Nationally Appropriate Mitigation Actions for developing countries in view of the post-2012 climate regime: case studies

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Abstract

The Kyoto Protocol adopted in 1997 commits the biggest polluters of that time to reduce their greenhouse gases emissions by 5% below their 1990 level by 2012. Since 1997, some countries have considerably evolved, economically and politically, so that they belong today to the most important greenhouse gases emitters. It is mainly the case of developing countries. Brazil, Chile, China, India, Indonesia, Mexico and the Republic of Korea best illustrate this phenomenon. These seven countries represent today half of the world population, one third of the world total greenhouse gases emissions and one fifth of the world gross domestic product. These seven countries have together with the United States of America and the European Union the environmental destiny of the world in their hand.

If developed countries are mainly responsible for past emissions (historical responsibility), developing countries are today the main emitters (current responsibility). Developing countries must therefore be integrated in the post-2012 climate agreement. They should however not be committed to the level of actions than developed countries, as they are still facing considerable development challenges (poverty eradication, health care, education). The deep analysis, realised within the framework of this thesis, of the seven countries mentioned demonstrates how different these countries are from one another: regarding their emitting sectors, their economic development, their political system, the quality of their institutions and their demographic development. These differences as well as the national circumstances of each country must be considered in the post-2012 agreement.

The official instrument foreseen for mitigation actions in developing countries which consider these differences is Nationally Appropriate Mitigation Actions, so called NAMAs: Nationally Appropriate actions by developing countries and Nationally Appropriate support by developed countries. We came to the conclusions that NAMAs should 1) provide an international platform, in form of a registry for instance, where all actions by developing countries would be consigned; 2) serve as official recognition for all the actions already realised by developing countries, even if these countries were not committed to do so; 3) be a flexible instrument to best fit the national circumstances and specific needs of each country; 4) be mid-term targets inscribed in a long-term strategy to fulfil one common ambitious objective, the objective of the UNFCCC: to stabilise the greenhouse gases concentration at a level that would prevent dangerous anthropogenic interference with the climate system. Achieving this ambitious goal is however only possible if: 1) developed countries specifically support, financially and technologically, actions by developing countries (as consigned in the Convention); 2) developing countries accept international verification of the actions undertaken, at least for actions receiving international support; 3) the post-2012 agreement is flexible enough to consider the unstable situation and changing national circumstances of most developing countries; 4) the post-2012 agreement is based on trust: trust between developing and developed countries; 5) incentives to act are more attractive than incentives to cheat (free-riding problem).

Abbreviations

ADB	Asian Development Bank
APEC	Asia-Pacific Economic Cooperation
BAU	Business As Usual
CDM	Clean Development Mechanism
CGE	Consultative Group of Experts
COP	Conference of the Parties
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
kWh	kilo Watt per Hour
LCDS	Low-Carbon Development Strategies
LULUCF	Land Use, Land Use Change and Forestry
MEF	Major Economies Forum
$MtCO_2$	Million Ton CO_2
$MMTCO_2$	Million Metric Ton CO_2
MRV	Measurable, Reportable, Verifiable
MW	Million Watt
NAFTA	North Free Trade Agreement
NAMAs	Nationally Appropriate Mitigation Actions
NGO	Non-Governmental Organisations
OECD	Organisation for Economic Cooperation and Development
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
tCO_2	Ton of CO_2

REDD	Reducing Emissions from Deforestation and Forest Degradation
R&D	Research and Development
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
WRI	World Resource Institute
WTO	World Trade Organisation

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1. Introduction

While the climate objectives until 2012 are consigned in the Kyoto Protocol, the ones for the period post-2012 are still under debate. An important step in designing the post-2012 climate policy framework is the 15th Conference of the Parties (COP 15) taking place in Copenhagen in December 2009. A considerable challenge for the post-2012 agreement is the integration of the so-called non-Annex I Parties, i.e. countries which are not committed to any quantitative objectives under the Kyoto Protocol. The reasons why non-Annex I Parties should be integrated into the global mitigation process are twofold. The first one is that significant mitigation of man-made Greenhouse Gases (GHG) emissions can only be achieved if all countries of the world act together. Many non-Annex I Parties are today responsible for a considerable share of the world GHG emissions: China, India, Indonesia, Brazil are part of the top ten of the world biggest GHG emitters. The second reason is the considerable development of some non-Annex I Parties between 1997 (adoption of Kyoto-Protocol and thereby introduction of the concept of Annex I and non-Annex I Parties) and today, as observable in countries like China, Chile, India, Mexico or the Republic of Korea. China and India are two of the countries experiencing the strongest economic growth worldwide. The Republic of Korea and Mexico are in present members of the Organisation for Economic Cooperation and Development (OECD). Chile is candidate to enter the OECD.

Although the non-Annex I Parties mentioned above show some characteristics of Annex I Parties, they however still face important development challenges regarding among others poverty eradication, health care and education. Non-Annex I Parties may therefore not afford the same commitment level as Annex I Parties. A solution suggested in the paragraph 1(b)(ii) of the Bali Action Plan is the establishment of so-called Nationally Appropriate Mitigation Actions (NAMAs) by developing countries (UNFCCC, 2007). This new concept follows the Convention's principle of "common but differentiated responsibilities" as well as considers the national circumstances of each country.

By carrying out case studies of seven non-Annex I Parties, this master thesis contribute to the development of the concept of NAMAs in view of COP 15. The seven countries analysed are two big polluters (China and India), two members of the OECD (Mexico and the Republic of Korea), a candidate to the OECD (Chile) and two countries strongly affected by land use change and deforestation (Brazil and Indonesia). Better understanding the concept of NAMAs, the potential of these countries to implement NAMAs, assessing which NAMAs may be expected, analysing the barriers faced by these countries, the role of international assistance and the possibility for a common framework are all objectives of this thesis.

After a brief introduction into the context of the negotiations in chapter two, chapter three covers country profile of the seven countries studied. For that purpose, environmental, economic, political, institutional and demographic indicators have been carefully chosen to best characterise countries in the context of climate regime. A justification of the indicators chosen, some brief comments and interpretations are furthermore available in chapter three. After highlighting the national circumstances of the seven countries, chapter four summarises policies regarding climate mitigation and closely related fields like energy and transport that have already been implemented (realised actions) as well as policies planed for the next years and decades (projected actions). Some quantified assessments of policies are also proposed in this chapter. Chapter five focuses on key parameters: firstly key drivers of the negotiations, secondly comparison of key parameters to assess the development of economic and environmental factors in these countries and thirdly key barriers on the way to implementing new technologies and policies. The following issues are then discussed in chapter six: the potential of the seven countries studied to implement any kind of NAMAs, the role of international assistance and the possibility to find common denominators between these countries. The main conclusions of this study are drawn in the last chapter of the thesis, chapter seven.

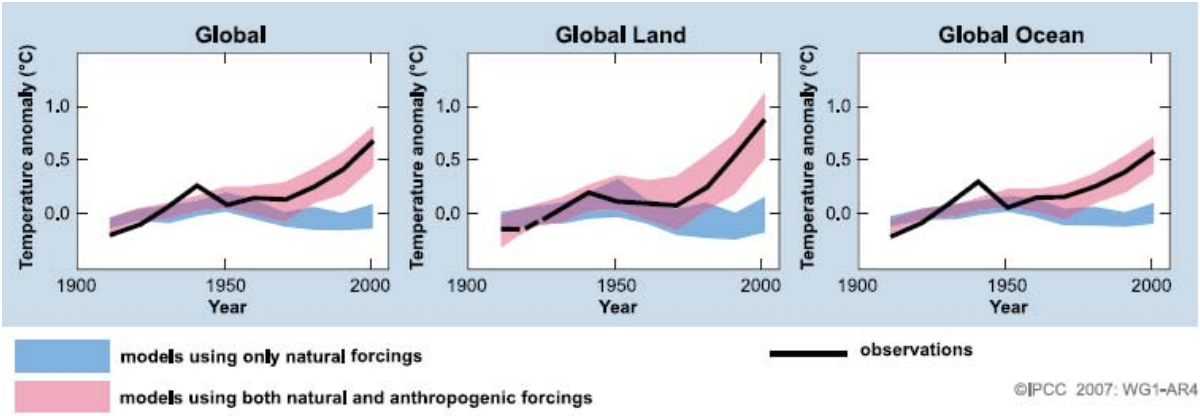
2. Context

That a climate change is happening is clearly demonstrated by scientists, as stated in the 4th **IPCC** (Intergovernmental Panel on Climate Change) assessment report:

"*Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level*" (IPCC, 2007).

Solar radiation which is a function of orbital parameters (know as the Milankovitch Cycles), volcanic activities as well as atmospheric and oceanic circulation modes are all natural forcings with a considerable impact on the Earth climate. With the industrialisation a new parameter has entered the climate equation: **anthropogenic greenhouse gases** (GHG). IPCC models clearly demonstrate the considerable impact of this new forcing (see figure 1).

Figure 1: Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using natural and anthropogenic forcings



Source: IPCC, 2007

Results are undeniable: cause of the considerable temperature increase of the last decades of the 20th century is the so called anthropogenic forcing, i.e. man-made GHG emissions. Indeed if observations and models using only natural forgings (blue color) are highly correlated with temperature observations until the middle of the 20th century, they strongly deviate from one another in the last decades of the same century. Models simulating both natural and anthropogenic forcings however perfectly match temperature observations for the whole century. This conclusion is valid for both land and ocean temperature, as well as for the five continents (IPCC, 2007).

1992 and the adoption of the **United Nations Framework Convention on Climate Change** (UNFCCC) mark the international recognition of the urgency to act and the need for a global response. Adopted by 192 Parties, the ultimate objective of the Convention is "*to achieve, in accordance with the relevant provisions of the Convention, stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*" (UNFCCC, 1992).

The ratification of the **Kyoto Protocol** in 1997 symbolises the first materialisation of the efforts consented by the 192 Parties. If the Convention encourages countries to stabilise their GHG emissions, the Kyoto Protocol commit them to do so. Under this treaty indeed, 37 industrialised countries and the European Union have committed to reducing their emissions by 5 percent by 2012 against 1990 levels. The Kyoto Protocol is placed under the principle of "common but differentiated responsibilities" (see subchapter 5.1), according to which developed countries should take the lead in combating climate change.

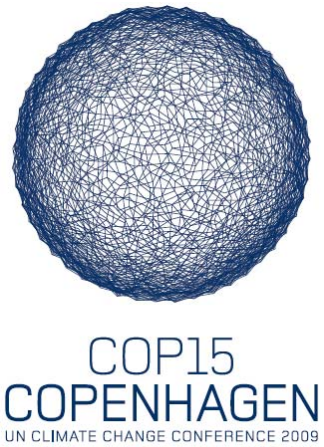
The framework for negotiations to elaborate an agreement regulating the international climate regime post-2012 was consigned at the 13th Conference of the Parties (COP) in Bali. This so-called **Bali Action Plan** aims at guiding negotiations until COP 15 taking place in Copenhagen in December 2009. Strategic elements of the Bali Action Plan are (UNFCCC, 2007):

- shared vision for long-term cooperative action
- enhanced national/international action on mitigation of climate change in a measurable, reportable and verifiable (MRV) manner
- enhanced action on adaptation
- enhanced action on technology development and transfer to support action on mitigation and adaptation
- enhanced action on the provision of financial resources and investment to support action on mitigation and adaptation and technology cooperation.

The COP 15 taking place in **Copenhagen** will be the fruit of two years of negotiations among Parties. It will be a decisive step in designing the post-2012 climate policy framework as well as setting concrete GHG mitigation targets for the commitment period post-2012.

The UNFCCC has identified four political essentials for a successful Copenhagen deal: ambitious emission reduction targets for developed countries, nationally appropriate mitigation actions (NAMAs) of developing countries, scaling up financial and technological support for adaptation and mitigation as well as an effective institutional framework with governance structures that address the needs of developing countries (UNFCCC, 2009d).

Figure 2: Logo of COP 15



Source: UNFCCC, 2009d

To be noticed is the equal emphasis of the importance of both **mitigation and adaptation** by the UNFCCC. Among scientists and policy makers, the debate mitigation and/or adaptation is still open. Whereas the total exclusion of one of these two options would clearly be irrational, the weight which should be accorded to the one or the other is still discussed. Some argue that we first have to adapt as consequences of climate change are perceptible today already. Others argue that the longer we wait for stabilising GHG emissions, the harder and more costly it will be to mitigate them in the future. The robustness of both arguments should go in favour of an equal emphasis on both mitigation and adaptation, as underlined by the UNFCCC.

Regarding mitigation, one of the biggest challenges of the Post-Kyoto agreement is to integrate the biggest polluters of the World and commit them to concrete mitigation actions. According to WRI statistics (WRI, 2009), three of the six biggest GHG emitters worldwide are not classified as Annex I Parties: United States of America (Rank 1), China (Rank 2) and India (Rank 6). If considering additionally GHG emissions from the Land Use, Land Use Change and Forestry (LULUCF) sector, four of the six biggest GHG emitters worldwide are not Annex I Parties: United States of America (Rank 1), China (Rank 3), Indonesia (Rank 4) and Brazil (Rank 5). If the United States of America have at least the same economic development level as Annex I Parties, the other countries listed are still developing countries. The international community can therefore not commit these countries to the same level as Annex I Parties. To be considered is on one side the different stage of development of these countries and on the other hand their considerable responsibility for the current and future GHG emissions. The way suggested by the UNFCCC to consider all these factors is the

introduction of Nationally Appropriate Mitigation Actions (**NAMAs**). The concept of NAMAs was firstly introduced and described in the Bali Action Plan. According to paragraph 1(b)(ii) of the Bali Action Plan, NAMAs should be "*actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner*" (UNFCCC, 2007). Whether unilateral actions, actions receiving support and/or actions for credits should be considered as NAMAs would be decided in a later negotiation phase. Examples of measurable, reportable and verifiable actions are provided in subchapter 5.1, MRV.

3. Country profiles

Aim of this chapter is to provide an overview of the environmental, economic, political, institutional and demographic situation in each of the seven countries analysed: Brazil, Chile, China, India, Indonesia, Mexico and the Republic of Korea. For that purpose, representative indicators have been chosen for each category. Data provide from official data banks which are worldwide recognised by the scientific community: the World Resource Institute (WRI, 2009), the Energy Information Administration (EIA (US administration), 2009), the World Bank (World Bank, 2009a) and the Freedom House (Freedom House, 2009).

3.1 Environmental indicators

Widely used as environmental indicators are GHG emissions. Indeed GHG best represent climate change as they are man-made and highly influenced by economic, political and demographic factors like trade, economic growth, political system and population. In this analysis a focus is set on GHG emissions with and without "Land Use, Land Use Change and Forestry" (LULUCF), GHG emissions by sector, energy consumption mix and carbon intensity of economy. The data chosen cover all the six official GHG identified by the IPCC: CO_2, CH_4, N_2O, PFC, HFC and SF_6. For comparison and simplification purposes, one common unit is preferred: CO_2 equivalent (CO_2e[1]). This conversion is a common standard process recognised by the IPCC. Some comparisons between the mentioned indicators have also been realised by the author of this study: evolution between 2000 and 2005, comparison between GHG emissions with and without LULUCF as well as carbon intensity of economy. GHG emissions data provide from the WRI (WRI, 2009), data characterising energy consumption mix from the EIA (EIA, 2009) and data for the calculation of the carbon intensity of the economy from the WRI and the World Bank (World Bank, 2009a).

GHG EMISSIONS WITH AND WITHOUT LULUCF

The three indicators below represent GHG emissions with LULUCF for the year 2000, without LULUCF for 2000 and without LULUCF for 2005. The choice of the year is motivated by comparison purposes. Indeed data considering emissions from the LULUCF sector are only available for the years previous to 2000 included. Comparing the recent evolution of GHG emissions is best covered by data for the years 2000 and 2005, hence data without LULUCF. But as LULUCF is responsible for a considerable part of the GHG emissions in some countries like Brazil and Indonesia, a comparison between data considering LULUCF and data not considering this sector is also interesting. Most representative for that purpose are data for the year 2000 with and without LULUCF. For each indicator, the total GHG emissions in million ton CO_2 equivalent ($MtCO_2e$), the corresponding position in the world ranking and non-Annex I Parties ranking, the % of the world total as well as GHG emissions per capita expressed in ton of CO_2 equivalent (tCO_2e) per capita are detailed. Considered for the world ranking and the world total are 186 countries from which 147 non-Annex I Parties.

Table 1: GHG emissions in $MtCO_2e$ with LULUCF for the year 2000

Countries	$MtCO_2e$ (rank world / rank non-Annex I)	% of world total	tCO_2e per capita (rank world / rank non-Annex I)
Brazil	2,313.8 (5 / 3)	5.67	13.3 (33 / 22)
Chile	91.4 (59 / 40)	0.22	5.9 (99 / 64)

[1] Definition of equivalent carbon dioxide (CO_2) concentration by IPCC: The concentration of carbon dioxide that would cause the same amount of radiative forcing as a given mixture of carbon dioxide and other greenhouse gases (IPCC, 2007, Annex II glossary).

China	4,771.0	(3 / 1)	11.69	3.8	(121 / 82)
India	1,551.9	(7 / 4)	3.8	1.5	(169 / 130)
Indonesia	3,066.3	(4 / 2)	7.51	14.9	(24 / 18)
Mexico	670.8	(12 / 6)	1.64	6.8	(84 / 50)
Republic of Korea	511.2	(17 / 8)	1.25	10.9	(45 / 30)

Source: WRI, 2009

Table 2: GHG emissions in $MtCO_2e$ without LULUCF for the year 2000

Countries	$MtCO_2e$ (rank world / rank non-Annex I)		% of world total	tCO_2e per capita (rank world / rank non-Annex I)	
Brazil	941.7	(8 / 3)	2.84	5.4	(79 / 42)
Chile	75.9	(54 / 31)	0.23	4.9	(84 / 46)
China	4,818.3	(3 / 1)	14.52	3.8	(98 / 59)
India	1,592.2	(5 / 2)	4.8	1.6	(155 / 116)
Indonesia	503.3	(16 / 6)	1.52	2.4	(124 / 85)
Mexico	574.0	(11 / 4)	1.73	5.9	(73 / 39)
Republic of Korea	510.0	(14 / 5)	1.54	10.8	(33 / 16)

Source: WRI, 2009

Table 3: GHG emissions in $MtCO_2e$ without LULUCF for the year 2005

Countries	$MtCO_2e$ (rank world / rank non-Annex I)		% of world total	tCO_2e per capita (rank world / rank non-Annex I)	
Brazil	1,014.1	(7 / 3)	2.69	5.4	(74 / 36)
Chile	83.8	(53 / 32)	0.22	5.1	(77 / 39)
China	7,219.2	(1 / 1)	19.12	5.5	(72 / 35)
India	1,852.9	(5 / 2)	4.91	1.7	(120 / 81)
Indonesia	594.4	(12 / 5)	1.57	2.7	(101 / 62)
Mexico	629.9	(11 / 4)	1.67	6.1	(65 / 30)
Republic of Korea	548.7	(16 / 7)	1.45	11.4	(31 / 15)

Source: WRI, 2009

Comparisons

The table below provides an added value to the figures detailed in the three previous tables. A first calculation gives the emission growth rate between 2000 and 2005. As previously mentioned, data for the year 2005 are only available without LULUCF. Compared are therefore data from the years 2000 and 2005 without LULUCF. The emission growth rate is given in percentage. Further indicated is a comparison between the rank for 2000 and 2005. Positive figures (+) indicate that the country has a higher rank in 2005 than in 2000. For example, China was number three in the world ranking in 2000 and number one in 2005. China is therefore two ranks upper in the ranking 2005 than 2000, the value “+2” is indicated in the table.

The second own calculation aims at demonstrating the importance of the LULUCF sector for some countries analysed. Compared are for that purpose data for the year 2000 without and with LULUCF. As reference are used GHG emissions without LULUCF. Calculated is then the difference of $MtCO_2e$ between data without LULUCF and data with. This difference is expressed in percentage. For example, Brazil has 941.7 $MtCO_2e$ without LULUCF and 2,313.8 $MtCO_2e$ with LULUCF for the year 2000, which correspond to a difference of 146%. Analogue to the first calculation, comparison of the ranking is given in brackets.

