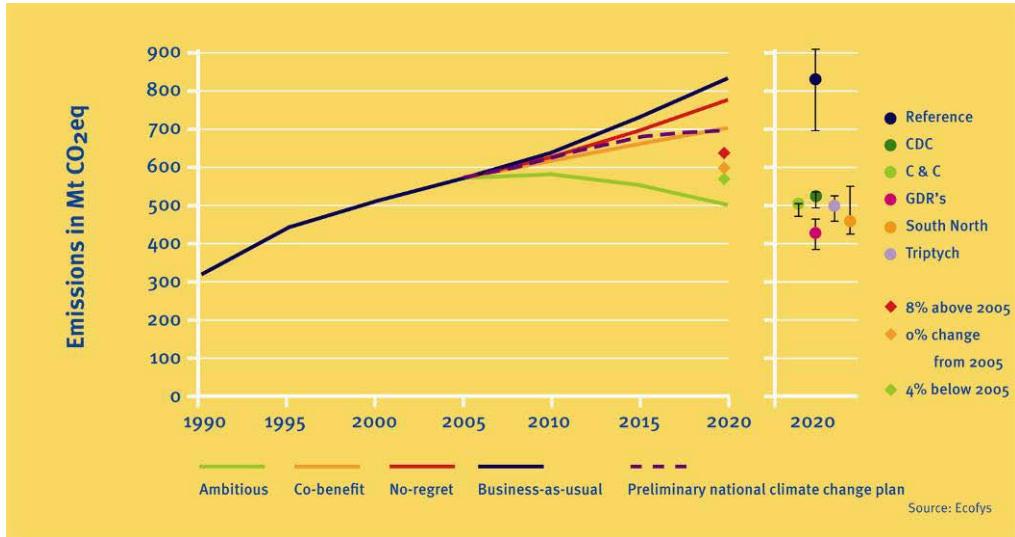
## South Korea

The three sectors with the highest GHG emission reduction potential between 2005 and 2020 under the ambitious scenario are power production, transport and the industry sector.

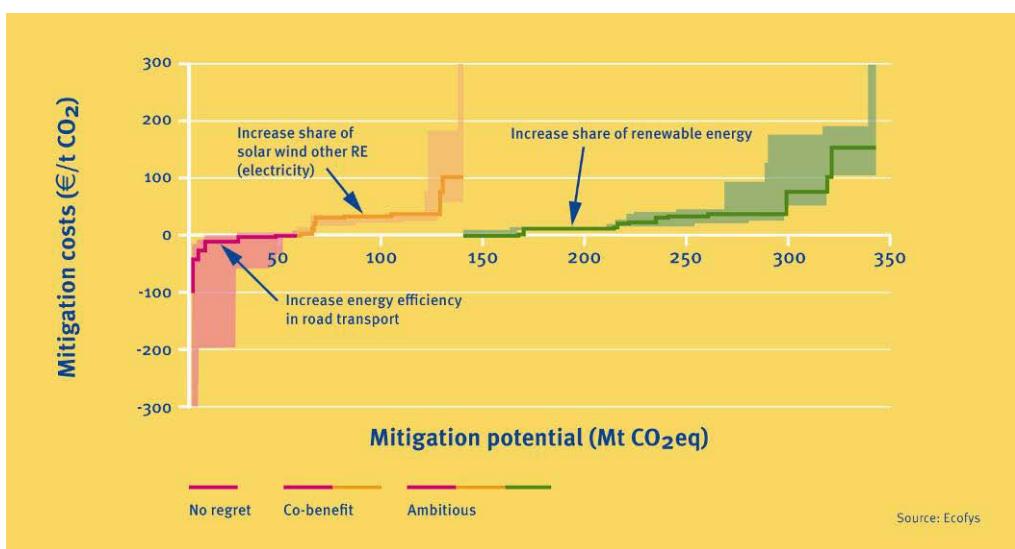
Under the no-regret scenario reductions of 7% below BAU (37% above 2005 emissions) are possible. Under the co-benefit scenario reductions of 16% below BAU (24% above 2005 emissions) are feasible. Under the ambitious scenario reductions of 41% below BAU (12% below 2005 emissions) are possible. According to South Korea's national climate change plan reductions of 17% below BAU (23% above 2005 emissions) are possible. Korea has presented three options for a national target, which are somewhere between our co-benefit and ambitious scenarios.