Table 4: Comparison GHG emissions 2000-2005 in $MtCO_2e$ without LULUCF and comparison GHG emissions 2000 in $MtCO_2e$ without and with LULUCF

Countries	Comparison 2000-2005 without LULUCF in % (comparison rank world / non-Annex I)		Comparison 2000 without and with LULUCF in % (comparison rank world / non-Annex I)	
Brazil	+ 8%	(+1 / =)	+ 146%	(+3 / =)
Chile	+ 10%	(+1 / -1)	+ 20%	(-5 / -9)
China	+ 50%	(+2 / =)	- 1%	(= / =)
India	+ 16%	(= / =)	- 3%	(-2 / -2)
Indonesia	+ 18%	(+4 / +1)	+ 509%	(+12 / +4)
Mexico	+ 10%	(-1 / -1)	+ 16%	(-1 / -2)
Republic of Korea	+ 8%	(+3 / +1)	+ 0%	(-3 / -3)

Source: own calculation based on data from the WRI (WRI, 2009)

Considering the evolution between 2000 and 2005 of the GHG emissions without LULUCF, all analysed countries have experienced an increase during the mentioned time framework, varying from around 10% for Brazil, Chile, Mexico and the Republic of Korea, to around 15-20% for India and Indonesia, until 50% for China. This huge increase of 50% places China at the head of the world GHG emissions ranking, overriding the US and the EU. All the seven developing countries except Mexico have also reach upper places in the worldwide ranking in 2005, places which were previously occupied by developed countries. The results obtained emphasise the importance of integrating developing countries in the Post-Kyoto Protocol. Indeed developing countries have considerably evolve between 1997 (ratification of Kyoto-Protocol) and today. Their economic activity has especially grown, notably due to an always more globalised world and trade, as demonstrated in subchapter 3.2.

The results obtained for Brazil and Indonesia demonstrate the importance of LULUCF. If the GHG emissions of Indonesia without LULUCF are in the mean of countries like Mexico or the Republic of Korea, they are six time higher when considering LULUCF. Brazil also experiences a considerable increase in GHG emissions when considering LULUCF, even if less obvious than for Indonesia. For some other countries like China, India or the Republic of Korea, the LULUCF sector does not play such an important role. Variations of a few percentages only are observable: -1% for China, -3% for India, +0% for the Republic of Korea. The negative value obtained for China and India are due to the particularity of the LULUCF sector. If this sector is responsible for GHG emissions due to wildfire for example, it also acts as a sink for GHG emissions. The sink function is assumed by forests which capture CO_2 for the photosynthesis.

If the first calculation delivers expected facts, the second one raises the importance of the completeness of data chosen. Emphasised by this second calculation is the key role played by the LULUCF sector. Sometimes neglected, this sector completely changes the GHG emission pattern of some countries. Considering data without LULUCF for countries like Brazil and Indonesia would provide strongly biased results.

GHG EMISSIONS BY SECTOR

The six tables below describe GHG emissions by sector for each of the seven countries analysed. The GHG emissions are emitted by the following sectors: energy, transport, industry, agriculture, LULUCF and waste. Data provide again from the World Resource Institute (WRI, 2009). The choice of the datasets (2000 with LULUCF, 2000 without LULUCF and 2005 without LULUCF) follows the same logic than for the previous paragraph.

Table 5: GHG emissions by sector in $MtCO_2e$ with LULUCF for the year 2000

Sector	World	Brazil	Chile	China	India	Indonesia	Mexico	Korea
Energy	19,883.1	195.8	40.4	3,014.2	953.7	268	333.3	343.5
Transport	4,848.1	125.7	16.0	218	92.2	63.3	102.7	87.9
Industry	1,369.4	30.9	2.1	377.2	57.3	14.4	22.0	45.8
Agriculture	5,729.3	549.2	13.9	1,040.6	375.0	125.2	71.6	17.0
LULUCF	7,618.6	1,372.1	15.5	-47.3	-40.3	2,563.1	96.8	1.2
Waste	1,360.5	40.2	3.5	168.2	114.0	32.5	44.4	15.8

Source: WRI, 2009

Table 6: GHG emissions by sector in percentage with LULUCF for the year 2000

Sector	World	Brazil	Chile	China	India	Indonesia	Mexico	Korea
Energy	48.7	8.6	44.3	63.1	61.5	8.7	49.7	67.2
Transport	11.9	5.4	17.5	4.6	5.9	2.1	15.3	17.2
Industry	3.4	1.3	2.3	7.9	3.7	0.5	3.3	9.0
Agriculture	14.0	23.7	15.2	21.8	24.2	4.1	10.7	3.3
LULUCF	18.7	59.3	16.9	-1.0	-2.6	83.6	14.4	0.2
Waste	3.3	1.7	3.8	3.6	7.3	1.0	6.6	3.1

Source: WRI, 2009

To be noticed is that energy accounts for half of the total worldwide emissions. Energy is by far the main emitting sector in China, India and the Republic of Korea (around two-third of their total emissions). Further significant sectors are agriculture for China and India (around 20%) as well as transport for the Republic of Korea (17%). As already mentioned in the comment of the previous tables, LULUCF and agriculture dominate Indonesian and Brazilian GHG emissions: LULUCF and agriculture account together for 83% of total Brazil's emissions and 87.7% of total Indonesia's emissions. Mexico and Chile present similar GHG emissions pattern, even if the corresponding amount of GHG emissions expressed in $MtCO_2e$ strongly differs (see table 5). Around half of their emissions are due to the energy sector. Other significant emitting sectors are transport (17% for Chile, 15% for Mexico), agriculture (15% for Chile, 10% for Mexico) and LULUCF (17% for Chile, 14% for Mexico).
That energy represents the main emitting sector may be interpreted as positive, as this sector focus the interest of both public and private actors. Energy is the driver of the world economy, the key resource for industry and thereby economic growth. Improving energy efficiency, increasing energy conservation, discovering new energy forms that would guarantee a country independence regarding energy and thereby considerably increase the energy security are all factors governments and industries are highly interested in. Co-benefits generated by the measures mentioned are highly beneficial for the climate, as less energy consumption directly lead to reduced GHG emissions.

The interest of the four following datasets (GHG emissions without LULUCF) is the possibility to compare data from 2000 with data from 2005 and so to calculate the growing rate of GHG emissions by sector. Unfortunately data for 2005 with LULUCF are not available. Therefore a comparison 2000-2005 can only be realised for countries where LULUCF plays an insignificant role (less than 10% of total GHG emissions, see table 6): China, India and the Republic of Korea.

Table 7: GHG emissions by sector in $MtCO_2e$ without LULUCF for the year 2000

Sector	China	India	Republic of Korea
Energy	3,014.2	953.7	343.5
Transport	218.0	92.2	87.9

Industry	377.2	57.3	45.8
Agriculture	1,040.6	375.0	17.0
Waste	168.2	114.0	15.8

Source: WRI, 2009

Table 8: GHG emissions by sector in percentage without LULUCF for the year 2000

Sector	China	India	Republic of Korea
Energy	62.6	59.9	67.4
Transport	4.5	5.8	17.2
Industry	7.8	3.6	9.0
Agriculture	21.6	23.6	3.3
Waste	3.5	7.2	3.1

Source: WRI, 2009

Table 9: GHG emissions by sector in $MtCO_2e$ without LULUCF for the year 2005

Sector	China	India	Republic of Korea
Energy	4,946.5	1,141	369.7
Transport	332.1	97.5	86.9
Industry	654.0	87.8	57.8
Agriculture	1,112.5	402.7	17.9
Waste	174.2	123.8	16.4

Source: WRI, 2009

Table 10: GHG emissions by sector in percentage without LULUCF for the year 2005

Sector	China	India	Republic of Korea
Energy	68.5	61.6	67.4
Transport	4.6	5.3	15.8
Industry	9.1	4.7	10.5
Agriculture	15.4	21.7	3.3
Waste	2.4	6.7	3.0

Source: WRI, 2009

Comparisons

Table 11: Comparison GHG emissions 2000-2005 in $MtCO_2e$ and in % by sector

Sector	Comparison 2000-2005 of GHG emissions by sector expressed in $MtCO_2e$ (reference table 7 and 9)			Comparison 2000-2005 of GHG emissions by sector expressed in % (reference table 8 and 10)		
	China	India	Korea	China	India	Korea
Energy	+ 64%	+ 20%	+ 8%	+9%	+3%	+0%
Transport	+ 52%	+ 6%	- 2%	+2%	-9%	-8%
Industry	+ 73%	+ 53%	+ 26%	+16%	+30%	+17%
Agriculture	+ 7%	+ 7%	+ 5%	-30%	-8%	+0%
Waste	+ 3%	+ 9%	+ 4%	-31%	-7%	-3%

Source: own calculation based on data from the WRI (WRI, 2009)

The figures in table 11 provide from own calculation based on tables 7, 8, 9 and 10. The formula used is the following: ("value 2005" – "value 2000") * 100 / "value 2000".

The first comparison of GHG emissions expressed in absolute value (i.e. $MtCO_2e$) highlights the fastest growing sectors. An increase in $MtCO_2e$ of more than 50% within the short time period 2000-2005 is observable for the energy, transport and industry sectors in China as well as for industry in India (red colour in the table). Further sectors experienced a significant increase of 20 to 30%: energy in India and industry in the Republic of Korea. Sectors with a slightly increase of less than 10% are agriculture and waste in the three countries as well as transport in India and energy in the Republic of Korea. The only sector with a slightly decrease is transport in the Republic of Korea.
Once again energy appears as the dominating sector. That energy represents the fastest growing sector together with industry reinforces the results obtained in tables 5 and 6.

The second calculation allows a comparison between the repartition of GHG emissions by sector in 2000 and 2005. The evolution of the GHG emissions repartition within each country can thereby be analysed. A sector gaining considerably in importance with an increase of more than 10% in the three countries is industry. Slightly changes (increase of less than 10%) can be observed for the energy sector in the three countries, for transport in China and for agriculture in the Republic of Korea. Slightly decreases (less than 10%) can be noticed for transport in India and the Republic of Korea, for agriculture in India and for agriculture and waste in the Republic of Korea. Two sectors in China have considerably lost in importance: around 30% reduction for agriculture and for waste.

To be concluded is that energy was and remains a key emitting sector for these three countries, particularly for China. A second conclusion that can be drawn is that even if industry is not so significant when considering the total GHG emissions, it is the fastest growing sector both in terms of absolute value and when considering the repartition between the main emitting sector. The third and last main point concerns the agriculture and waste sectors which are generally loosing in importance. This can be explained by the fact that these sectors are growing more slowly than the other ones. Nevertheless they should not be neglected, especially in China and India where they together account for around one-fourth of the total GHG emissions.

ENERGY CONSUMPTION MIX

Table 12: Energy consumption mix in percentage for the year 2004

Country	Oil	Natural Gas	Coal	Nuclear	Hydroelectric power	Other renewables
Brazil	48%	7%	5%	1%	36%	2%
Chile *	41%	23%	30%	0%	6%	0%
China	22%	3%	69%	1%	6%	0%
India	31%	8%	53%	1%	6%	1%
Indonesia	53%	30%	12%	0%	2%	3%
Mexico	55%	32%	5%	1%	4%	2%
Republic of Korea	50%	12%	24%	14%	<1%	<1%

Source: EIA, Energy Information Administration, 2009

* EIA data source not available for Chile. Other data source used: data for the year 2000 from Romero, 2004.

So called dirty energies clearly dominate the energy mix of the seven developing countries analysed. In both China and India coal represents more than half of the total energy

consumed. In the remaining countries oil is the privileged energy source. Natural gas is also widely used in Indonesia and Mexico. In six of the seven countries studied, nuclear power is an unexploited energy source. The only exception is the Republic of Korea where nuclear accounts for 14% of the total energy consumption. Due to abundant water resources, Brazil is a worldwide leader of a renewable form of energy: hydroelectric power which covers more than a third of the total national energy consumption. Even if hydroelectric power is gaining in importance in developing countries, particularly with the increasing number of Clean Development Mechanism (CDM) projects dealing with this form of renewable energy, statistics demonstrate that it remains a secondary energy source. Other renewables (solar, wind, ...) are quasi inexistent in the analysed countries. This shows the considerable potential for this kind of sustainable energy sources to progressively replace dirty energies like coal and oil.

CARBON INTENSITY OF ECONOMY

The carbon intensity of the economy is an indicator combining environmental information with economic one. It is calculated by dividing GHG emissions per unit of economic output. GHG emissions provide from table 3 and are expressed in $MtCO_2e$ (WRI, 2009). Economic output is characterised by the Gross Domestic Product (GDP) confined in table 14 and is expressed in billion US$ (World Bank, 2009a).

Table 13: Carbon intensity of economy for the year 2005

Country	GHG emissions in $MtCO_2e$	GDP in billion US$	Carbon intensity of economy ($MtCO_2e$ / billion US$)
Brazil	1,014.1	882.19	1.15
Chile	83.8	118.25	0.71
China	7,219.2	2,235.91	3.23
India	1,852.9	810.15	2.28
Indonesia	594.4	285.87	2.08
Mexico	629.9	846.99	0.74
Republic of Korea	548.7	791.43	0.69

Source: own calculation based on data from the WRI (WRI, 2009) and the World Bank (World Bank, 2009a)

Combining environmental and economic indicators delivers interesting results. Brazil and Mexico, with comparable GDP, show for example strongly differentiated emissions patterns. Even more striking is the comparison between India and the Republic of Korea: similar GDP but more than three times more GHG emissions for India than the Republic of Korea. This demonstrates the complexity of the system and all the parameters influencing GHG emissions. The GDP is a factor strongly influencing the GHG emissions of a country, but it is not sufficient to explain the differences in GHG emissions between the countries. Other influencing factors may be, as demonstrated in the following chapters, the structure of the economy, the political system, the population or the surface of the country.
As previously mentioned (see comment on table 4), GHG emissions for the year 2005 do not consider emissions from LULUCF. The carbon intensity of Brazil and Indonesia is therefore strongly underestimated.
For comparison, the carbon intensity of the United States for the year 2005 is equal to 0.56 (6,963.8 $MtCO_2e$ / 12,376.1 billion US$). The carbon intensity of the US is quite low, due to a very high GDP and an economic structure strongly dominated by services (low-emitting activities, 76% of total GDP).

High carbon intensities may also be interpreted as a sign for high improvement potential, as demonstrated in the following chapters.

3.2 Economic indicators

Together with political factors, economic factors are key elements influencing the environmental quality of a country. The relationship between economic growth and environment has been and is still widely discussed among scientists. A way to find out how economy affects environmental quality is to decompose economic activity into the three effects (scale, composition and technique effect). A further theoretical hypothesis is provided by the so called Environmental Kuznets Curve which expresses pollution as a function of income.

SCALE, COMPOSITION AND INCOME EFFECT

The **scale effect** describes the causal relation between the intensity of economic activity and environmental degradation: the larger the scale of economic activity, the higher the level of environmental degradation. The scale of economic activity is characterised by the following indicator: GDP per capita per square kilometre (see table 14).

The **composition effect** is important when considering environmental quality as different economic sectors impact the environment differently. Typically, industrial and manufacturing sectors pollute much more than the services sector. The composition effect also gives insights in which development phase a country may be, according to the structural transformation theory by Fourastié (Fourastié, 1949). This theory describes the evolution of the distribution between the three economic sectors. Three stages can be differentiated: a first stage where agriculture dominates (70% agriculture, 20% industry, 10% services), a second where industry dominates (20%, 50%, 30%) and a third one where services dominate (10%, 20%, 70%). This classical approach was developed to characterise the development path of industrialised countries. The applicability of this scheme to developing countries is still debated among scientists. The indicator best representing the composition effect is the GDP by sector (see table 15).

The **technique effect** or **income effect** depicts the evolution of preoccupations, consumption pattern and preferences of the population with increasing revenue. At lower income levels, people are concerned with basic survival needs like food and housing (see phase one of Environmental Kuznets Curve, subchapter below). With increasing income, people become aware of environmental quality, have an increasing desire for green products and foremost have financial means to afford higher costs to preserve the environment (see phase three of Environmental Kuznets Curve, subchapter below). Environmental quality is therefore positively correlated with per capita income. The indicator chosen to characterise this effect is the GDP per capita (see table 14).

Interesting is then to investigate which effect(s) is (are) dominating, what the net effect is.

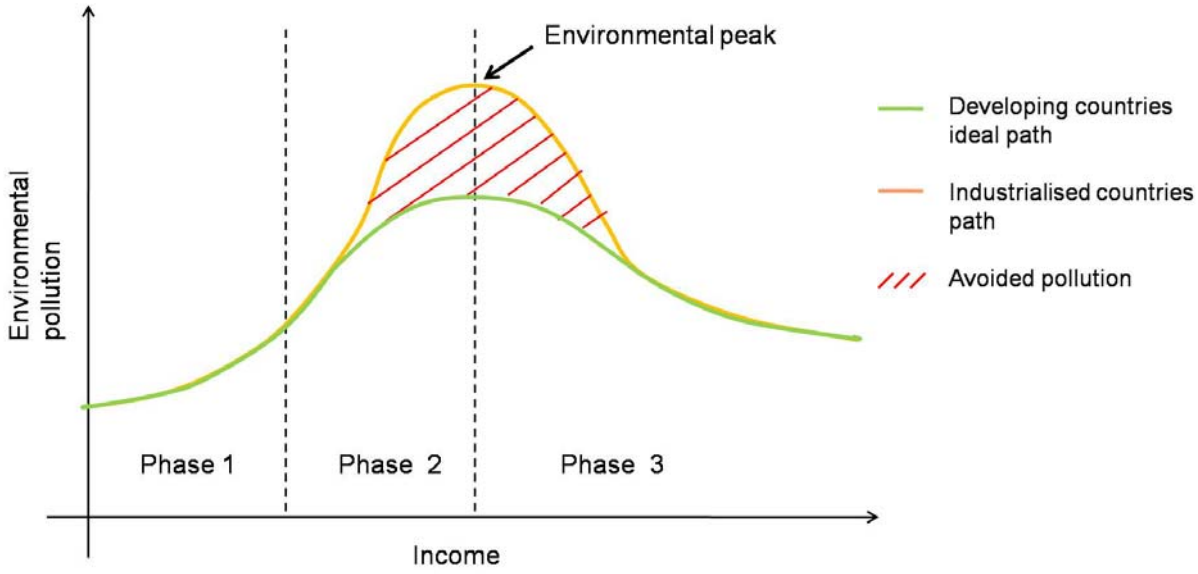
ENVIRONMENTAL KUZNETS CURVE

The Environmental Kuznets Curve is a hypothesised relationship between various indicators of environmental degradation and income per capita. Resulting is an inverted U-shaped

function of income per capita which may be divided into three phases (see figure 3): a first phase where environmental pollution growths slower than income, a second one where pollution growths faster than income and a third one where pollution declines with growing income. The environmental pollution peak is reach at the moment where pollution begins to decline, thus between phase two and three.
The shape of the curve may depend on technologies and institutions in place in the country studied. For instance, developing countries (green line) may adopt cleaner technologies and develop regulatory institutions to control pollution earlier than developed countries (orange line) used to (Hayward, 2005).

Calculating Environmental Kuznets Curve for countries may indicate where the country stands and help to predict possible evolution paths based on different scenarios. To date, no systematised designs of such curves for each country are available in the literature. The complexity of the relationship between the environment and economic factors may be a reason for that. Indeed many other factors interfere with this relationship: the role of institutions, public demand for environmental improvement, technologies available, etc. As some important variables of environmental performance are not considered in Environmental Kuznets Curve, they may deliver an oversimplified interpretation of the relationship studied.

Figure 3: Environmental Kuznets Curve



Source: Own configuration

Environmental Kuznets Curve haven been tested by numerous empirical studies: in some studies for local pollutants like SO_2 in others for global ones like CO_2. The generalisation of results obtained for local pollutants to CO_2 may be a too straightforward process. Indeed GHG may be very different from local air pollutant, especially because GHG are substantially more costly to abate and because GHG are not restricted to local areas.

Grossman and Krueger (Grossman, 1995) analyse four types of indicators: concentration of urban air pollution (SO_2 and suspended particles, but neither ozone nor GHG), measures of oxygen in river basins, concentration of faecal contaminants in river basins and concentration of heavy metal in river basins. Results obtained by Grossman and Krueger support the Environmental Kuznets Curve concept. A deterioration of environment was detected at initial phase of economic development, followed by a phase of consequent improvement of environment correlated with increasing economic growth. The shape of the resulting curve is

analogue to the theoretical one depicted in figure 3. The indicators used however describe very local phenomena. The conclusions of the study may thereby be used with caution, especially when drawing general conclusion about impact of economic growth on environment.

Holtz-Eakin and Selden (Holtz-Eakin, 1994) study the relationship between economic growth and CO_2. Results obtained strongly differ from the theoretical approach suggested by Environmental Kuznets Curve. GHG emissions continue to growth with growing economy, no peak is foreseen. The substantial economic and population growth in lower-income nations is one of the reasons. Another result obtained by Holtz-Eakin and Selden concerns the impact of variations in economic growth rate on GHG emissions. They come to the conclusion that the overall pace of economic development does not lead to dramatic changes in CO_2 emissions. This last finding should however be nuanced. Indeed data used in subchapter 5.2 of this study show that abrupt changes in economic growth directly influence GHG emissions. The Asian Financial Crisis and its impact on GHG emissions of the Republic of Korea well illustrate this issue (see subchapter 5.2, figure 14).

Roberts and Grimes (Roberts, 1997) also deal with the question of whether emissions providing from industrial development constantly increase with economic development or whether a turning point, from which economic development still increase but emissions decrease, can be reached. They conclude that if certain local pollutants like SO_2 may effectively reach such a turning point and thereby follow the Environment Kuznets Curve theoretical model, it is not the case for most CO_2. The inverted U-curve, characteristic of Kuznets Curve, only occurs for a relative small number of wealthy countries where structural and technological changes overcome the economic growth effect.

Taskin and Zaim (Taskin, 2000) obtain similar results by using a different methodology than the previous authors mentioned: the Nadaraya-Watson kernel estimation methodology. Environmental Kuznets Curve again well describes the evolution of local air pollutant like suspended particles and SO_2. For CO_2 however the relationship with economic growth expressed in per capita income has been found to be monotonic, i.e. CO_2 emissions increase as per capita income increases.

The considerable difference between CO_2 and SO_2 can be best explained by the concept of domestic versus global public good. SO_2 is a local pollutant which can be locally combated. It is therefore a domestic public good. Governments have direct interest to act, as the resulting profits are local. CO_2 on the other hand is a global public good. If one country emits CO_2, it globally affects the earth, as CO_2 pollution does not stop at the border of a country. Similarly if one country mitigates its CO_2 emissions, all the others countries benefit from this action for free. Governments may therefore be less willing to invest into such goods as into domestic goods. Indeed, while one country carry the costs, all the other countries benefit from this action for free even if they behave in a non-appropriate way. A country may therefore be tempted to let the other countries mitigate CO_2 emissions while it will continue to emit CO_2. This problem is known as the free-riding incentive.

INDICATORS

A focus on four economic indicators is set: Gross Domestic Product (total, per capita, growth rate and per km2), Gross Domestic Product by sector, Trade Indicator based on exports and imports rate as well as Foreign Direct Investment (FDI). For comparison purposes, all indicators provide from the World Bank (World Bank, 2009a) and are given for the year 2005.

GROSS DOMESTIC PRODUCT

Table 14: Gross Domestic Product (market net value) in US$ for the year 2005

Country	Total (billion US$)	Per capita (thousand US$)	Growth rate (%)	GDP per km2 (million US$ per km2)
Brazil	882.19	4.72	3.2	0.10
Chile	118.25	7.25	5.6	0.16
China	2,235.91	1.72	10.4	0.23
India	810.15	0.74	9.4	0.25
Indonesia	285.87	1.30	5.7	0.15
Mexico	846.99	8.22	3.2	0.43
Republic of Korea	791.43	16.44	4.2	7.97

Source: World Bank, 2009a

Two of the seven countries analysed show the strongest economic growth rate worldwide: China, the third economic power after the US and the EU, and India. Due the fact that these two countries are also the two most populous countries of the world, their GDPs per capita are on the other hand very low. This last consideration reminds the world community that even if their economies experience remarkable growth rate, China and India are still facing considerable development challenge due to the large population they harbour. Lowering the poverty rate is one of these challenges. Other countries like the Republic of Korea illustrate a different economic situation: lower growth rate than China or India, but much higher GDP per capita. These countries have an economy more similar to the one of developed countries and may currently dispose about more capital to be mobilised for mitigation and/or adaptation measures. At the per capita scale, people can also afford to take more care of the environment.

A decisive factor is the GDP per capita as it indicates the economic wealth of each particular individual. Per capita values reflect what their purchasing power is and what their influence towards political decisions may be. They therefore contain more information than total values which do not mirror the distribution of wealth. As mentioned in the theoretical introduction of subchapter 3.2, GDP per capita values are used to characterise the ***technique or income effect***. The evolution of GDP per capita and its comparison with environmental quality is analysed in subchapter 5.2, figures 11 to 16.

The growth rate is also a good indicator for the dynamic of an economy. Countries with high growth rate may be expected to increase their GHG emissions within the next years, at least until they reach the turning point of their economic structure (from industry to services as main economic sector).

Indicator of the intensity of economic activity (***scale effect***) is the GDP per square kilometre as suggested by Bernauer et al. (Bernauer, 2009a). Due to its very limited land surface and a dynamic economy, the Republic of Korea is by far the country with the highest intensity of economic activity. China and India are characterised by similar intensities as the proportion between their GDP and land surface is similar. To be noticed is however the factor three distinguishing China from India: both GDP and land surface of China are three times higher than the ones of India. While the scale effect describes the mean intensity of economic activity in a country, it does not provide information on the geographical repartition of the economic activity in the country. Economic activity in China and India is for example concentrated in particular regions, like the east coast of China as well as the north-west coast and south of India.

GROSS DOMESTIC PRODUCT BY SECTOR

Table 15: Gross Domestic Product by sector in percentage for the year 2005

Country	Agriculture (%)	Industry (%)	Services (%)
Brazil	6	29	65
Chile	4	42	54
China	13	48	40
India	19	29	52
Indonesia	13	47	40
Mexico	4	34	62
Republic of Korea	3	40	56

Source: World Bank, 2009a

The repartition of the GDP by sector indicates which sectors are generating the highest revenue, reflects the ***composition effect*** and indicates in which development phase a country may be according to Fourastié structural transformation theory (see theoretical introduction to subchapter 3.2).
Brazil, Mexico and the Republic of Korea already have an economy dominated by services sector. According strictly to Fourastié Theory, these countries are on the way to reach stage three of development. The industry sector however remains too important to classify these three countries as services countries.
In Chile and India, services also generate most of the economic revenue, but less clearly than for the three previous countries. Industry in Chile as well as industry and agriculture in India still play key roles. The two countries are entering a transitional phase from a domination of the industry sector to a domination of services.
In China and Indonesia the services and industry sectors are responsible for a considerable percentage of the GDP. The notable difference with Brazil, Chile, Mexico and the Republic of Korea is the remaining importance of agriculture, accounting for around one-seventh of their GDP.
To be noticed is that this indicator only represents the repartition of the GDP by sector. Other important factors like the employment rate by sector should not be forgotten when characterising the importance of an economic sector.
The evolution of GDP by sector is illustrated and analysed in subchapter 5.2, figures 17 to 20.

TRADE INDICATOR

In order to examine how trade opening may affect the environment, trade economists (Antweiler et al., 2001) have extended the conceptual framework in which economic activity is separated into three independent effects (scale, composition and technique effects) to trade.

The ***scale effect*** describes the causal relation between increased free trade economic activity and increased energy use, leading to increased GHG emissions.

The ***composition effect*** depicts the change of a country production towards products were the country has a comparative advantage. This change reflects how trade may increase economic efficiency of a country. The composition can have a positive or negative effect on the environment. If the sector extended is less emitting (more emitting, respectively) than the previous sector, the effect on the environment will be positive (negative, respectively).

The ***technique effect*** illustrates the possibility of a decline in GHG emission intensity due to improvements in energy efficiency. Free trade influences this effect in two ways: firstly, trade

increases the availability of green goods, services and technologies; secondly increasing trade often implies increasing income due to intensified economic activity, which may increases the desire of the society for a better environmental quality.

To assess the effects of trade on the environment, it is necessary to assess which of these three components is/are predominating, depending on the characteristics of the country analysed, especially on its comparative advantages.
If the two first effects may be hard to influence, the technique effect shows potential to mitigate climate change. Indeed, as most of the green technologies (renewables, etc.) are available in the developed countries, the liberalisation of these technologies and their transfer to developing countries may be a quite effective way to rapidly and efficiently meet the climate change challenge. In case of success, the technique effect may help to positively balance the scale and composition effect, leading thus to a positive effect of trade on the environment.

Export is a decisive parameter when analysing trade as it illustrates the production rate of a country and where a country has comparative advantages. The trade indicator is calculated by adding the exports with the imports and dividing this sum by the GDP: (exports + imports) / GDP. For this study, exports and imports are expressed in percentage of GDP for the year 2005 (World Bank, 2009a). The trade indicator is therefore calculated the following way: (exports in % of GDP + imports in % of GDP) / GDP.

Table 16: Trade indicator for the year 2005

Country	Exports (% of GDP)	Imports (% of GDP)	Trade indicator (exports in % of GDP + imports in % of GDP) / GDP
Brazil	15	12	0.27
Chile	33	22	0.55
China	37	32	0.69
India	20	23	0.43
Indonesia	34	30	0.64
Mexico	27	29	0.56
Republic of Korea	42	40	0.82

Source: own calculation based on data from the World Bank (World Bank, 2009a)

Countries with the highest trade activity are the Republic of Korea, China and Indonesia. More than two-third of their GDP provides from exchanges with foreign countries. For comparisons, the United States of America and Japan only have less than a third of their GDP resulting from trade.

All the seven countries analysed present a quite balanced export / import ratio. However differences in the structure of exports and imports as well as the repartition between the different economic sectors could be considerable between these countries. Unfortunately this dataset does not provide such detailed information.

The Republic of Korea is the country with the highest trade indicator and the highest GDP per capita (see table 14) and could therefore be considered as the most advanced country of the sample.

Unfortunately no data set detailing for each country the relationship between trade and scale, composition as well as technique effect is currently available. The ***scale effect*** may however be reconstructed by considering trade indicator and energy consumption data and then comparing their evolution over time.

Table 17: Relationship between trade and scale effect for the years 2000 and 2005

Country	Trade indicator 2000	Trade indicator 2005	Evolution 2000-2005 in %	Energy use 2000	Energy use 2005	Evolution 2000-2005 in %
Brazil	0.22	0.27	+ 22.73	1,090	1,159	+ 6.33
Chile	0.52	0.55	+ 5.77	1,684	1,813	+ 7.66
China	0.44	0.69	+ 56.82	876	1,319	+ 50.57
India	0.27	0.43	+ 59.26	453	492	+ 8.61
Indonesia	0.71	0.64	- 9.86	734	798	+ 8.72
Mexico	0.64	0.56	- 12.50	1,533	1,713	+ 11.74
Republic of Korea	0.79	0.82	+ 3.80	4,030	4,415	+ 9.55

Source: World Bank, 2009a and own calculation

If the scale effect may be verified in Chile and China, it is not so significant in the other countries. The strongest deviations can be observed for Indonesia and Mexico. In both countries the trade indicator decreased by around 10% between 2000 and 2005. According to the scale effect, the energy use should have followed a similar track. Statistics however deliver other results: an increase of around 10% for the energy use instead of a decrease of the same percentage. In these countries the composition and/or technique effect may have played a more dominant role. Information to reconstruct the two latest effects mentioned is unfortunately lacunar. The composition and technique effects will therefore not be discussed in details within the framework of this analysis.

Two further theories also describe the relationship between trade and environmental quality: the ***pollution haven hypothesis*** and the ***factor endowment theory***. The first one illustrates the impact of environmental regulation on environmental quality, the second one the impact of the endowment of factors of production on environmental quality. Both theories are used to explain the effect of trade and FDI on environment. They are described in the subchapter below.

FOREIGN DIRECT INVESTMENT

If high FDI inflows are positive for the economic growth of the host country, they may also have negative effects on its environmental quality. This is one of the conclusions of Bernauer's study about globalisation, democracy and the environment (Bernauer, 2009b). China may be the best example to support this conclusion: highest GHG emissions worldwide (see table 3) and simultaneously highest FDI inflows worldwide (World Bank, 2009a). This is also one of the key assumptions of the ***pollution haven hypothesis***, according to which polluting firms will find more profitable to relocate to countries with lax environmental standards, i.e. developing countries. This implies a relocation of the pollution from developed to developing countries, illustrated by FDI inflows. Countries investing in developing countries (i.e. countries with high FDI outflows) win in environmental quality to the detriment of the host countries (i.e. countries with high FDI inflows).

A further parameter should however not be neglected: the distribution of the world endowment of production factors (Bernauer, 2009b). This aspect is described under the ***factor endowment theory*** (FET). If a country is abundant in capital used for polluting activities (non-polluting activities, respectively), the country will expand its polluting activity (non-polluting activity, respectively). The country will thereby experience a deterioration (improvement, respectively) of its environment due to greater international trade. The effect of FDI flows on environmental quality can similarly be studied. If a country is abundant in

capital used for polluting activities (non-polluting activities, respectively), it will experience an increased outflow of polluting capital (non-polluting capital, respectively) combined with an inflow of non-polluting capital (polluting capital, respectively). The country will thereby experience an improvement (deterioration, respectively) of its environment due to greater FDI. If ratios of factor endowments are similar across countries, then the pollution haven hypothesis dominates. An increase in trade will thus lead to a deterioration (amelioration, respectively) of the environment in countries with lax (stricter, respectively) environmental regulations as they will attract polluting (non-polluting, respectively) capital.

The table below describes the FDI inflows in million US$ for the seven countries analysed.

Table 18: Foreign Direct Investment (FDI) in million US$ for the year 2005

Country	Direct inflows (million US$)
Brazil	15,066
Chile	6,984
China	79,127
India	6,677
Indonesia	8,336
Mexico	20,945
Republic of Korea	6,309

Source: World Bank, 2009a

FDI inflow may be a useful indicator of economic health and investment appeal. Countries with major inflows like China represent growth opportunities for developed countries like Europe, US and Japan. As the Chinese environmental regulation is not as strict as the one of industrialised countries, the relocation of polluting firms is reinforced. This supports the pollution haven hypothesis.
Mexico also experiences major inflows due to its membership in the North Free Trade Agreement (NAFTA) between Canada, the US and themselves. An important part of these inflows can be explained by the relocation of manufacturing activities from the US and Canada to Mexico.

3.3 Political and institutional indicators

POLITICAL SYSTEM

Research on factors influencing environmental quality has so far essentially focussed on economic factors (impact of trade, influence of FDI, Environmental Kuznets Curve, etc.). The effect of political determinants has recently attracted attention. This new field of research is however at an early stage of development. Literature is thereby limited.

Gleditsch and Sverdrup (Gleditsch, 2003), Li and Reuveny (Li, 2006), Bernauer (Bernauer, 2009b) as well as other researchers come to the conclusion that democracies positively affect environmental quality. Bättig (Bättig, 2009) brings an interesting new input, by distinguishing policy output from policy outcome. Results of the study show that “the effect of democracy on levels of political commitment to climate change mitigation (policy output) is positive. In contrast, the effect on policy outcome, measured in terms of emission levels and trends, is ambiguous.” Indeed, if policy output is largely under control of policymakers, policy outcome is influenced by factors which may be outside of their control. Between the willingness to act and concrete actions often stand implementation problems. This shift between “words” and “deeds”, the difficulty to move from paper to practice, from policy

processes to concrete measurable actions is a considerable obstacle. Filling the gap "words/deeds" may be one of the biggest challenges for developing countries, particularly as developing countries are known to be generally slower than developed countries regarding such processes. Developed countries however also face this problem as pointed out by Bättig et al. (Bättig, 2009). The process from the elaboration of a policy to its implementation is slow in democracies as many parties are involved: parliament(s), consultations of third parties, public voting, etc. In an autocracy, in contrast, the leader has the right to take decision and implement laws by itself. The short time horizon of policy makers, especially the one of elected governments in contrast to non-democratic ones, often results in an undersupply of public goods (the environment for instance) in democracies as underlined by Congelton (Congelton, 1992). Short-run benefits are overweighed in regards to long-term impacts like climate change.

If the willingness to act is there, implementation may be faster in autocratic regimes than democratic ones. An example is provided by Singapore (Sovereign Republic) and its vehicle quota system introduced in 1990 to limit the number of new vehicles. Introduction of such a quota would not be conceivable in a democratic country like the Republic of Korea for example, as underlined by a member of the Korean delegation at the UNFCCC. The transition from "words" to "deeds" will be a decisive parameter in winning or loosing the race against time to avoid too adverse effects of climate change.

Another interesting political parameter influencing environmental quality is civil liberties. Civil liberties are a privileged proxy for aggregate interest group influence. Civil liberties are for example the free access to information and the freedom of speech. In political systems where civil liberties are respected, the population, even small but well informed groups of individuals, can exert political influence. The number of NGOs present in a country may well illustrate the degree of civil liberties. Bernauer et al. (Bernauer, 2009b) distinguish two principal group of influence regarding the environment: labour unions and green parties. Labour unions are found to be negatively correlated with environmental quality, whereas green parties are positively correlated. Green parties may contribute to increase the awareness of the population toward environmental issues. It is however important that green parties and NGOs inform in a scientific and honest way, not by means of propagandas.

The table below describes the political system, political rights and civil liberties of the seven countries analysed. These three parameters providing from the Freedom House (Freedom House, 2009) well characterise the political status of a country.

Table 19: Political system, political rights and civil liberties for the year 2005

Country	Political system	Political rights	Civil liberties
Brazil	Federal republic	2	3
Chile	Republic	1	1
China	Communist state	7	6
India	Federal republic	2	3
Indonesia	Republic	3	4
Mexico	Federal republic	2	2
Republic of Korea	Republic	1	2

Source: Freedom House, 2009

Figures characterising political rights and civil liberties are to be interpreted the following way: 1 represents the highest political rights and civil liberties level, i.e. the highest freedom rate and 7 the lowest political rights and civil liberties level, i.e. the lowest freedom rate. The ratings reflect an overall judgment based on survey results as well as global events from the 1st of January 2005 through the 31st of December 2005.

Political systems play a key role in the way of functioning of a government. Incentives to act strongly differ from a democracy to a communist state for example. Political systems may be in some way a barrier or in other way an opportunity for implementing green strategies as demonstrated in the previous and following chapters.

All the seven countries, except China, are democracies with a very good level of political right between one and three, as well as a good level of civil liberties with value oscillating between one and four. Figures for China, the only communist state of the sample, clearly indicate the political authority of the system. Political rights could for instance not be lower according to the Freedom House.

All the seven countries analysed present a well structured institutional framework regarding climate change. In all the seven government, a ministry is especially dedicated to environment. Even more specifically, each of the seven countries has already launched a special Committee on Climate Change integrating all the ministries concerned directly or indirectly by climate change. Non-Governmental Organisations (NGO's) focussing on environment in general and climate change in particular are also represented in the seven countries analysed.

INSTITUTIONS

Next to the type of political system, the quality and reliability of institutions are key elements when analysing the way a government functions. Indicators best matching the purpose of this study are the following: political stability, government effectiveness, rule of law and control of corruption. Bureaucratic characteristics are important indicators as they go beyond the general classification democracy/autocracy. They are drivers of the political system and a proxy for its effectiveness. Political stability describes the probability that the government in place will be destabilised. Government effectiveness is an aggregate indicator regrouping the quality of the public service provision, the quality of bureaucracy, the competence of civil servants, the independence of the civil service from political pressures and the credibility of the government's commitment to policies (World Bank, 2009a). Rule of law characterises the extent to which agents have confidence in the rules of society. Control of corruption is often a key point, especially in developing countries. The exercise of public power for private gain is indeed a widespread process in such countries.
The four indicators chosen provide from the same databank: the World Bank (World Bank, 2009a). Values oscillate between -2.5 and +2.5, with -2.5 corresponding to the worst possible outcome and +2.5 to the best possible one.