The ambition level of the announced possible targets of South Korea exceeds that of the co-benefit potential, but is still less ambitious than the results from all of the effort-sharing approaches analysed here. The approaches assign relatively high responsibility and capability to South Korea. Those approaches that acknowledge that

South Korea is already very efficient result in slightly less ambitious reduction requirements.



**Figure 11 Emission scenarios with allowances according to a range of global effort-sharing approaches in 2020 for South Korea**



**Figure 12 Indicative mitigation costs for emission scenarios in 2020 for South Korea**

## 5. Suggested modalities for the development of Low-Carbon Development Strategies

To give clear directions for all future investments and make strategic use of the resources to be provided by industrialised countries, non-Annex I countries should ideally develop integrated LCDS. These should set out a long-term vision for low-emission development as well as comprehensive “Nationally Appropriate Mitigation Actions” (NAMAs) covering all the key emitting sectors that are needed to implement this vision. Ideally, national plans should be developed in a transparent and participatory process through high level cross-ministerial and multi-stakeholder groups.

The actions taken by developing countries should be inscribed into an international register under the UNFCCC and would need to be "MRVable" – measurable, reportable and verifiable – to qualify for financial and technological support. The guidance and requirements for elaborating NAMAs as well as the assessment process could be inspired by the reporting infrastructure that is already in place under the FCCC.

What is emerging for developing countries in the negotiations is a framework for highly diversified actions, based on countries' differing national circumstances. While some more advanced developing countries may adopt actions like sectoral no-lose targets, for the most part developing country actions will probably not be target-based but consist of specific policies and measures. This makes MRV far more challenging.

Attempting to measure the impacts of a specific action is not at all straightforward. While it will be necessary to get a clear picture of both the implementation of NAMAs as well as the development of emissions in developing countries, it might therefore be recommendable to separate MRV of the two, especially at the beginning while no strong technical capacities are in place neither nationally in developing countries nor internationally for the review process. That is, NAMAs could in the starting phase be MRVed not as regards their emission impact but as regards their implementation. How successful developing countries are in reducing their emissions could then be assessed at the aggregate level through much more robust and frequent emission inventories and an international review process.

Several non-Annex I countries have in the meantime attained levels of development and per capita emissions that are comparable to or even exceeding those of a number of Annex I countries. Such countries could therefore assume legally binding emission targets. Among the six countries in this report, this applies in particular to South Korea.

However, as the first commitment period has shown, commitments to legally binding emission targets do not automatically mean that countries will in fact reduce their emissions. We therefore suggest that all countries with binding targets – Annex I countries and newly industrialised countries – should therefore develop commitment achievement plans (CAPs). These should essentially contain a coherent vision and action programme for how each country wants to achieve a rapid transition to a low-carbon society. Like LCDS, these should be developed in a participatory process. In addition, the CAPs should be submitted to an international review process. The modalities for the development and review of the CAPs should build on the modalities already in place for the development and review of national communications, GHG inventories etc. The Conference of the Parties should review the results of the technical analysis and may decide to request countries to revise their CAPs to ensure that they are consistent with meeting their obligations.

## **6. Conclusions**

This report shows for the first time a comparable overview of the national climate plans of Brazil, China, India, Mexico, South Africa and South Korea. As most of these countries have not provided aggregated scenarios for their plans, the scenarios in this report are our interpretation of the national climate plans.

The aggregated reductions of the climate plans are quite substantial and would lead to substantive emission reductions if implemented as planned. Our estimates show that national climate plans could lead to a joint reduction of 25% below BAU by 2020 (see

Figure 13). According to the ambitious scenario a reduction of 40% below BAU would be possible. The aggregated results are dominated by those projected for China.