Table 20: Political stability, government effectiveness, rule of law and control of corruption for the year 2005

Country	Political stability	Government effectiveness	Rule of law	Control of corruption
Brazil	-0.1	-0.1	-0.4	-0.2
Chile	0.94	1.21	1.2	1.35
China	-0.2	-0.1	-0.4	-0.7
India	-0.7	-0.1	0.18	-0.3
Indonesia	-1.2	-0.5	-0.8	-0.9
Mexico	-0.2	-0	-0.5	-0.4
Republic of Korea	0.56	1.03	0.85	0.63

Source: World Bank, 2009a

Values obtained for the seven countries analysed are rarely above zero. This illustrates the fragility of the system in place in the countries in question. For comparison most of the EU countries have value around 1.5. Slightly better than the other countries studied are Chile and the Republic of Korea. Both countries are members of the OECD or on the way to become one. To be noticed is that the only autocracy of the sample, China, does not possess worst values than the democracies studied. This last point underlines the importance to consider both the type of political system and its bureaucratic qualities. These two characteristics are independent from one another, as illustrated by China.
The quite low values obtained by five of the seven countries analysed may presage some difficulties in the establishment of policies and especially in their implementation and respect. This kind of barriers as well as other ones are detailed in subchapter 5.3.

3.4 Demographic indicators

Demographic indicators are not to be neglected, as they often reflect resources consumption and may also explain some correlations between demographic and environmental indicators. For instance, the population per km2 may be a parameter to be considered when discussing transportation policies. High density of population may facilitate public transport, while dispersed population may complicate its broad utilisation.

Malthus (Malthus, 1798) already analysed the interaction between population growth and natural resources at the end of the 18th century. He came to the conclusion that due to increasing population natural resources are exploited more intensively which leads to an overconsumption of these resources and thereby to environmental degradation. Deforestation well illustrates this phenomenon: growing population have an increasing need for arable land which leads to the conversion of forest to cultivable areas. As underlined by Cropper et al. (Cropper, 1994), the negative effect of population growth on environmental quality may however be damped by economic growth and the introduction of new technologies (technique effect, see subchapter 3.2).
Another argument in favour of population growth may be that larger population may dispose about more smart people to come out with intelligent solutions to overcome the problem of environmental degradation, for example by developing high-performance technologies or intelligent policies.

POPULATION, SURFACE AND POPULATION PER KM2

Table 21: Population, population growth rate, surface of the country and population per km2 for the year 2005

Country	Total population (millions)	Population growth rate (%)	km^2 (thousand)	Population per km^2
Brazil	186.83	1.4	8,514.9	22
Chile	16.30	1.1	756.6	22
China	1,303.72	0.6	9,598.1	136
India	1,094.58	1.4	3,287.3	333
Indonesia	220.56	1.4	1,904.6	116
Mexico	103.09	1.0	1,964.4	52
Republic of Korea	48.14	0.2	99.3	485

Source: World Bank, 2009a

This table shows the diversity between the countries chosen: from countries with large population and few inhabitants per km2 to countries with moderate total population but high population per km2.

Two of the seven countries analysed are the most and second most populous countries of the world: China and India. They together account for more than one-third of the whole humanity. Due to their enormous population, these two countries are facing considerable sustainable development challenges. The stabilisation of the population growth is an important factor to stabilise the resources consumption for instance. Both governments have already taken some measures in the last decade to counteract the potential strong increase in population. Effects of these measures are demonstrated by the low population growth rates of the two countries.

The Republic of Korea shows a completely different pattern: a country with a small territory being home for a rather large population, reaching a high population density of nearly 500 inhabitants per square kilometres.

Brazil represents again another kind of pattern: large territory, low population and therefore a considerable place for natural resources like forest in that case.

The differences between the countries studied in terms of population and surface reinforce the representativeness and broad applicability of the study.

4. National Climate Policies

4.1 National circumstances

BRAZIL

Brazil is considered at the continental scale as the political and economic leader of Latin America. At the world scale, Brazil is often regarded after China and India as one of the world manufacture centres. Brazilian production covers both agriculture and industry (cement, aluminium, chemicals, ...). The GDP growth clearly demonstrates the dynamic of these economic activities. Between 1990 and 2000 the GDP per capita increased by 13% (Brazil, 2004). Despite a growing economy and improved social indicators, Brazil faces great regional disparities. Eradicating poverty and improving health conditions are the two main sustainable development goals of the Brazilian Government, as underlined in the National Communication to the UNFCCC (Brazil, 2004).
The largest South American country is home of 55,000 vegetation species which corresponds to around 22% of the world total (Brazil, 2004). Together accounted, the fauna and the flora gather around 4 million species. Brazil also harbours over a third of the cumulated tropical forests of the Earth. Part of it, is the ecosystem having the greatest biological diversity in the World: the Amazon Rainforest. This luxuriant vegetation is partly due to abundant precipitation. These abundant water resources constitute a considerable capital resource for Brazil for a further reason. More than a third of the total energy mix (see subchapter 3.1) is covered by hydroelectric power. Figures regarding electricity production are even more demonstrative: 95% is generated by hydroelectric power plants. Brazil is by far worldwide leader of this type of renewable energy (Brazil, 2004).
Next being a considerable source of GHG emissions, deforestation causes the lost of many local species, endangering thereby the worldwide biodiversity capital. Reducing emissions from deforestation should be a priority of the Brazilian Government.

CHILE

Confined between the Andes Mountains and the Pacific Ocean, Chile is the longest and narrowest country of the world (4,300 km by 232.5 km). This geographical particularity provides Chile with a remarkable biological and climatic diversity.
Economic policies, maintained consistently since the 1980s, have contributed to steady growth in Chile and reduced poverty rates by over half (CIA, 2009). The rapid economic growth of the last decade of the 20th century was followed by a parallel increase in energy consumption. Both the GDP and the average annual energy consumption rose by 7.4% from 1990 to 1996 (Chile, 2000). Principal economic activities are mining, commercial fishing, manufacturing as well as agriculture and forestry. Chile is among others responsible for over a third of world's copper production. Many trade agreements in favor of trade liberalisation were ratified since the 1990s: free trade agreements with Canada, Mexico and Central America, preferential trade agreements with Venezuela, Columbia and Ecuador, association agreement with Argentina, Brazil, Paraguay and Uruguay and more recently free trade agreements with the EU and the Republic of Korea. Chile is also member of Asia-Pacific Economic Cooperation (APEC) organisation aimed at promoting trade to and within Asian markets. Chile further encourages trade by implementing promotional regulatory instruments like unilaterally lowered across-the-board import tariff for all countries with which Chile does not have a trade agreement.
With a highly developed trade system, a domination of services and industry sectors, a low population growth rate, the economic and social characteristics of Chile are not far away

from the ones of a developed country. The candidature of Chile to enter the OECD is the recognition of the high development level reached by this country.
Extending across 38 degrees in latitude, Chile disposes about a wide range of weather conditions, classified under the following climatic zones: desert (Atacama Desert), alpine tundra, glaciers, humid subtropical, oceanic and even Mediterranean climate. Volcanoes and fjords further characterise the diversified Chilean landscape. Deforestation, erosion, desertification and extreme events are the most feared climate change impacts.

CHINA

Considering the total GDP (see subchapter 3.2, GDP 2005) China is one of the biggest players in the world economy. Indeed it occupies the third position in the world ranking. Considering however the GDP per capita, China no more belongs to the top of the ranking. It even falls to the rank number 106 (WRI, 2009). Taking into account the second parameter, the GDP per capita, China defines itself as currently being at a relatively low level of economic development (China, 2007b). This considerable difference between the total GDP and the GDP per capita can partly be explained by the large disparities between rural and urban residents as well as between the eastern and western areas of the country. Despite of the fast growth of the Chinese economy, the poverty rate is still very high in some areas of China. Poverty eradication remains therefore a considerable challenge for China.
Due to the fact that it represents the largest population of the world, this country is facing many further challenges: massive employment pressure, urbanisation process with about 10 million new rural labours moving yearly to urban areas (China, 2007b), strongly increasing per capita energy consumption, etc.
The latest challenge regarding increasing energy consumption is especially critical for environmental issues as China's primary energy mix is dominated by coal (more than two-third of the total energy consumption, see subchapter 3.1). The direct consequence of the coal domination is the high CO_2 intensity of China's energy production and consumption (see table 13). Coal may remain the main energy source for the next years and decades, as Chinese coal resources are by far not exhausted. The availability of Chinese coal at very low costs reinforces the economic attractiveness of this dirty energy source.
With its vulnerable ecosystems, China is especially concerned by environmental impacts. Desertification of grassland is one of the main ecological problems China is facing. For 2005, 27.4% of the country's territory was accounted as area of desertification (China, 2007b). The Chinese coastline and its numerous islands may be vulnerable to another consequence of climate change: the sea level rise. Forest areas are a further fragile ecosystem.
Consequences of climate change may also affect the climatic conditions in China. China belongs to the continental monsoon climate which implicates an uneven seasonal and spatial precipitation distribution as well as drastic seasonal temperature variations (China, 2004). Climate change may be expressed by changing weather patterns and increasing extreme events which may often cause natural and human disasters. Such events may have a particularly strong impact in China in terms of affected area and population, as well as its associated costs.

INDIA

With over a billion inhabitants, India is the second most populous country in the world. India is mostly a rural society: three fourth of the households live in rural areas and 64% of the population depends on agriculture (India, 2004). The Indian economy is growing at a fast rate (9.4% in 2005, see subchapter 3.2), achieving self-sufficiency in food for a rising population, building up infrastructure and developing technological capabilities. However India is still facing many sustainable development challenges like poverty eradication, improvement of social infrastructure, health and education. Rising population combined with rapid economic

growth also leads to rising energy consumption. This increase in energy consumptions is reinforced by the fact that with increasing incomes people are improving their living-standard, hence increasing their use of high-energy devices like electric bulbs, televisions, refrigerators, washing machines, etc. Resulting mainly from this considerable increase in energy use, the GHG emissions are growing at a very fast rate in India: + 16% GHG emissions between 2000 and 2005 (see subchapter 3.1). When considering the absolute GHG emissions, India is the fifth biggest polluter of the world. Hence considering the GHG emissions per capita, India disappears from the top of the ranking to fall to rank 155 (WRI, 2009). Like in China, the dominating energy source is coal with a share of 53% (see subchapter 3.1). This is due to the large coal reserves on the Indian territory, the low price and the local availability of this energy source. Even if renewable energies are gaining in importance, coal will remain the dominant energy source in India for the next years or even decades.
Varied soils, climate, biodiversity and ecological systems make India vulnerable to consequences of climate change. Indian forests ranging from evergreen tropical rain forests to dry alpine ones represent an especially sensitive ecosystem.

INDONESIA

17,508 islands, 81,000km of coastline, 33 provinces with their own political legislature and governor, around 230 million inhabitants, 300 ethnic groups, 150 active volcanoes and 1,531 bird species make Indonesia a highly diversified country (Indonesia, 1999). Indonesia is since at least the seventh century an important trade region: China, India and European were the most prominent powers who monopolised Indonesian natural resources across the centuries. The last colonisation period dominated by the Dutch ended after World War II. End of the colonisation did not mean liberty for Indonesia. After a short Japanese invasion, a period of authoritarianism began with the enthronisation of President Sukarno. It is only since 2004 and the first direct election, that a strengthening of democratic process was achieved. Since then, Indonesia entered a period of relative political and economic stability.
If agriculture has been the largest employer for centuries, a gradually shift from traditional sectors to industrial and services sectors has taken place during the last decades. Industry and services are dominating today's economic structure with respectively 47 and 40% share of GDP (see subchapter 3.2). The economic development of Indonesia was however hurt by many crises. The latest and hardest one was the Asian Financial Crisis in 1997-1998.
Dominated by a tropical monsoon climate, Indonesia harbours a range of vulnerable sea and costal ecosystems. Especially vulnerable to climate change are mangroves and coral reefs. Climate change and the induced potential sea level rise may further endangered numerous costal zones and islands. Adaptation is therefore a consequent challenge faced by Indonesia. With high poverty rate, social and health constraints, Indonesia may not be able to finance adaptation measures by indigenous financial sources only. International cooperation should play a key role in helping emerging countries, which are often the most vulnerable ones, to develop and implement effective adaptation measures. Deforestation and related wildfires causing heavy smog as well as overexploitation of marine resources are the two key environmental issues impacting Indonesia. Air and water pollution, waste management and traffic congestion are further areas with considerable potential for improvement.

MEXICO

After experiencing an intensive growth in urbanisation processes in the sixties, a strong and rapid population increase until the seventies as well as difficult economic situations with high inflation rate with the most difficult period during the financial crisis of 1982-1987, Mexico could stabilised all these parameters during the last years or decades.

Predominantly an urban country, Mexico experienced two phases of urbanisation: firstly an intensive growth in urban population and secondly a physical expansion, mainly of informal structure. In 1995 more than 60% of the total Mexican population was living in agglomeration of more than 15'000 inhabitants (Mexico, 2006).
From 7 children per woman in 1960 to 2.65 children in 1995 (Mexico, 2006), the decline in fertility is the most visible factor of demographic changes in Mexico during the last decades.
Since 1995 and the formal entry of Mexico into the World Trade Organisation (WTO), the creation of the North Free Trade Agreement (NAFTA) between Mexico, Canada and the United States in 1994 and finally the entry of Mexico into the Organisation for Economic Cooperation and Development (OECD) in 1994, Mexico has entered an area of economic stability with a GDP growth rate of 3.2% in 2005 (see subchapter 3.2).
Even if Mexico disposes about considerable proven hydrocarbon reserves (80% of which corresponded to crude oil and condensates, 20% to natural gas), their exploitation is expected to last until around 2030 only (Mexico, 2006). Mexico is therefore forced to search for other energy sources. Some coal and uranium reserves can be found in Mexico. But more promising are renewable energies: thermal foci (mud volcanoes, fumaroles, ...); solar energy due to the ideal location of Mexico, making it one of the world regions with greatest insolation; wind power and biomass. Hydroelectric power generation may also be possible in regions with important water resources, like the south-eastern Mexico. The main problem of water resources is not their scarcity, but their uneven distribution: high water availability where the population density is low and vice versa.
Mexico has a great diversity of climates and a very diversified topographic profile. These particularities explain the existence of practically all the ecosystems of the planet in one country only. Due to this diversity, Mexico has one of the largest biological patrimonies of the world: 60 to 70% of all species of the world can be found in Mexico (Mexico, 2006). Climate change may particularly affect this biodiversity.
Due to its location in the Gulf of Mexico, the state of Mexico is particularly exposed to storms and hurricanes. Climate change and notably the induced sea temperature increase reinforce hurricane activity. Considerable costs to adapt and afford consequences of this increase in both intensity and frequency are thereby generated. Mitigating emissions as soon as possible is the only hope to limit the damages foreseen.

REPUBLIC OF KOREA

Since the 1970s, the Republic of Korea has taken aggressive economic development measures which guarantee a high year-to-year economic growth. The only growth interruption occurred during the Asian Financial Crisis of 1997-1998. A rapid and efficient reaction of the Government could however avoid the most adverse effects. Corporate restructuring and removal of inefficiencies in industries were the most important concrete measures adopted. This successful restructuring, though forced by the Crisis, boosted the Korean economy, so that a positive growth rate was again possible one year only after the Crisis. Leading industries in the Republic of Korea are shipbuilding, electronics, auto manufacturing, textile industry, mining and petrochemical industry. Due to rapid urbanisation and related increasing reallocation of pastures to building zones, agriculture land has continuously diminished during the past decade. A positive direct consequence underlined by the Republic of Korea in its National Communication is the falling consumption of nitrogenous fertiliser (Republic of Korea, 2003). If agricultural land is declining, livestock production is however increasing. This is due to the changing diets of Koreans which consume more and more meat.
The Republic of Korea has a high population density of 485 persons per km2 (see subchapter 3.4). The senior population ratio according to UN standards demonstrate that even if the Republic of Korea is considered as an emerging country, it has already reach the stage of so called aging society, like most of the developed countries (Republic of Korea, 2003).

The land surface is covered by 65% forest and 19% farmland (Republic of Korea, 2003). Forests mostly consist of young trees (less than 30 years old), which have not reached full maturity. Therefore most of the timber found in Korean market is imported. Korean forests remain thereby preserved, at least for the moment. The high variability of precipitation between the seasons (high in summer, low in winter) disadvantages hydropower generation.

The Republic of Korea is the 11th largest energy consumer worldwide. Energy consumption follows a parallel track to economic development, as in most countries. This statement is confirmed by the worldwide ranking: 11th rank in energy consumption, 13th economic rank (WRI, 2009). So called dirty energies dominate the Korean energy production: 50% oil and 24% coal (see subchapter 3.1). The growing importance of securing energy supply has however incentivised the Korean Government to explore sustainable and cost-efficient energy sources.

The transport sector is experiencing a strong increase in the use of domestic aviation, shipping and personal cars. This is characteristic for a society with high increase in national income. As example, the number of cars has experienced a 100-fold growth in thirty years: from 127,000 cars in 1970 to 12,694,000 in 2001.

The increase in private transport illustrates the “westernisation” of the Korean society. Changing these new lifestyles and consumption pattern towards green ones is a considerable challenge undertaken by the Republic of Korea under its long-term development program called “Green Growth”.

4.2 Realised actions

As this research work focuses on mitigation, policies related to mitigation only will be considered. Adaptation should however not be neglected when debating climate change policies in general. The importance of considering both adaptation and mitigation is discussed in chapter 2.

National Climate Change Policies already implemented in the seven countries analysed are described in this subchapter. First are examined countries with broad and detailed policy frameworks: China, India, Mexico and the Republic of Korea. Second countries with recent or still emerging policies: Brazil, Chile and Indonesia.

CHINA

Among developing countries, China is a precursor regarding environmental matters, especially regarding energy. China has indeed enacted numerous laws and policies regarding natural resources and environment protection for years. This long-term tradition is demonstrated for instance by the early consignment of energy efficiency and conservation policies in the national economic and social development plans. Indeed such policies were already integrated in the sixth Five-Year Plan covering the time period 1981-1985. Since then five further Five-Year Plans have been established, the latest for the period 2006-2010. Energy targets contained in these Five-Year Plans are ambitious, like the latest one of reducing energy consumption per unit GDP by 20% in 2010 as described below. China has also understood that a considerable part of the success lies in improving education, training and public awareness. Customers are finally the ones who will choose a “green lifestyle” or not and thereby actively contribute to mitigate climate change and adapt to its consequences.

Not to be forgotten is that if China has adopted energy efficiency and conservation policies at a very early stage, reasons for this mobilisation were not only environmental ones. One of the main concerns of China was and is economic growth. To achieve this goal, colossal amount of energy is required. Even if China possesses massive coal reserves, energy is a limited resource that must be efficiently used and as much as possible conserved. Reliability of the power network, enhancement of economic productivity and competitiveness, energy security and independence are further explanations for the numerous energy policies adopted by China. With an increasing scarcity of fossil fuels, energy issues will considerably gain in importance within the next years.

Measures adopted by China are numerous, covering all the main emitting sectors: energy, industry, transportation and forest. As mentioned above, policies concerning energy purposes are especially highly developed in China. Types of measures are diversified, from general policy processes, to financial and regulatory instruments.
The non-exhaustive list below should provide an overview of Chinese policies and instruments influencing climate mitigation. Information provide from the China’s National Climate Change Program (China, 2007b), from a State Council’s paper called “China’s Policies and Actions for Addressing Climate Change (China’s State Council, 2008), from a publication of China’s Ministries called “China’s Scientific & Technological Actions on Climate Change” (China, 2007a), from the initial National Communication on climate change (China, 2004), from a CCAP’s paper (CCAP, 2007), from two publications by Chatham House (Chatham House, 2007 and 2008) as well as from a Tyndall Centre’s paper by Dr. Wang (Wang, 2009).

GLOBAL FRAMEWORK

Year	Sector	Type of measure	Measures	Aim, effects
1994	Sustain-able develop-ment	Policy process	China's Agenda 21	June 1992, Rio de Janeiro, the UNDP adopts the Agenda 21 (calls for all nations to develop and put into effect their own national strategies, plans and policies for sustainable development). China's Agenda 21 has been formulated so that it corresponds to Agenda 21 and reflects the Chinese situation.
2003	Sustain-able develop-ment	Policy process	Program of Action for Sustainable Development in China in the Early 21st Century	Specifies the objectives, principles, priority areas and safeguard measures for the country's sustainable development in the early 21st century. Help to implement China's Agenda 21.
2006	Science and techno-logy	Policy process	Medium and Long-term Development Plan for Science and Technology	Made energy and environment priority fields in the development of science and technology.
2006	Multi-sectoral	Multi-sectoral policy process	11th Five-Year Plan for National Economic and Social Development (2006-2010)	The main target is the one concerning energy intensity reduction: target of 20% reduction of energy consumption per unit GDP by 2010, reference year 2005.
2007	Climate	Policy process	China's National Climate Change Program	Objectives, basic principles, key areas of actions, as well as policies and measures to address climate change and sustainable development for the period up to 2010.

ENERGY

Year	Sector	Type of measure	Measures	Aim, effects
1996	Conser-vation	Policy process	Policy Outlines of Energy Conservation Technologies	Prohibit for example new construction of oil-fired power plants in the power industry.
1999	Capacity building	Policy process	Capacity Building for the Rapid Commercia-lisation of	Objectives of the project: 1. to develop national capacity for identifying, developing and implementing commercial renewable energy projects and accelerate the commercial adoption of these technologies.

			Renewable Energy in China	2. to lower existing technical, institutional and policy barriers to the commercialisation of market-ready renewable energy technologies.
2002	Renew-able	Financial (tax incentive)	Reduced VAT and income tax for wind energy projects	In order to increase the attractiveness of wind energy projects in China, the Value Added Tax (VAT) for wind generation equipment has been lowered from 17% to 8.5% and income tax for wind projects from 33% to 15%.
2004	Conser-vation	Policy process	Medium and Long-term Energy Conservation Plan	Aims to push the whole society towards energy conservation and energy intensity reduction. Is among others estimated to reduce cement sector emissions by 15% and iron and steel emissions by 9% below BAU (reference: year 2005) in 2020. Include the Plan and Method Regarding the Monitoring of Energy Conservation.
2004	Conser-vation	Regulato-ry instru-ment	Top Ten Energy Conservation Program	1. upgrading of low-efficiency coal-fired industrial boiler 2. district heat and power cogeneration 3. recovery of residual heat and pressure 4. oil saving and substitution 5. energy conservation of motor system 6. optimisation of energy system 7. energy conservation in buildings 8. green lighting 9. energy conservation in government agencies 10. building the energy conservation monitoring and technological support system.
2005	Nuclear power	Policy process	Medium and Long-term Plan for the Development of Nuclear Power	According to this plan (2005-2020), nuclear power is a strategic energy source that should be actively developed to meet the country's growing demand of energy sources. Principle of “safety first and quality first”.
2006	Renew-able	Policy process	Law on Renewable Energy	Framework policy which lays out the general conditions for renewable energy to become a more important energy source in China. Renewable energy as preferential area for energy development. According to this law, the State Council is responsible for overall implementation and management of the development and utilisation of renewable energy at the national level. Include feed-in tariff (incentive structure to encourage the adoption of renewable energy through government legislation).
2007	Renew-able	Policy process	Medium and Long-term Development Plan for Renewable	Future share of renewable energy in primary energy to reach 10% and 15% in 2010 and 2020 respectively. Concretely for 2020: 300,000 MW hydropower; 30,000 MW wind power;

			Energy	30,000 MW biomass; 1,800 MW solar power; 300 million m^2 coverage of solar hot water heaters.
2007	Conser-vation and emission reduc-tion	Policy process	Working Plan for Energy Conservation and Emission Reduction	Details the goals and policies that will be employed to achieve the 20% target of the 11^{th} Five-Year Plan.
2007	Conser-vation	Policy process	Law on Energy Conservation	Specify the management system as well as Rewards and Punishment rules concerning energy conservation. Set up a target responsibility and evaluation system to save energy.
2007	Renew-able	Financial (tax incentive)	Preferential Tax Policies for Renewable Energy	Preferential tax policies to encourage the development of energy conservation and renewable energy (income tax cuts for the producers and consumers of renewable energy, as well as a reduction of the import tax for "green" equipment).
2008	Efficien-cy	Subsidies Voluntary agree-ment	Efficient Light Bulb Subsidy Program	Subsidise 50 million low-energy bulbs onto the market. Private-public partnership.
2008	Energy saving, building	Regulato-ry instru-ment	National Building Energy Standards	50% reduction of building's total operation load based on a building's energy consumption during the 1980s, calculated using average consumption by building type within a designated climate zone.

INDUSTRY AND RECYCLING

Year	**Sector**	**Type of measure**	**Measures**	**Aim, effects**
2002	Industry	Policy process	Law on Clean Production Promotion	Promote cleaner production, increase the efficiency of the utilisation rate of resources, reduce and avoid the generation of pollutants, protect and improve environments, ensure the health of human beings and promote the sustainable development of the economy and society.
2009	Recy-cling	Policy process	Recycling Economy Promotion Law	Optimal utilisation of resources and recycling, following the basic 3R principles (Reduce, Reuse, Recycle), with “moderate consumption, low emission, high efficiency” as fundamental characteristics.

TRANSPORTATION

Year	Sector	Type of measure	Measures	Aim, effects
2005	Fuel efficiency for passenger cars	Regulatory instrument	Vehicle Fuel Economy Standards	Fuel efficiency standards, estimated to reduce transportation sector emissions by 5% below BAU in 2020.
2006	Car	Financial (tax incentive)	Vehicle Excise Taxes	Based on vehicle size (car with engines of 1.0L or less = tax decrease of 1%; engines from 3.0 to 4.0L = tax increase of 25%; engines over 4.0L = tax increase of 40%).

FOREST

Year	Sector	Type of measure	Measures	Aim, effects
1998	Protection, afforestation	Policy process	Forest Law	Protecting, cultivating and rationally exploiting forest resources; accelerating territorial afforestation; bringing into play the roles of the forest in terms of storing water, saving soil, adjusting the climate, improving the environment and supplying forest products.
2000	Protection	Policy process	Natural Forest Protection Program (NFPP)	Three major objectives expected between 2000 and 2010: **1.** protecting existing forest resources in natural forests; **2**. afforestation; **3**. assisting in the relocation of surplus/redundant forest workers in the concerned NFPP provinces. Strategies: **1.** commercial logging ban in natural forests, closure of mountains to the extraction of timber, firewood, non-timber forest products and to grazing by local communities; **2.** reducing the annual allowable cut from key state owned enterprise areas by 19.9 million m^3 and observing strict conservation measures in forests covering 94.2 million hectares; **3.** establishing 8.7 million hectares of new forest land (an additional 3.7% to forest cover).

EXAMPLES OF FURTHER CONCRETE MEASURES ADOPTED

In its National Climate Change Program (China, 2007b), China mentions results obtained by the implementation of previous policies. Some effects of policies are quantified in $MtCO_2$.

Others are not quantified, however not because they are not quantifiable but because the necessary resources to measure them were not available.

QUANTIFIED MEASURES

Sector(s)	**Measure(s)**	**$MtCO_2$ reduced in year x**
Economy and energy	Restructuring economy and improving energy efficiency	1,800 $MtCO_2$ from 1990 to 2005
Energy	Developing low-carbon and renewable energy	380 $MtCO_2$ in 2005
Forest	Afforestation, forest management and deforestation avoidance	5,110 $MtCO_2$ from 1980 to 2005
Demography	Controlling population growth	1,300 $MtCO_2$ in 2005

NON-QUANTIFIED MEASURES

Sector(s)	**Measure(s)**	**$MtCO_2$ reduced in year x**
Energy (conservation)	Supporting 111 key energy-conservation projects	Not quantified, 2006
Energy (conservation)	Supporting 681 key energy-conservation projects	Not quantified, 2007
Energy	Energy-saving standards	Not quantified
Energy (efficiency)	Fuel consumption restriction standard for motor vehicles	Not quantified
Government	Strengthening of laws and regulations	Not quantified
Government	Improving institutions and mechanisms	Not quantified
Research	Enhancing climate change research	Not quantified
Public	Raising public awareness	Not quantified

CHANGE IN CHINA'S EMISSIONS DUE TO POLICIES ADOPTED BETWEEN 2000 AND 2005

The Centre for Clean Air Policy (CCAP) has published in 2006 an interesting study about recent efforts and implications of mitigation policies in diverse developing countries (CCAP, 2006a). Compared are projections for 2020 based on a "business as usual" (BAU) scenario with projections for 2020 taking into account the impact of recent policies (policies adopted between 2000 and 2005). The deviation from BAU is expressed in percentage and consigned in the last column of the table. To be noticed is that the study does not consider emissions from agriculture and deforestation. Projections are based on scenario B2 [2] from

[2] Definition of scenario B2 from the IPCC special report: The IPCC has defined four main scenarios: A1, A2, B1 and B2. While A1 and B1 characterise a convergent world, A2 and B2 represents a heterogeneous world. Scenarios A2 and B2 are more ecologically friendly than A1 or B1.
Key assumptions under the scenario B2 are: emphasis on local solutions to economic, social and environmental sustainability as well as strong emphasis on community initiative and social innovation to find local, rather than global solutions (IPCC, 2000).

the IPCC special report on emissions scenarios (IPCC, 2000). The BAU scenario does not include policies adopted since 2000.

Sector	**BAU scenario**		**Recent policies scenario**		
	2000 emissions ($MMTCO_2$, million metric ton CO_2)	2020 emissions ($MMTCO_2$)	2020 emissions ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
Electricity	1,199	3,102	2,960	-142	-5%
Cement	643	1,098	937	-162	-15%
Iron/Steel	200	323	294	-29	-9%
Pulp/Paper	63	141	111	-30	-21%
Transport	195	676	643	-34	-5%
TOTAL	2,299	5,340	4,945	-395	**-7%**

Even if policies adopted between 2000 and 2005 have a positive effect on mitigating GHG emissions (-7% from BAU), the total emissions will still growth for the next years. Emissions in 2020 are estimated to increase by 115% over 2000 levels (CCAP, 2006a), which correspond to more than a doubling of CO_2 emissions within 20 years.

To be underlined is the economic interest China has to invest in efficient energy sources, as already mentioned in the introductory lines of subchapter 4.2, China.

INDIA

Since the beginning of the 21st century, India has adopted numerous measures regarding GHG emission mitigation. If most of the policies concern the energy sector, transportation and forests also benefit from mitigation measures. India can be considered as one of the developing countries with the broadest policy framework. Classified below are some of the various policies adopted by the Government of India to combat climate change and/or serve further interests, like energy security or covering a strongly increasing energy demand. Information provide from India's National Action Plan on Climate Change (India, 2008), from a publication by the Planning Commission of the Government of India (India, 2006), from the initial National Communication to the UNFCCC (India, 2004), from a Teri's publication (Teri, 2006), from two publications by the CCAP (CCAP, 2006a, 2006b) as well as from a publication by the Pew Center on Global Climate Change (Pew Center, 2008).

GLOBAL FRAMEWORK

Year	**Sector**	**Type of measure**	**Measures**	**Aim, effects**
2007	Econo-my	Policy process	11th Five-Year Plan (2007-2012)	Guiding economic policy, focused on strong GDP growth rate, but also on other targets like education, health, environment, energy, science and technology.
2008	Climate	Policy process	National Action Plan on Climate Change	Outlining existing and future policies and programs addressing climate mitigation and adaptation. Eight core National Missions running up to 2017. For each mission, lead ministry responsible

				for developing objectives, implementing strategies, timelines, monitoring and evaluation criteria to be submitted to the Prime Minister's Council for Climate Change.

ENERGY

Year	Sector	Type of measure	Measures	Aim, effects
2001	Efficien-cy	Policy process Regulato-ry instr.	Energy Conservation Act	Improving energy efficiency in energy intensive industrial sectors (certified energy manager, periodical energy audits, energy-consumption norms, ...).
2003	Electrici-ty	Policy process	Electricity Act	Framework for preparation of the National Energy Policy and Tariff Policy.
2005	Electrici-ty	Policy process	National Electricity Policy	Objectives: access to electricity available for all households in next five years, electricity demand to be fully met by 2012, supply of reliable and quality power in an efficient manner at reasonable rates, per capita availability of electricity to be increased to over 1000 kWh by 2012.
2006	General frame-work	Policy process	Integrated Energy Policy	Long-term energy policy guidance. Broad objective of "meeting energy demand at the least cost in a technically efficient, economically viable and environmentally sustainable manner". Key provisions: promotion of energy efficiency in all sectors, mass transport, renewable, nuclear and hydropower, R&D on clean energy technologies.
2006	Renew-able	Subsidies Regulato-ry instru-ment	National Tariff Policy	Implementing a higher tariff base for consumers with a large energy demand. Including provisions regarding renewable energy and cogeneration (minimum percentage for purchase of energy from these sources, taking into account resource availability and impact on tariffs).
2007	Energy saving, building	Regulato-ry instru-ment	Energy Conservation Building Code	Optimising the building's energy demand based on their location in different climatic zones: minimum requirements for building envelope components, lighting, electrical system, water heating and pumping systems.
2007	Efficien-cy	Subsidies	Bachat Lamp Yojana	Innovative initiative put in place by the Central Government to enhance lighting efficiency in the Indian household sector by making Compact Fluorescent Lamps available at prices comparable to that of Incandescent Lamps.
2008	Renew-able	Subsidies	Solar Power Generation	Subsidy for solar power plants: 12 rupees (US$ 0.30) per kWh for solar photovoltaic

			Based Incentive	power and 10 rupees per kWh for solar thermal power fed to the electricity grid.
2008	Renew-able	Subsidies	Generation Based Incentives for Wind Power	To be eligible, new wind power projects must have at least 5 MW of grid-connected capacity and must be installed at sites validated by the Centre for Wind Energy Technology. Investors in eligible projects will receive an INR (Indian Rupee) 0.5/kWh payment for ten years.

INDUSTRY

Year	**Sector**	**Type of measure**	**Measures**	**Aim, effects**
2005	Industry	Policy process	National Steel Policy	Increasing the capacity and efficiency of steel production and thus indirectly reduce energy consumption and GHG emissions.

TRANSPORTATION

Year	**Sector**	**Type of measure**	**Measures**	**Aim, effects**
2002	Frame-work for all kind of transport	Policy process	Integrated Transport Policy	Meeting the transport demand generated by higher GDP growth rate, promoting sustainable, safe and regionally balanced transport system with increased emphasis on energy efficiency and environmental conservation.
2003	Fuel efficien-cy for passen-ger cars	Policy process	National Auto Fuel Policy	Mandating that all new four-wheeled vehicles meet Bharat Stage III emission norms (similar to Euro III emission norms[3]) for air pollutant and comply with Euro IV standards by 2010.
2006	Mass transport	Policy process	National Urban Transport Policy	Ensure safe, affordable and quick development of mass transit strategies for cities. Enhance transport access for the growing number of city residents.
2008	Biofuel	Policy process	National Policy on Biofuels	Indicative target of a minimum of 20% ethanol-blended petrol and diesel across the country by 2017.

[3] European emission standards for passenger cars :

Type of vehicle	**Euro III** (expressed in g of Carbon Monoxyde per km)	**Euro IV** (expressed in g of Carbon Monoxyde per km)
Diesel vehicles	0.64	0.5
Petrol vehicles	2.2	1

FOREST

Year	Sector	Type of measure	Measures	Aim, effects
2008	Refores-tation	Regulato-ry instru-ment	Green India Program	Reforesting 6 million hectares of degraded forest lands which corresponds to 10% of the total Indian forest cover.

To be noticed are some contradictory policies, like for example the National Electricity Policy. Indeed this policy aims at providing access to electricity to all households in the next five years. If this measure will considerably improve the lifestyle of an important part of the population, especially the rural one, it will at the same time increase the demand for electricity. This will inevitably lead to an increase in GHG emissions unless they will introduce clean energy sources.

CHANGE IN INDIA'S EMISSIONS DUE TO POLICIES ADOPTED BETWEEN 2000 AND 2005

Like for China, the CCAP has realised a study about the impact of policies adopted between 2000 and 2005 on the mid-term emissions (projections for 2020, CCAP, 2006a). Projections are again based on the scenario B2 defined by the IPCC. Policies concerning agriculture and LULUCF are once more not integrated in the study.

Sector	**BAU scenario**		**Recent policies scenario**		
	2000 emissions ($MMTCO_2$)	2020 emissions ($MMTCO_2$)	2020 emissions ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
Electricity	427	952	1,062	110	12%
Cement	67	334	339	5	1%
Iron/Steel	66	317	300	-17	-5%
Pulp/Paper	6	12	13	1	1%
Transport	97	644	547	-97	-15%
Residential	47	76	80	4	+6%
Commercial	7	18	18	0	0%
TOTAL	717	2,352	2,358	6	**0%**

Concluded can be that the policies adopted between 2000 and 2005 are not sufficient to lower GHG emissions. Considering the total GHG emissions from the seven sectors studied, no deviation from BAU can be observed, this despite the policies adopted. However, most of the policies listed in the tables above were implemented after 2005. Their effects are therefore not considered in this CCAP study (CCAP, 2006a).

MEXICO

Mexico has a long history in environmental and mitigation policies. Concerned by pollution problems in megacities like Mexico City for decades, the Government of Mexico has adopted numerous policies to reduce pollution. Some policies were established well before the 21st century. Some, like the Law of Ecological Balance and Protection of the Atmosphere, were implemented in the 1980s and even already reformed at the beginning of the 1990s. Mexico is also a precursor concerning emissions inventory. The first inventory was established for the metropolitan area of the Valley of Mexico in 1989. A new inventory was then created in 1995. Both inventories can however not directly be compared, as they were prepared with different methodologies.
This dynamic was maintained by the Government through the years, making Mexico one of the most active developing countries in the field of environmental protection. The beginning of the 21st century marks the creation of policies specific to climate change, GHG emissions mitigation and adaptation: National Strategy on Climate Change in 2007, Special Program on Climate Change in 2009, etc.

Below a non-exhaustive list of the major policies in all fields related to environment in general and GHG mitigation in particular is presented. Information provide from the following documents: National Strategy on Climate Change Mexico (Mexico, 2007), the three official National Communications for the UNFCCC (Mexico, 1997, 2001 and 2006) and a publication by the CCAP (CCAP, 2007).

GLOBAL FRAMEWORK

Year	Sector	Type of measure	Measures	Aim, effects
1988, reformed 1996	Ecosystem and atmosphere	Policy process	Law of Ecological Balance and Protection of the Atmosphere (LGEEPA)	Contemplate the dispositions regarding ecological classification, evaluation of impact and environmental risk, protection of flora and fauna, rational use of natural resources, social participation and ecological education as well as control, safety and sanction measures.
1997	Sustainable development	Policy process	Agenda 21 for Mexico	June 1992, Rio de Janeiro, the UNDP adopts the Agenda 21 (calls for all nations to develop and put into effect their own national strategies, plans and policies for sustainable development). Mexico's Agenda 21 has been formulated so that it corresponds to Agenda 21 and reflects the Mexican situation.
2001	Research	Policy process	Mexican Carbon Program	Aim to coordinate scientific activities related to the study of the carbon cycle in Mexico, serve as the Mexican scientific counterpart to similar programs in other countries, develop and encourage scientific research concerned with the carbon cycle in Mexico and systematise scientific data about carbon.
2007	Climate	Policy process	National Strategy on Climate Change	Mexican Government's commitments to climate change mitigation and adaptation. Identify the most promising GHG mitigation opportunities in Mexico.