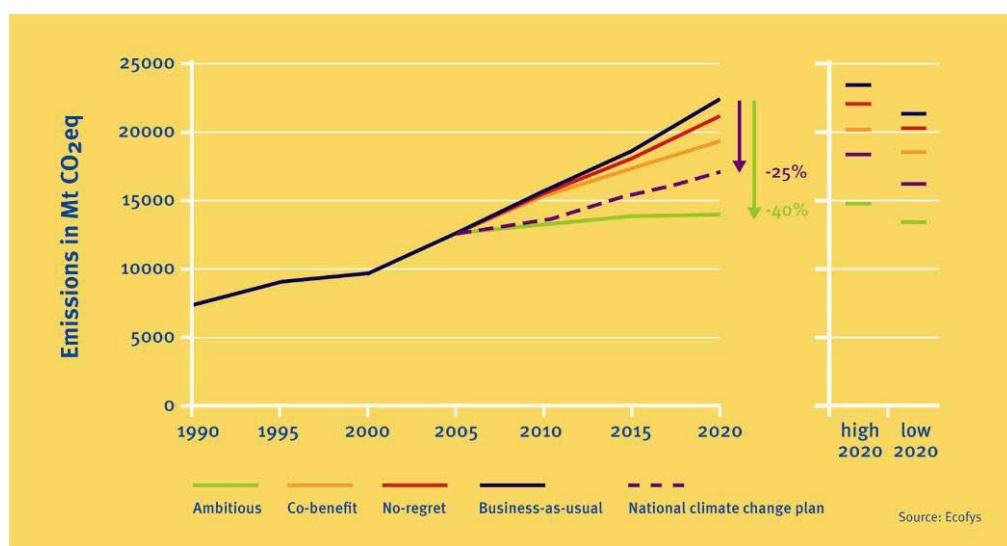
We also compared for the first time the mitigation potential scenarios to what various effort-sharing approaches would suggest.

China's climate plan is very ambitious according to our interpretation. It is well beyond the co-benefit potential, many measures of the plan are already implemented and it is roughly in line with results of effort-sharing approaches.

Under all effort sharing approaches, Mexico, South Africa and South Korea have to achieve a significant deviation from the reference by 2020 and well beyond the co-benefit potential. Only Mexico has proposed action in its climate plan that is in line with these results.

Brazil's climate plan can be judged as ambitious, but depends on the successful halting of deforestation. First results of a new policy have already achieved a reduction in deforestation rate.

India's plan is the least concrete, reflecting the relative development state of India compared to the other countries. Nevertheless, according to our interpretation India's plan does not even attain the level of the co-benefit potential and should therefore be further strengthened.



**Figure 13 Reduction potential for the combined emissions of Brazil, China, India, Mexico, South Africa and South Korea under a range of scenarios *including LUCF* (left) and sensitivity analysis (right). Note that aggregate reductions are estimates and therefore need to be interpreted with care.**

A closer analysis of the details of the national plans reveals that the level of ambition varies significantly between sectors. On the one hand, the countries that are not very ambitious overall usually have one or two sectors where ambitious plans have been developed. In particular the plans for the power sector are in each country among the most detailed and the most ambitious. On the other hand, the plans of the more ambitious countries all have some "blind spots", that is, emission reduction potential that does not appear to be addressed in the national plans. Significant further

improvements of the level of ambition may therefore be possible without too much effort.

This report provides in addition a method to identify such further action as Nationally Appropriate Mitigation Action (NAMAs): We compared the mitigation potential per sector with the reductions achieved through the national plans.

For the purpose of this report, we define a NAMA as any kind of measure that reduces emissions. We distinguish the following three basic types of NAMAs:

- Emission-target based NAMAs, which may take the form of binding or voluntary ("no-lose") sectoral or national emission targets.
- Technology-specific NAMAs, such as targets for the share of renewable energy sources in power production, efficiency targets or standards.
- Policy-based NAMAs, such as feed-in tariffs, financial incentives or pricing instruments.

The discussion in this report is restricted to emission-target based and technology-specific NAMAs. Discussing reasonable policy-based NAMAs would require having detailed information about the current policy landscape in each individual country, which was not feasible within the framework of this project.

Due to data availability the most detailed assessment was pursued for overall emissions and for the power and industry sectors. For the other sectors much less data was available and therefore a less elaborate approach was taken which focuses on individual actions.

Priority areas for further action should be those sectors where national plans are less ambitious than at least the no-regret or the co-benefit potential. While our results are sensitive to the (often scarce) data availability, the method as such could be further explored in the future. If sufficient data was available, it would be possible to do a detailed analysis of the mitigation potential also in those sectors where only very limited data was available in this project. These are in particular the domestic, transport and waste sectors. In addition, it would be possible to do a detailed projection of the impacts of existing and planned policies and measures sector by sector. If these projections fell significantly short of mobilising the available mitigation potential, further steps could analyse possible ways of increasing a country's efforts. Such an analysis would need detailed and reliable data on emissions and emission drivers as well as detailed information on existing and planned policies and measures.