				Full and effective implementation of the energy measures identified in this strategy is estimated to reduce GHG emissions by 106.8 MMTCO_2e annually through 2014.
2009	Climate	Policy process	Special Program on Climate Change (version submitted to consultation)	Through this program Mexico's government wants to show that it is possible to mitigate climate change and adapt as much as necessary without compromising development and even with financial benefits. Long-term program, running until 2050 in three different stages: 2008-2012 (mitigation goal = 100 MtCO_2e), 2013-2030 and 2031-2050. Long-term goal: to reduce emissions by 50% in reference to year 2000.
Not available	Emissions and pollution	Regulatory instrument	Registration of Emissions and Pollutant Transfer	Basic tool of environmental management so that at different levels (companies, associations, municipal, state and federal government) actions can be undertaken in relation to: 1) plans of action for reducing GHG in compliance with the Convention on Climate Change (UNFCCC); 2) compliance with environmental regulations; 3) evaluation and communication of environmental risks; 4) prevention of pollution and reduction of waste at the source and throughout the process; 5) control of air pollution; 6) administration of watersheds; 7) public access to environmental information; 8) environmental administration and certification. Includes a multimedia inventory of emissions and pollutant transfer.
Not available	Environmental information	Register	National System of Information on Environment and Natural Resources (SNIARN)	Concentrate and make available all the environmental information. Content: the Natural Protected Areas Registry (RENANP), all reports of atmospheric quality (air pollution), the National Register for Emissions and Pollutant Transfer (RETC); the National System of Information on Biodiversity of Mexico (SINABIO), the National Subsystem of Information on Wildlife as well as the National System of Information on Integral Waste Management (art. 5, LGEEPA).

ENERGY

Year	**Sector**	**Type of measure**	**Measures**	**Aim, effects**
1993	Efficiency	Label	FIDE (Electrical Energy	Voluntary label which identifies energy-efficient products on the Mexican market and certifies that the product has met

			Saving Trust Fund) Label	specified standards. Identification as a FIDE certified energy-efficient product.
Revised 2000	Electricity	Policy process	Public Service Law on Electrical Energy	Goals: independent production, self-sufficiency and co-generation to increase efficiency in fuel use and contribute to moderating the growth in GHG emissions.
2002	Efficiency	Regulatory instrument	Official Mexican Norms in Energy Efficiency (NOMs)	Regulate the minimum efficiency of energy-consuming equipment and systems that are produced and marketed in Mexico. Energy saved in 2005 through the application of the NOMs: 14,251 million kWh in electricity consumption (estimated to prevent 8 $MtCO_2$ GHG emissions).
2004	Renewable	Policy process	Plan of Action to Eliminate Barriers to the Development of Wind Electric Power in Mexico	Eliminate some of the barriers that have delayed the growth of the wind-electric market through the development of technical know-how, analysis and improvements to the legal framework, support for actions and strategic studies, outreach activities and the development and implementation of wind projects for example in La Ventosa, Oaxaca State.
Modified 2005	Renewable	Policy process	Income Tax Law	Taxpayers who invest in equipment and machinery for generating energy from renewable sources will be able to deduct 100% of the investment in one fiscal year.
2005	Renewable	Policy process	Law for the Use of Renewable Energy Sources	Give greater legal certainty to the renewable energy projects developed both for public service and for self-production as well as independent power generation.
2005	Renewable	Policy process	Program for the Use of Renewable Sources of Energy	Goal of achieving 8% of electricity generation from renewable by 2012, excluding large hydroelectric facilities.
2005	Renewable	Policy process	National Hydrogen Plan	Promote the transition towards an economy in which hydrogen fuel would play an important role.
2006	Renewable	Policy process	National Rural Electrification Program	Installation of electric power systems, based on renewable energies, to improve the quality of life and to develop productive activities in 50,000 households between 2006 and 2010.
2007	Efficiency	Policy process	Law for the Better Use of Renewable Energy and the Financing of Energetic Transition	Part of the National Strategy on Climate Change. Promote energy efficiency. Open the door to private investment in the generation of electricity derivated from renewable energy.
2008	Sustainability, renewable	Policy process	Law for the Sustainable Use of Energy	Promote the better use of renewable sources of energy and the sustainable use of energy.

Not available	Renewable	Policy process	Large Scale Renewable Energy Project (PERGE)	Develop five large scale renewable energy projects through a 70 million US$ donation from the Global Environment Facility (GEF) to reach an approximate installed capacity of 500 MW.
Not available	Renewable	Subsidies	Green Fund	Created by the PERGE. Promote and accelerate projects using renewable energy connected to the electrical network.

INDUSTRY

Year	**Sector**	**Type of measure**	**Measures**	**Aim, effects**
1997	Environment	Policy instrument	Integrated System of Regulation and Environmental Management in Industry	Juridical framework for the industrial sector that aims to make compatible environment care with success in the marketplace. Include the Annual Operation Permit, the Voluntary Program in Environmental Management and the Sole Environmental License.
1997	Emissions, pollution	Regulatory instrument	Annual Operation Permit (COA)	Instrument for monitoring, updating and providing information on each industrial establishment regarding emissions and pollutant transfer.
1997	Environmental management	Regulatory instrument	Voluntary Program in Environmental Management (PVG)	Aims at developing the capacity for environmental management in each industrial establishment and at considering environmental protection as part of the system of total management.
1997	Environmental license	Regulatory instrument	Sole Environmental License (LAU)	Coordinates the COA and the PVG. Instrument of direct regulation of obligatory nature for industrial establishments under federal jurisdiction that permits the coordination, in a single process, of the evaluation, verdict and monitoring of the corresponding obligations and processes, regarding environmental impact and risk, emissions to the atmosphere, exploitation of national waters, discharge of wastewater into bodies of water and federal lands, as well as in relation to the generation and treatment of dangerous waste.
1997	Environment	Regulatory instrument	Program for Industrial Environmental Regulations	Implementation of standards and norms for water, atmosphere, environmental impact and natural resource use. Intense efforts of verification and inspection that assist companies in complying with these regulations.

FOREST

Year	Sector	Type of measure	Measures	Aim, effects
Revised 1993	Reforestation	Policy process	National Reforestation Program	Restoring strategic areas, enriching forest masses, introducing appropriate species and effectively developing agroforestry programs. Among its goal is the production of 340 million trees.
1995	Protection of Natural Areas	Policy process	Program of Protected Natural Areas 1995-2000	Protection of Natural Areas as they constitute the primary instrument in conserving both biodiversity and ecological goods and services.
Revised 1997	Forest management	Policy process	Forestry Law	Evaluate environmental damage and the measures necessary to rectify the situation. Implement the necessary means to regulate the improvement, conservation, restoration and rational use of the natural resources destined to agricultural and forest activities. Divide forest area into zones in order to facilitate the planning of the use of forest resources in a more sustainable manner.
1997, revised 2001	Commercial plantation	Regulatory instrument	Program for Commercial Forest Plantations	Revive degraded forest lands and promote sustainable commercial forestry projects. Save between 3 and 7 $MMTCO_2e$ between 2007 and 2012 and up to 30$MMTCO_2e$ by 2020.
2002	Sustainability	Policy process	General Law for Sustainable Forest Development	Through the sustainable management of forest resources, contribution to the social, economic, ecological and environmental development of the country.
2006	Reforestation	Regulatory instrument	ProÁrbol Reforestation Program	Planting of 250 million indigenous Mexican trees in 2007. Expected to avoid 15-35 $MMTCO_2e$ through 2012.
Not available	Forest development	Policy process	Programs of Forestry Development	Emphasis on the conservation and use of forest resources. Directly encourages producers to prepare or update forest management programs, to carry out conservation work and train them in management techniques aimed at regional and community development. Strategies: to increase the surface being exploited and increase yields through aid for technical assistance and training; to generate a greater added value by means of aid for productive organisation and to diversify products and uses, by granting aid for diversification, exploiting non-timber yielding resources and promoting alternative uses for forests.

ATMOSPHERE

Year	Sector concerned	Type of measure	Measures	Aim, effects
1997	Regional air quality improve-ment	Policy process	Specific Programs 1997-2000 to Improve Air Quality on the Metropolitan Areas	Improve air quality in the metropolitan areas of the Valley of Mexico, Guadalajara, Monterrey and the Valley of Toluca. Goals: 1. clean industry, 2. clean vehicles, 3. efficient transportation and new urban order, 4. ecological recovery. General strategies: economic incentives, inspection and supervision, social participation, environmental information and education as well as integration of metropolitan policies (urban development, transportation and ecology). Specific strategies for goal 1: Reduction of emissions per unit of added value in industry and services, improvement and incorporation of new technologies. For goal 2: reduction in the vehicle emission per km travelled, improvement and replacement of automobile fuels. For goal 3: regulation of total km travelled by automobiles, ample offer of safe and efficient public transportation. For goal 4: Stamping out erosion due to the invasion of urban unplanned development onto forest and agricultural land, ecological recovery of urban and urban/rural ecosystems.
2002	Regional air quality improve ment	Regulato-ry instru-ment	Programs to Improve Air Quality in the Valley of Mexico, Monterrey, Guadalajara and Toluca	Continuation of the Specific Programs 1997-2000 to Improve Air Quality on the Metropolitan Areas. Include more than 80 measures that affect transportation, industry, services sector, natural resources, health and education.

As previously mentioned, Mexico is very dynamic in creating and revising environmental policies. Two examples are the reform of the Law of Ecological Balance and Protection of the Atmosphere in 1996 and the reform of the Forestry Law in 1997.
The first one was reformed in order to: 1) increase efficiency of the environmental regulation system, extend its reach and minimise social costs, 2) broaden the perspectives of government administration and social participation, 3) orient the production and consumption decisions towards collective objectives of environmental protection, 4) promote technological change with a preventive focus, 5) present clear rules that would give security to investment and disseminate long-term decisions in favour of environmental protection, 6) generate opportunities promoting technological adaptation and the development of new production alternatives and 7) create an atmosphere of trust between the environmental authorities and the private sector.

The Reform of the Forestry Law in 1997 was also directed towards very concrete points of improvement: 1) reinforcing the link between environmental and forest legislation, 2) regulating afforestations (commercial forest plantations) in order to minimise their environmental impact, facilitating the participation of the social sector and granting legal security to those who carry out this type of activity, 3) fortifying the mechanisms for authorising the exploitation of timber-yielding and non-timber yielding forest resources, taking into account the traditional uses of the indigenous communities, 4) improving the control systems for transporting forest products, in order to eradicate illegal cutting, 5) fortifying the chapter on sanctions for offenders of forest legislation and regulations, 6) favouring the improvement in quality of technical forest services and 7) regulating and controlling the soundness of imported forest products, in order to prevent the entry of plagues and forest illness.

The dynamism of the Government of Mexico is also reflected in the number of National Communications published. If most of the developing countries are at their first National Communication, Mexico already published its Third one in 2006 and is preparing its Fourth one for 2010.

In its Third National Communication (Mexico, 2006), Mexico notably informs about measures adopted and their quantified impact on GHG emissions mitigation expressed in $MtCO_2$.

Results obtained for the domain of energy efficiency:

Sector(s)	**Measure(s)**	**$MtCO_2$ reduced in year x**
Domestic	Substitution of fluorescent lamps, air conditioning and refrigerators	0.95 $MtCO_2$ in 2005
Industry	Diverse projects	0.95 $MtCO_2$ in 2005
Incentives and market development	Programs for motors, lighting units and compressors	1.06 $MtCO_2$ in 2005
Farming	Pump wells and LFC in farms	0.93 $MtCO_2$ in 2005
	Daylight Saving	1.42 $MtCO_2$ in 2005
Subtotal		*5.6 $MtCO_2$ in 2005 (5.9 $MtCO_2$ in 2006)*
Appliances	Energy efficiency standards	8 $MtCO_2$ in 2006
Total		***13.9 $MtCO_2$ in 2006***

Further measure with very concrete results in the field of transport:

Sector	**Measure**	**$MtCO_2$ reduced in year x**
Transport	Bus Rapid Transit (BRT) systems in Mexico City	37.42 $MtCO_2$ per year

Some other measures listed in the Third Communication have not been yet quantified in $MtCO_2$. Examples concerning the transportation sector are described bellow:

Sector	**Measures**	**$MtCO_2$ reduced in year x**
Transport	Introduction of a greater number of diesel vehicles	Not quantified
Transport	Increase in the energy efficiency of light vehicles	Not quantified
Transport	Introduction of the European Norm for	Not quantified

	gasoline vehicles	
Transport	Introduction of hybrid vehicles	Not quantified

Some further measures are taken at the city scale. This is for instance the case in Mexico City. Examples of measures concerning the transport sector are the following:

Sector	**Measures**	**$MtCO_2$ reduced in year x**
Transport	Obligatory school public transportation system instead of private one	Not quantified
Transport	Expansion of collective transportation system	Not quantified
Transport	Replacement of medium capacity vehicle service concession with new high capacity vehicles	Not quantified
Transport	Replacement of obsolete vehicles stock for the Mexico City government	Not quantified

REPUBLIC OF KOREA

The Republic of Korea enacted its first environmental act in 1963. This early initiative in preserving the environment was pursued over the years. Today more than 50 official ***Acts*** aiming at safeguarding the environment are enacted. Unfortunately the detailed content of these numerous Acts are reserved for internal use only and thereby not available in official UN languages. A list of the main Acts is however provided in the official Environmental Review by the Republic of Korea (Republic of Korea, 2007a). Six Acts were enacted during the 1960s: the Waste Cleaning Act (1961), the Water Supply & Waterworks Installation Act (1961), the Environmental Pollution Prevention Act (1963), the Act Relating to Toxic & Hazardous Substances (1963), the Sewerage Act (1966) and the Act Relating to the Protection of Birds, Mammals & Hunting (1967). Between 1970 and 1990 five further Acts were enacted: the Environmental Conservation Act (1977), the Compound Waste Treatment Corporation Act (1979), the Natural Park Act (1980), the Environmental Pollution Prevention Corporation Act (1983) and the Waste Control Act (1986). The enactment of Acts experienced a considerable acceleration between 1990 and today with the creation of more than 45 Acts: Acts concerning air quality, water quality, wildlife protection, enhanced pollution control, etc.

If specific frameworks regarding climate change seem to exist in form of "***Comprehensive National Action Plans against Climate Change***", no detailed information about these plans is available to the international community. Four such Plans have been implemented until today: the 1st one from 1999 to 2001, the 2nd one from 2002 to 2004, the 3rd one from 2005-2007 and the 4th one for the period 2008-2012. According to a statement by Mr. Kwon Haeryong, Deputy Director-General for International Economic Affairs of the Republic of Korea, these actions plans covering mitigation, adaptation as well as research and development (R&D) should have achieved a stabilisation of the annual growth rate in GHG (Republic of Korea, 2007b). The 4th plan is aimed at strengthening the Korean GHG inventory system, increasing the utilisation of low-carbon energy sources, investing for R&D in the areas of carbon capture & storage and renewable energies, as well as raising public awareness. How these goals are going to be achieved, which legal instruments will be enforced and what are the expected quantified outcomes, are all unknowns.

Surprising is that no trace of this “Comprehensive National Action Plans” is to be found in the second ***National Communication to the UNFCCC*** (Republic of Korea, 2003), though the first Action Plans (1999-2001) was already achieved. In its second National Communication, the Republic of Korea has chosen to detail policies and measures adopted instead of existing legal instruments. The main disadvantage is thereby the absence of indications about how the measures and policies mentioned should be implemented and which legal instruments are available for this purpose. Below are an overview of the main recent measures and policies adopted and sometimes their expected outcomes, as described in the second National Communication (Republic of Korea, 2003). The measures cover the following sectors: energy, transportation, agriculture and livestock, LULUCF, waste and inventory.
Specific mitigation measures have not been yet adopted by the Republic of Korea. They are however part of the future measures planed to be adopted (see subchapter 4.3).

ENERGY

Sector	**Type of measure**	**Measures**	**Aim, effects**
Demand, energy conserva-tion	Financial support	3-Year Plan for Energy Audit	Execute annual expansion of energy audit (inspection, survey and analysis of energy flows to seek opportunities to reduce energy input) targeting energy intensive industries and buildings. Support with low interest policy funds to implement the improvement.
Demand, energy conserva-tion	Voluntary agreement	Expansion of Voluntary Agreement (VA)	Continue expansion and promotion of existing VA to enter agreement with 600 businesses by 2003. In 2004, the second phase agreement will be executed.
Demand, energy conserva-tion	Financial support	Energy Service Companies (ESCO)	Induce expansion of existing ESCO with financial support.
Demand, energy efficiency	Regulatory instrument Financial support	High Efficiency Equipment Certification Program	Expand and support high-efficiency products distribution.
Demand, energy efficiency	Regulatory instrument Financial support	Energy Efficiency Standards and Labelling Program	Gradually expand items for energy efficiency standards and labelling program. Upgrade efficiency standards and expand human resources for follow-ups. Foster professional agencies for the measurement of efficiency.
Supply, renewable	Regulatory instrument Financial support	Formation of a Market Demand for Renewable Energy	Secure cost-effective renewable energy by preserving margin from electricity transaction costs. Form test villages to build a supply base for renewable energy. Expand supply and induce spread of renewable energy adequate to the characteristics of the area.
Supply, renewable	Financial support	Expansion of Integrated Energy Supply	Expand supply range of district heating and cooling services evaluated as having high energy conservations and environmental

		Project	improvement effect.
Supply, renewable	Regulatory instrument	Stable Supply of Natural Gases	Secure stable supply from natural gas producing countries. Construct pipelines and terminals in major cities across the country.
Supply, renewable	Regulatory instrument	Stable Supply Level of Nuclear Energy	Increase supply level of nuclear energy generation for long-term power supply and demand. Successfully implement plan for the operation and construction of nuclear power plant.
Supply, renewable	Financial support	Promotion of Landfill Gas (LFG) Projects	Promote projects utilising methane gas from landfills as source of energy for power generating facilities and industrial fuel.
Building	Regulatory instrument	Mandatory Standards for Building Insulation and Energy-Efficient Designs	Raise insulation level by over 20% in building sector to minimise energy consumption. Expand mandatory application of new high-efficient energy equipments to building design. Enforce education and promotion for efficient implementation of energy efficiency building design standard.
Building	Regulatory instrument Financial support	Energy Efficiency Labelling Program for Buildings	Increase support for and delivery of certificate of Building Energy Efficiency for buildings above a given energy performance standard. Annually expand applicable buildings.
Building	Regulatory instrument Financial support	Green Building Certification Program	Issue certification for buildings that have the capacity to improve environmental performance and reduce energy consumption and GHG emission through life cycle assessment.

TRANSPORTATION

Sector	**Type of measure**	**Measures**	**Aim, effects**
Green vehicles	Regulatory instrument Financial support	CNG Buses	Mandate the use of low or no pollution emitting vehicles after the Air Quality Preservation Act. Plan to provide 5,000 vehicles by 2003 and replace all buses nationwide by 2007 (around 20,000 buses).
Green vehicles	Regulatory instrument Financial support	Compact Cars	Provide benefit such as tax reduction, discounts in public parking for compact cars. The proportion of compact cars reached 8% by the end of 2001 and continuous effort is being made to increase the rate.
Green vehicles	Regulatory instrument Financial support	Development of Diesel Cars	Support development of post-treatment technology and other technologies related to diesel cars. Promote technological development for diesel engine filters and catalyst.

Transportation system	Regulatory instrument	Promotion of Efficient Transport Mode Sharing	Raise mode sharing rate for railway from 7.6% in 1997 to 14.2% in 2004. Improve mode sharing by establishing Transportation System Efficiency Act.
Transportation system	Regulatory instrument	Reduction of Traffic Congestion Areas	Improve traffic congested areas through construction of detours for example.
Transportation system	Regulatory instrument	Expansion of Public Transportation Service	Expand urban railroad and light rail transit. At the end of 2001, 127 sections totalling 510.4 km were designated as exclusive bus lanes in eight cities and provinces.
Transportation system	Regulatory instrument Financial support	Traffic Demand Management	Reduce traffic inducement charge for companies implementing Traffic Demand Management. Implement urban transportation demand management by designating urban traffic congestion special management area, developing traffic control system, limiting parking use, etc.
Transportation system	Regulatory instrument	Regulation on Idle Running Vehicles and Restrictions on Car Use	Regulate idle running vehicles through the amendment of Air Quality Preservation Act.
Logistics	Regulatory instrument	Establishment of Comprehensive Logistics Information Network	Establish and promote the 3rd Comprehensive Logistics Information Network to build a comprehensive logistics information network that collectively treats logistics duties.
Logistics	Regulatory instrument	Promotion of Logistics Standardisation	Improve standards for compatibility among logistics related facilities and equipments. Strengthen international collaboration for Korean, Chinese and Japanese logistics standardisation. Establish joint target and task allotting system among government institutions for logistics standardisation policy.

AGRICULTURE AND LIVESTOCK

Sector	**Type of measure**	**Measures**	**Aim, effects**
Farming improvement	Research Education Formation	Reduction of Methane from Irrigated Rice Paddies	Develop and provide technologies for measuring and/or reducing methane from rice paddies. Encourage rice cultivating patterns, water management and varietal improvement.
Farming improvement	Research Education Formation	Reduction of Nitrous Oxide from Uplands	Develop and provide technologies for measuring and/or reducing nitrous oxide. Strongly recommend soil tested fertilisation. Provide information and promote fertiliser use efficiency.

Farming improve-ment	Research Financial support	Improvement in Enteric Fermentation[4] of Ruminant Livestock	Develop technologies for measuring and/or reducing level of methane emissions. Reduce methane emissions through enteric improvement of livestock. Increase distribution of high quality forage and add fermentation enhancer in forage.
Farming improve-ment	Research Financial support	Improvement in Livestock Manure Treatment Facilities	Develop technologies for measuring and/or reducing GHG emissions from livestock manure. Promote the improvement of livestock manure treatment facilities and continually expand investment. Reinforce promotion for the improvement of facility management and operational methods.

LULUCF

Sector	**Type of measure**	**Measures**	**Aim, effects**
Forest expansion	Regulatory instrument Financial support	Promotion of Forest Tending Projects	Expand Forest Tending Project, which was promoted (1998-2001) with an investment of 649.9 billion on 1,024,000 ha of forest, to 2,800,000 ha of forest by year 2007.
Forest diseases	Regulatory instrument	Control of Forest Pest Insects and Diseases	Prevent the spread of forest insect pests and diseases through early detection. Concentrate diseases and pest insects control on pines which cover over 40% of damaged forest areas.
Forest fire	Regulatory instrument	Enforcement of Forest Fire Management System	Promote activities for prevention and various promotional campaigns. Establish preparations for rapid forest fire suppression and distribute fire extinguishing equipments. Mandate mutual cooperation by related ministries and offices for efficient prevention and suppression.
Deforesta-tion, replanta-tion	Regulatory instrument Financial support	Control of Deforestation and Replantation of Harvested Areas	Strengthen deforestation standards through the establishment of Forest-Land Management Law. Provide financial support to induce afforestation of idle land. Legalise mandatory replantation of harvested areas.
Urban Greening	Policy process	Promotion of Urban Greening	Promote urban greening and establish green belts in rural areas. Spread the Green Movement to urban communities.

[4] Definition of enteric fermentation: fermentation that takes place in the digestive systems of ruminant animals.

WASTE

Sector	Type of measure	Measures	Aim, effects
Waste reduction	Regulatory instrument Financial support	Waste Minimisation	Provide guideline for reducing waste (at production stage) in plants, controlling waste generated from packing (at distribution stage) and minimising waste generation at consumption stage.
Recycling	Regulatory instrument Financial support	Waste Recycling	Execute Extended Producer Responsibility System, promote and support the recycling industry and maximise waste recycling to increase consumption of recycled products.
Infrastruc-ture	Financial support	Municipal Waste Landfill Facilities	Construct 71 additional landfill facilities to increase the sanitary landfill rate to 100% by 2004.
Infrastruc-ture	Financial support	Waste Incineration Facilities	Expand waste incineration facilities to incinerate 30% of all waste by 2011.
Infrastruc-ture	Financial support	Sewage and Wastewater Treatment Facilities	Expand sewage treatment facilities by 2005 to raise the sewage service rate to 80%.

INVENTORY

Sector	Type of measure	Measures	Aim, effects
GHG emissions	Research	GHG National Registry System	Between 2002 and 2003, conduct basic research, formulate operational plans, implement test projects and systematise related tasks so that by 2004 the GHG registering computer system is fully operational.
Technolo-gies	Research Informa-tion	Inventory Data Base by Industry and Technology	Establish technology oriented statistics system. Research and evaluate technology by sector and stage. Design and build database. Develop software and establish operational system.

BRAZIL

Brazil has recently concretised its willingness to combat climate change and especially deforestation by enacting and implementing corresponding action plans, programs and laws. Some of these important policies, especially the ones concerning the most emitting sector by

far, i.e. LULUCF, are summarised below. Information provide from the National Plan on Climate Change (Brazil, 2008), from the initial National Communication to the UNFCCC (Brazil, 2004), from publications by the CCAP (CCAP, 2007) and by McKinsey&Company (McKinsey&Company, 2009).

Year	Sector	Type of measure	Measures	Aim, effects
2002	Renewable energy	Policy process	Program for Incentive of Alternative Electric Energy Source (PROINFA)	Goal = produce 10% of the total electricity from renewable sources by 2022.
2002	Protection of Natural Areas	Policy process	Amazon Regions Protected Areas (ARPA)	Financed by the German Development Bank, the GEF, the World Bank and the World Wildlife Fund. Aim to protect the Amazon forest by bringing 50 million ha (12% of Amazon forest coverage) into a network of parks and reserves over ten years.
2004	Protection, deforestation	Financial (fiscal incentive)	Action Plan for Protection and Control of Deforestation in the Legal Amazon (PPCDA)	Fiscal incentives to enhance the economic potential of deforested areas and programs to create income through exploitation of degraded areas. Measures: improve forest management, forest plantation, monitoring and licensing procedures.
2006	Monitoring	Regulatory instrument	Forest Exploitation Detection System (DETEX)	Part of the PPCDA. Online control of the transport of forest products.
2006	Monitoring	Regulatory instrument	Certificate of Forest Origin (DOF)	Part of the PPCDA. Online control of the transport of forest products.
2006	Forest management	Policy process	Law on the Management of Public Forests	Guarantee the allocation of areas to be managed by local communities. Led to the creation of the First Sustainable Forest District to combat deforestation near roads.

Through these diverse measures and further ones, some progress concerning deforestation rate was achieved within the last years. Although the deforestation rate still increased between 2000 and 2004, from 18,000 km^2 to 27,000 km^2, recent efforts have contributed to invert the trend. Indeed the deforestation rate between 2005 and 2006 was strongly decreasing, contrasting with the one of the two preceding years: from an increase of 50% between 2000 and 2004 to a decrease of 50% during a half shorter time period, 2005 and 2006. Such a low deforestation rate as the one reached in 2006 was not seen since the mid-1990s. Estimates published by the CCAP announced the fall in deforestation to have avoided the emissions of more than 442 $MMtCO_2e$ in 2006 (CCAP, 2007). This welcome decrease in deforestation rate is on the one hand due to policies like the one cited above, but on the other hand also to macroeconomic factors, like a fall in commodity prices. In Brazil most of the GHG emissions emanate from the LULUCF sector (see subchapter 3.1). GHG emissions from the remaining sectors (electricity, industry, transport, residential, etc.) are less

significant, but still contain a certain reduction potential as shown in the table below (CCAP, 2007).

CHANGE IN BRAZIL'S EMISSIONS DUE TO POLICIES ADOPTED BETWEEN 2000 AND 2005

Sector	**BAU scenario**		**Recent policies scenario**		
	2000 emissions ($MMTCO_2$)	2020 emissions ($MMTCO_2$)	2020 emissions ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
Electricity	23	38	33	-5	-14%
Cement	26	40	41	0.2	0.5%
Iron/Steel	46	82	76	-5	-6.5%
Pulp/Paper	25	59	57	-2	-3%
Transport	106	245	202	-44	-18%
Residential	NA	36	23	-13	-37%
Commercial	NA	12	8	-4	-32%
TOTAL	227	512	439	-73	**-14%**

CHILE

With the implementation of the UN Framework Convention on Climate Change, Chile has increased its awareness regarding climate change and its impacts. The necessity to create a new national institutional body was recognised, so that the National Advisory Committee on Global Climate Change (CNAG) was created in 1996. Two years later its working structure was defined, specific groups formed as well as an agenda of tasks developed. The CNAG regroups all the ministries and services related to climate change, like the Ministry of the Economy, Development and Reconstruction, the Ministry of Transportation and Telecommunication, the National Energy Commission and the National Science and Technology Research Commission. The CNAG elaborated ***Strategic Guidelines on Climate Change in Chile***, which were then used to prepare the ***Working Plan on Climate Change***. This Working Plan aims at pursuing the following objectives (Chile, 2000):

- Reaffirm the commitments assumed in the UNFCCC
- Promote the ratification of the Kyoto Protocol
- Participation of the relevant sectors and Chilean specialists in discussing the economic mechanisms exposed in the Kyoto Protocol
- Application of the Clean Development Mechanism (CDM)
- Design basic guidelines on new ways to limit and/or reduce the emission of GHG for developing countries
- Develop and implement a National Action Plan for Climate Change
- Create a special fund for technical and scientific research and training in climate change in Chile

The ***National Action Plan on Climate Change*** which should contain concrete actions and means of implementation is still in elaboration.

During the past decades, Chile has adopted different measures contributing to reduce GHG emissions. These measures were however often taken for purposes other than climate

change. An example may be provided by the Oil Crisis in 1973 which incentivised Chilean industries to foster energy efficiency and reduce energy consumption. As underlined in the first National Communication to the UNFCCC (Chile, 2000), these efforts were unfortunately not accompanied by complementary incentives to ensure their durability after the end of the Crisis. Two decades later, GHG emissions had experienced such an increase that the National Energy Commission decided to implement an ***Efficient Energy Use Program***. This Program was financed by national resources as well as bilateral cooperation funds. Focus of the Program was the diffusion of techniques and practices which contribute to a better use of energy and a reduced consumption. The Program achieved concrete results in many sectors. In the industrial sectors, the Program is estimated to have reached a 10% decrease in energy use (Chile, 2000). In the municipal sector, lights were replaced in 60% of the municipalities. In the building sector, an automatisation project for public building was launched. The real potential and benefits of this Program to indirectly reduce GHG emissions need however to be evaluated as mentioned in the National Communication (Chile, 2000).

Another sector where considerable efforts were achieved is forestry. Forests contribute to mitigate GHG emissions by capturing GHG gases. The ***Decree Law N° 19,561*** concretises the willingness of the Chilean Government to "regulate forestry activities on lands best suited for forestry and on eroded soils and to foster afforestation, especially by owners of small forest holdings and where necessary to prevent soil erosion and to protect and replenish the country's soils" (Chile, 2000). It indentifies 200,000 potential beneficiaries, with around two million hectares of land for planting and 27 million hectares in need of protection or reforestation. A further legal instrument implemented also aims at protecting native forests by requesting an authorisation from the National Forestry Corporation before any intervention in a native forest. Documents like a Forestry Management Plan and an Environmental Impact Study must thereby be delivered to the National Forestry Corporation for approbation.

Two examples of projects implemented after the ratification of the UNFCCC are the "Reduction of GHG in Chile" and the "Removing Barriers to Rural Electrification Projects with Renewable Energy Sources". "Reduction of GHG in Chile" is a project financed by the GEF which begun in 1996. Identifying and applying energy efficient measures and renewable energies are the overarching objectives. The second project which was launched in 1999 may be considered as a specific part of the first one. It aims at developing preparatory activities for a comprehensive program to use renewable energy sources for rural electrification in Chile. If these projects consist of an important preparatory phase and demonstrate the good willingness of the Government, projects aiming at concrete actions are still lacunar.

INDONESIA

Deforestation, loss of biodiversity, coral reef degradation, land degradation, agricultural productivity loss and water resources depletion are the main environmental concerns of Indonesia. The GHG emissions perfectly reflect this situation as more than 80% of the total GHG Indonesian emissions are due to LULUCF.

Deforestation increased dramatically during the 1990s, especially during the Asian Financial Crisis of 1997-1998. The average annual deforested surface is estimated at 2 to 2.5 million hectares. The percentage of land area covered by forest has fallen from 65.2% in 1990 to 58% in 2000 (Asian Development Bank, 2005). Illegal logging, forest conversion for agriculture use, fire and mining are the main causes.

An impactful turning point was the implementation of the ***Regional Autonomy Law*** in 1999, combined with the ***Fiscal Autonomy Law*** in the same year. These laws aim at decentralising power from the central government to local authorities. According to these laws, local governments are responsible for sectors, including public works, health, education, agriculture, transportation, communication, trade and industry, land management as well as natural resource and environmental management. The central government remains responsible for foreign policies, justice, national defence and security, monetary and fiscal policies. Local governments are obligated to maintain the sustainability of their resources, but at the same time they have the right over income from the utilisation of forestry, fisheries and general mining resources. This latest right strongly incentivises local governments to infringe the obligation to maintain sustainability. A further difficulty is the lack of coordination between the different agencies. Even if the ministries (of environment, forest, etc.) try to coordinate their efforts, a considerable synchronisation potential remains. For example, no single agency is responsible for coordinating the access to natural resources and ensuring that resources are sustainably managed. The decentralisation further reinforces the difficulty to coordinate efforts to enforce laws, for instance from the deciding board which designs the law to the local level where the law should concretely be implemented and actions undertaken.

A further important policy is the medium-long-term development strategy, named ***PROPENAS***, which was introduced in 2000. PROPENAS sets five broad national objectives: 1) ensure national cohesion and social stability, 2) achieve good governance and rule of law, 3) accelerate economic recovery and strengthen the foundations for sustained growth, 4) develop the social sectors and human welfare, 5) strengthen regional autonomy, rural and urban development as well as structural poverty programs. To better define these broad objectives, key components have been identified for the following issues:

- governance: anti-corruption program, administrative and fiscal decentralisation, improved public financial management, civil services reform, dismantling the state monopolies and deregulating trade, investment and industry.
- growth strategy: macroeconomic stability, strong banking sector and generating market confidence.
- Infrastructure: rehabilitation and improvement of existing infrastructure, improving infrastructure services, expanding employment and business opportunities
- Social sector: ensure all citizens access to basic services
- Primary and secondary education. Basic health service delivery, preventive healthcare
- Decentralisation: facilitate participatory decision making, create greater accountability, enhance the quality and delivery of public services, strengthen implementation of programs and enhance the impacts of development.

The Central government has developed core strategies to achieve these goals, ministry by ministry. Below are examples for the two ministries especially concerned with the environment, the Ministry of Environment (MOE) and the Ministry of Forest (MOF):

- MOE: capacity strengthening of the regional governments to conduct good environmental governance; empowerment of the society (promoting society's demand for a healthy and clean environment, for a sustainable development); promoting environmental compliance of state owned firms and government institutions to halt activities which reduce the quality of environment; conservation of the environment (forest fire control, forest recovery, water conservation, coral reef protection, …); institutional development as well as development of communication and information systems.
- MOF: combating illegal logging; controlling forest fire; restructuring the forestry sector; establishment of plantation forest and reforestation as well as streamlining the decentralisation of the forestry activities.

If PROPENAS sets broad targets and defines a broad framework, it does not specify which concrete mechanisms and concrete actions should be undertaken in order to achieve these goals. Considering the decentralisation due to the enforcement of the Regional Autonomy Law, the concrete implementation of PROPENAS may be even more difficult.

A specific action plan has been established for biodiversity: the ***Biodiversity Strategy and Action Plan for 2003 to 2020***. It contains diverse action plans: one for human resources capacity building in biodiversity management, one for strengthening the resources, technologies and local knowledge biodiversity management, one for improving biodiversity conservation and rehabilitation, one for institutional capacity building and biodiversity policy development as well as a last one for capacity building in resolving conflicts in biodiversity. If the policies planed to achieve these goals are more detailed than the one of PROPENAS, the challenge remains to succeed in applying concepts at the local level.

Specific laws regarding mitigation are not so numerous in Indonesia. Two main laws cover this issue: the ***Environmental Management Law*** (1997) and the ***Forestry Law*** (1999). The Environmental Management Law defines the principles, objectives and targets of the environmental management in Indonesia, rights and duties and authorities to manage the environment. The Forestry Law addresses the role to be played by customary communities and the society at large in managing the protection of forests. The law further defines the forest utilisation system which consists of forest utilisation rights and concessions. The ADB (Asian Development Bank, 2005) underlines the short-term perspective of the measures envisaged which might be contra-productive to the global sustainable goal. Both laws provide however a first basis to build on the necessary legal and regulatory policy protocols.
Concerning financial issues, Indonesia receives support from many developed countries and institutions. On the country side, support from the USAIS (United States of America), from the EU especially for forestry programs, from the JICA (Japan) for community development in the natural resources sector, from the French Government for mitigation, from the German Government, from Australia for concrete forestry projects in Kalimantan, etc. On the institutional side, support is furnished by the Global Environment Facility (GEF), the Asian Development Bank (ADB), the World Bank and NGOs like the WWF which mainly support biodiversity programs. For instance, investments of the World Bank for the time period 2004-2006 amount to around 2.6 billion US$ allocated to community driven development and local services. Most of the listed financial aid goes directly to the sectors it is aimed at. This could change in the future with the introduction of a new financial mechanism by the Indonesian Government: the Indonesia Climate Change Trust Fund (see subchapter 4.3).

Next to the Forestry Law, some encouraging signs emerge from REDD mechanism (Reducing Emissions from Deforestation and Forest Degradation). In May 2009, the Indonesia's forestry minister has formally enacted regulations mechanism for ***REDD***. Indonesia is thereby the first nation to enact such legislation. The World Bank communicated encouraging figures showing that there are currently around 20 REDD projects at different stages of development in Indonesia (World Bank, 2009b). The government has however not announced how REDD revenue would be handled and what the government's share would be. As a Jakarta-based lawyer, Mr. Luke Devine, underlines, "the earlier draft talked about 30% share of the REDD entitlements going to the central government; the signed regulation just says it will be separately regulated" (Indonesia, 2009). This demonstrates once more the influence of the political system in force and the difficulties to avoid corruption in many developing countries.

The energy sector is by far not the main concern of the Indonesian Government in matter of environment protection. Renewable energies are underdeveloped, facing numerous barriers but raising few incentives, as underlined in a report by the World Bank and the Indonesian Department for International Development (World Bank, 2007). The contrast between the estimated potential for renewables and the installed capacity is striking:

Figure 4: Indonesia renewable energy potential compared to installed capacities

Renewable Sources	Potential		Installed Capacity	
Hydro	75,67	GW	4,200	MW
Geothermal	27	GW	807	MW
Mini/micro hydro	500	GW	84	MW
Biomass	49,81	GW	445	MW
Solar	4,8	kWh/m^2/day	8	MW
Wind	3-6	m/s	0,6	MW

Source: World Bank, 2007.

Considerable barriers to the deployment of new technologies, like subsidies for fossil fuel, hinder progress towards an increase of green energies (see subchapter 5.3). Some actions by international institutions can still be found. For instance, the Asian Development Bank has proposed some services in the domain of energy efficiency for 2009 (ADB, 2008). Aim of the project is to reduce energy losses by rehabilitating equipment and optimising energy flow through the existing distribution networks. Expected outcomes are savings in domestic and industrial power usage and reduction in carbon dioxide emissions by more than 5 million tons.

Concluded can be that despite the policy framework established by the government, the lack of capacity and enforcement at the local level impedes an efficient enforcement of the laws and thereby concrete results in mitigating climate change. The variety of national, provincial and district level organisations responsible for implementing policies is a considerable obstacle. Lack of cross-sectoral coordination further reinforces this problem.

4.3 Projected actions

This subchapter focuses on projected actions planed by the same seven countries to further mitigate GHG emission within the next years, decades. Estimates of mitigation potential are also provided for some countries. The order of the countries follows the one of the previous subchapter: first China, India, Mexico and the Republic of Korea, then Brazil, Chile and Indonesia.

CHINA

Due to a quasi uninterrupted economic growth over the last 30 years, China has become one of the largest GHG emitter worldwide (see subchapter 3.1). According to model simulations, the Chinese economy in 2050 will continue to grow to between 8 and 13 times faster than today (Wang, 2009). The primary energy demand will consequently rise and thereby the GHG emissions, even if a peak in emissions is estimated to be reached by 2020-2030 (Wang, 2009). Energy is often identified as the key sector to a successful transition to low carbon development. Indeed energy can be considered as the motor of the economy, especially as it concerns every population stratum, from the individual consumption to industrial production. Decoupling GHG emissions from economic growth is one of the greatest challenges of the 21st century faced by all countries of the World, especially countries with high economic growth rates, like China. According to a recent publication by the Tyndall Centre for Climate Change Research (Wang, 2009), "decoupling carbon emissions growth from economic development is challenging but achievable in China". It is however vital to reach a GHG emissions peak as early as possible. The structural move of China from heavy industries towards a more balanced service economy and high tech industries may be one of the keys to achieve a low carbon development path in China.

The decisive official background document for the next years is the China's National Climate Change Program (China, 2007b) adopted in 2007. This Program should fulfil the following overall objectives declared by the Government of China: to make achievements in controlling GHG emissions, to enhance adaptation capacity, to make new progress in advancing science and technology R&D, to remarkably raise public awareness, to further strengthen institutions and mechanisms.

According to this National Climate Change Program, China will make its efforts to realise the objectives and tasks presented in the program through adopting a series of institutional, legal, economic and technological instruments in order to: 1. strengthen energy conservation; 2. optimise energy mix; 3. improve ecological environment; 4. enhance adaptation capacity; 5. intensify R&D and improve research capacity; 6. raise public awareness and 7. improve mechanisms for climate change administration.

Six principles have guided the elaboration of the National Climate Change Program: 1) to address climate change within the framework of sustainable development, 2) to place equal emphasise on both mitigation and adaptation, 3) to integrate climate change policy with other interrelated policies, 4) to rely on the advancement and innovation of science and technology, 5) to follow the principle of "common but differentiated responsibilities" and 6) to actively engage in wide international cooperation. The application of these six guiding principles should guarantee an equitable and efficient National Climate Change Program.

China's position on mitigation is also consigned in this Program.

> *"Parties included in Annex 1 to the UNFCCC should take the lead in reducing GHG emissions according to the principle of "common but differentiated responsibilities". The overriding priority of developing countries is to achieve*

sustainable development. China will, in accordance with its sustainable development strategy, take effective measures to improve energy efficiency, promote energy conservation, develop renewable energy, strengthen ecological preservation as well as carry out tree planting and afforestation in an endeavour to control its GHG emissions and to make contribution to mitigating climate change."

Six key areas of actions for mitigation are identified in the Program:

1. Energy production and transformation:
- strengthen energy legislation, promote the implementation of China's national energy development strategy, promote the optimisation of energy mix, mitigate GHG emissions from energy production and transformation
- strengthen institutional innovation and mechanism construction, accelerate China's institutional reform in energy sector, further promote mechanism construction for renewable energy development
- intensify relevant policies and measures in energy industry
- improve technology self-innovation capacity, promote the sustainable development of energy industries, develop technologies for the clean and efficient development and utilisation of coal, develop exploration, exploitation and utilisation technologies of oil and gas resources, develop nuclear power generation technology, renewable energy technology, power transmission and distribution as well as grid safety technologies.

2. Energy efficiency improvement and energy conservation:
- improve existing energy-saving regulations and standards, strengthen supervision and monitoring on energy conservation
- establish target-oriented responsibility and assessment systems for energy conservation, carry out comprehensive resource planning and electric power demand side management, promote energy-saving products
- formulate preferential policies for energy-saving products, study financial and tax policies to encourage the development of energy-saving and environmental-friendly vehicles
- strengthen the development and dissemination of energy conservation technologies in key sectors: iron and steel industry (apply advanced technologies and equipments), nonferrous metal industry (use of large, high-efficient and energy saving equipments), oil and petrochemical industry (optimisation technologies), building material industry (new advanced process for cement and glass industry), transportation (elimination of old energy intensive automobiles and old ships, electrification of railway, adoption of energy saving airplane), agriculture machinery (apply advanced energy saving diesel engine technology, apply renewable energy), building (priority to the development of green building design technology), commercial and residential energy conservation (promote highly-efficient energy saving household and office appliances)
- further carry out the 10 key energy conservation priority programs in the Medium and Long-term Energy Conservation Plan (see subchapter 4.2, China).

3. Industrial processes:
- develop circular economy[5]
- apply the principle "reduction, reuse and recycle of waste"
- encourage the saving of iron and steel
- further promote the production of bulk cement and slag cement

[5] New development strategy, new economic development pattern developed by China, aiming at maximising resource efficiency as well as minimising waste discharge and realising sustainable economic and social development (Zengwei, 2008)

- launch the campaign of building materials conservation which include the promotion of “four-saving buildings” characterised by energy conservation, water saving, material saving and land saving
- strengthen the emission control of nitrous oxide and other kind of GHG (HFCs, PFCs, SF_6, etc.).

4. Agriculture:
- strengthen the establishment and implementation of laws and regulations aiming at improving agricultural production, increasing agricultural ecosystem carbon storage and forbidding any destruction of pasture or waste of land
- intensify the construction of ecological agriculture in highly-intensive production areas
- further enhance technology development and transfer by selecting and breeding rice varieties with high yields and low GHG emission rates, scientific irrigation, reducing methane emissions from livestock, reducing nitrous oxide emissions from croplands.

5. Forestry:
- improve formulation and implementation of laws and regulations and develop new regulations on conservation of natural forests
- develop target-oriented management responsibility system for afforestation by governments at all levels and forestry sectors, national voluntary tree-planting
- strengthen key forestry ecological programs so as to protect existing forest and enhance carbon sequestration.

6. Waste:
- reduce waste from the source, recovery, utilisation and non-hazardous disposal
- establish compulsory standards for waste classification and recovery so as to improve the comprehensive utilisation of waste resources
- develop and disseminate advanced waste incineration and composting technology
- reform the waste disposal system by establishing a charging system for disposal of domestic waste
- formulate incentive policy for the recovery and utilisation of landfill gas.

The National Climate Change Program contains also very precise, short-term and ambitious objectives to be reached by 2010.

Short-term Objectives by 2010

- Endeavours to control GHG emissions:
  - to reduce energy consumption per unit GDP by 20%
  - to increase the share of renewable energy to 10% in primary energy supply
  - to stabilise nitrous oxide emissions from industrial processes at 2005 level
  - to control the growth rate of methane emissions
  - to increase the forest coverage rate to 20%
  - to increase carbon sink by 50 million tons over 2005 level.

- Endeavours to enhance adaptation capacity of ecosystems:
  - to increase improved grassland by 24 million hectares, to restore grassland suffering from degradation, desertification and salinity by 52 million hectares and to increase the efficient utilisation coefficient of agricultural irrigation water to 0.5
  - to place 90% of typical forest ecosystems and national key wildlife under effective protection
  - to increase nature reserve area to 16% of the total territory
  - to improve 22 million hectares of desertified lands

  - o to reduce the vulnerability of water resources to climate change, to complete the construction of anti-flood engineering systems in large rivers and to enhance the capability of farmland to resist drought
  - o to recover and expand mangroves area so as to remarkably raise the capability to resist marine disasters.

- Efforts to strengthen scientific research and technology innovation:
  - o to reach advanced levels in research on climate change
  - o to make remarkable progress in technology R&D on energy development, energy conservation and clean energy
  - o to improve adaptation technology in agriculture and forestry.

- Efforts to raise public awareness and to enhance management:
  - o to widely disseminate knowledge related to climate change and to raise public awareness on climate protection
  - o to establish and strengthen institutions and mechanisms to address climate change.

China further communicates some projected results to be achieved by 2010, expressed in very concrete terms ($MtCO_2$).

Sector(s)	**Measure(s)**	**$MtCO_2$ to be reduced by 2010**
Renewable	Developing hydropower	500 $MtCO_2$
Renewable	Developing nuclear power	50 $MtCO_2$
Efficiency	Expediting technological advancement in thermal power generation	110 $MtCO_2$
Technology improvement	Utilising coal mine methane	200 $MtCO_2$
Renewable	Developing biomass energy	30 $MtCO_2$
Renewable	Developing wind, solar and geothermal energy	60 $MtCO_2$
Conservation	Implementing 10 key energy conservation priority programs	550 $MtCO_2$

The CCAP has published an interesting study regarding the emission reduction potential in China (CCAP, 2006a). They have estimated for each of the main emitting sector, except LULUCF and agriculture, the emission reduction potential by 2020. Different degrees of mitigation policies are distinguished regarding their price (US$ / tCO_2). Compared are then projections for 2020 following a BAU baseline with projections for 2020 taking into account the implementation of mitigation measures of the cost of x US dollars per ton of CO_2.

For China, an emission reduction potential of nearly 20% by 2020 could be achieved with implementation of all feasible mitigation measures in all sectors analysed (equivalent to nearly a billion ton emission reduction from BAU level). Almost half (45%) of these reductions are possible in the electricity sector, with another one fifth available in both cement and transportation sectors. Implementation of the lowest cost measures only (net saving or less than $5 per ton) would reduce GHG emissions by 7% below BAU level by 2020 (397 $MMTCO_2$ emission reduction). Implementation of higher cost measure but still less than $10 per tCO_2 would lead to a total reduction of 510 $MMTCO_2$ in 2020 (10% below BAU levels).

Below are the detailed figures for each sector: electricity, cement, iron and steel, transportation and the cumulated emissions from the four sectors.

Electricity

Advanced policy options scenario	2020 BAU emissions ($MMTCO_2$)	2020 emissions considering policy options ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
< \$ 0 / tCO_2	3,102	3,058	-44	-1%
< \$ 5 / tCO_2	3,102	-	n/a	n/a
< \$10 / tCO_2	3,102	3,033	-69	-2%
All options	3,102	2,658	-444	-14%

Remark: options <$10 also include options <$0 and <$5.
Domestic policy options foreseen to achieve these potential reductions are the following: fuel pricing programs or energy taxes to promote conservation, capacity building efforts to increase public awareness and encourage energy efficiency activities as well as promotion of renewable energies through subsidies, taxes or caps.

Cement

Advanced policy options scenario	2020 BAU emissions ($MMTCO_2$)	2020 emissions considering policy options ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
< \$ 0 / tCO_2	1,098	1,005	-93	-8%
< \$ 5 / tCO_2	1,098	970	-128	-12%
< \$10 / tCO_2	1,098	900	-198	-18%
All options	1,098	866	-223	-21%

The cement sector is a promising source of low-cost emission reduction. Indeed estimates provided by the CCAP (CCAP, 2006a) indicate that some measures would even generate benefits instead of costs. This is the case for the following measures considered for the <$0 policy scenario:

- preventive maintenance (24 $MMTCO_2$ at a savings of $5 per ton)
- use of waste fuels (22 $MMTCO_2$ at a savings of $4 per ton)
- process control and management (20 $MMTCO_2$ at a savings of $2 per ton)
- kiln shell heat loss reduction (11 $MMTCO_2$ at a savings of $2 per ton)

Many of these low-costs options are also expected to produce significant economic co-benefits through increased productivity as well as improvement of air and water quality.

Iron and steel

Advanced policy options scenario	2020 BAU emissions ($MMTCO_2$)	2020 emissions considering policy options ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
< \$ 0 / tCO_2	323	321	-1.6	-0.5%
< \$ 5 / tCO_2	323	303	-20	-6%
< \$10 / tCO_2	323	284	-39	-12%
All options	323	257	-66	-20%

If the implementation of policies inducing costs less than $0 does not achieve a significant emission reduction, measures under $5 per ton are estimated to achieve a 6% reduction by

2020 (19 $MMTCO_2$). But even if the deviation in percentage seems considerable (-20% if all policies are implemented), the amount of $MMTCO_2$ reduced is insignificant.

Options available at a cost less than $5 are: establishment of an energy management centre (4 $MMTCO_2$ at a savings of $4 per ton) and advanced coke ovens (9 $MMTCO_2$ at a cost of $3 per ton). More expensive options (< $10) may be advanced blast furnace technology (25 $MMTCO_2$ at a cost of $5 per ton) and adjustment of the ratio of iron/steel (44 $MMTCO_2$ at a cost of $8 per ton). Officials share knowledge and training with plant managers, as well as direct financial incentives (subsidies, tax credits, ...) for capital investments in modern plants or advanced technologies and R&D may contribute to the implementation of the mentioned policies. Since China is a worldwide major producer of iron and steel, measures that would simultaneously improve the efficiency and competitiveness may be very welcome.

Transportation

Advanced policy options scenario	2020 BAU emissions ($MMTCO_2$)	2020 emissions considering policy options ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
< $ 0 / tCO_2	676	473	-203	-30%
< $ 5 / tCO_2	676	470	-206	-30%
< $10 / tCO_2	676	-	n/a	n/a
All options	676	460	-216	-32%

Vehicle ownership in China is currently low, but emissions from this sector are growing rapidly due to strong economic growth and expansion of the middle class. This provides a substantial opportunity for emission reduction. A 30 % reduction from BAU is achievable through fuel economy improvements in passenger cars alone. The required technologies to achieve these benefits are estimated to be cost-effective to consumers. Examples of measures are:

- transmission technologies (19 $MMTCO_2$ at a savings of $18 per ton)
- vehicle technologies (44 $MMTCO_2$ at a savings of $12 per ton)
- combined engine, vehicle and transmission technologies (4 $MMTCO_2$ at a savings of $11 per ton)

The savings are generated through co-benefits.

Fuel taxes, emissions standards, financial, technical and training assistance provided by the government as well as international policy to assist developing countries with financing and technology transfer may all help China to reach its ambitious mitigation target.

All sector mitigation options

Advanced policy options scenario	2020 BAU emissions ($MMTCO_2$)	2020 emissions considering policy options ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
< $ 0 / tCO_2	5,340	4,998	-342	-6%
< $ 5 / tCO_2	5,340	4,943	-397	-7%
< $10 / tCO_2	5,340	4,829	-511	-10%
All options	5,340	4,346	-994	-19%

This table summarises the figures of the four sectors analysed above (electricity, cement, iron and steel as well as transportation) and of the pulp/paper sector (negligible in comparison to the four other sectors).

Considerable deviation from BAU may be accomplished if all policies options suggested by the CCAP would be implemented. The costs induced by the implementation of all policies could be precisely calculated if details about each policy would be known.

INDIA

India is another developing country experiencing a strong economic growth coupled with high GHG emissions rate. Maintaining high economic growth rate is essential for increasing living standards of the vast majority of people and reducing their vulnerability to the impacts of climate change. Economic growth should however not endanger the environment. A solution to this dilemma is a sustainable development path. Aim of this development path would be to further achieve economic growth, but without compromising the environment. To achieve this ambitious goal, India has established a National Action Plan on Climate Change, which is guided by the following principles (India, 2008):

- protecting the poor and vulnerable sections of society through an inclusive sustainable development strategy, sensitive to climate change
- achieving national growth objectives through a qualitative change in direction that enhances ecological sustainability, leading to further mitigation of GHG emissions
- developing efficient and cost-effective strategies for end use demand side management
- deploying appropriate technologies for both adaptation and mitigation of GHG emissions extensively as well as at an accelerated pace
- engineering new and innovative forms of market, regulatory and voluntary mechanisms to promote sustainable development
- effecting implementation of programs through unique linkages, including with civil society and local government institutions and through public-private-partnership
- welcoming international cooperation for research, development, sharing and transfer of technologies enabled by additional funding and a global Intellectual Property Rights regime that enables technology transfer to developing countries under the UNFCCC.

To concretise these principles, India has defined concrete measures regrouped under eight National Missions (India, 2008). These eight National Missions constitute the core of the National Action Plan on Climate Change. They reflect the willingness of the Government of India to simultaneously advance economic development and climate change related objectives (mitigation and adaptation) by means of long-term and integrated strategies.

The Eight National Missions

National Solar Mission

Located in the equatorial sun belt of the earth, India receives abundant radiant energy from the sun. Solar energy therefore shows great potential as future energy source. Advantages of this renewable energy source are the possibility to decentralise the energy distribution, the absence of GHG emissions and the improvement of energy security due to the partial substitution of coal and petroleum. The National Solar Mission aims at significantly

increasing the share of solar energy in the total energy mix with the ultimate goal of making solar energy competitive with fossil-based energy options. The National Solar Mission is responsible for the deployment of commercial solar technologies in the country, the establishment of solar research facility, the realisation of integrated private sector manufacturing capacity for solar material, the networking of Indian research efforts with international initiatives and the purveyance of funding support for the above listed activities. Concrete goals of the missions are among others to increase the production of photovoltaic to 1,000 MW/year and to deploy at least 1,000 MW of Concentrating Solar Power (CSP) generation capacity.

National Mission for Enhanced Energy Efficiency

The legal framework for the implementation of energy efficiency measures for energy intensive sectors is provided by the Energy Conservation Act (see subchapter 4.2, India). Current initiatives under this Act are estimated to yield savings of 10,000 MW by 2012. To further enhance energy efficiency, the National Mission plans four new initiatives:

- mandating specific energy consumption decreases in large energy consuming industries, for that purpose developing a market based mechanism to enhance the cost-effectiveness of these energy-efficiency improvements with a system for companies to trade energy saving certificates
- developing innovative measures for the promotion of energy efficiency like tax incentives including differential taxation on appliances certified as energy efficient through an energy labelling program
- creating new financial mechanisms for enabling public-private-partnership to capture energy savings through demand side management programs in the municipal, buildings and agricultural sectors
- developing fiscal incentives.

National Mission on Sustainable Habitat

This Mission aims at improving the energy efficiency in buildings, managing solid waste and promoting public transport. For that purpose the Mission calls for three initiatives:

- extension of the Energy Conservation Building Code (see subchapter 4.2, India) in its application and incentives for retooling existing building stock
- recycling of material and urban waste management, with a special emphasise on power production from waste
- better urban planning and modal shift to public transport.

Capacity building is a further important component of this Mission.

National Water Mission

Ensuring integrated water resource management, minimising wastage and ensuring more equitable distribution are the goals of this Mission. Due to the development and implementation of new regulatory mechanisms, 20% improvement in water use efficiency is expected.

National Mission for Sustaining the Himalayan Ecosystem

With its high biodiversity, forest cover, glaciers and other ecological values, the Himalayan Ecosystem is particularly vulnerable to climate change. Furthermore, glaciers are a key element in the Indian water supply chain. This Mission aims at conserving this privileged ecosystem. Established will also be an observational and monitoring network to assess water resources and health of this particular ecosystem.

National Mission for a Green India
The Green India Mission deals with ecosystem services including carbon sinks with the aim to enhance them. Already announced by the Prime Minister is a campaign for the afforestation of 6 million hectares of degraded forest lands, the so called Green India Program (see subchapter 4.2, India). The national target for the forest cover is set by 33% of India's territory. To compare, the current area under forests represents 23% of the territory.

National Mission for Sustainable Agriculture
Employing more than half of the whole Indian population and contributing to a fifth of the Indian GDP (India, 2008), agriculture is a key element of the Indian economy. Making Indian agriculture more resilient to climate change by developing climate-resilient crops for example, improving risk management by expanding weather insurance mechanisms for instance, integrating tradition knowledge and new technologies are all aims of the National Mission for Sustainable Agriculture.

National Mission on Strategic Knowledge for Climate Change
Global and regional climate modelling, data gathering and assimilation, socio-economic impacts of climate change on health, demography, migration patterns, etc., are elements contributing to a better understanding of the climate and its evolution. To achieve this, the Mission plans to create a new Climate Science Research Fund as well as to encourage private sectors initiatives for the development of new adaptation and mitigation technologies.

All the eight above mentioned Missions will be institutionalised by respective agencies and implemented by inter-sectoral groups. The Prime Minister's Council on Climate Change will follow and periodically review the progress of the eight Missions.

Similarly to China, the CCAP has estimated the mitigation potential by 2020 for high emitting sectors, namely electricity, cement, iron and steel as well as transportation (CCAP, 2006a). Unfortunately, emissions from agriculture and LULUCF are neither reported.

Electricity

Advanced policy options scenario	2020 BAU emissions ($MMTCO_2$)	2020 emissions considering policy options ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
< \$ 0 / tCO_2	952	914	-38	-4%
< \$ 5 / tCO_2	952	891	-61	-6%
< \$10 / tCO_2	952	871	-81	-9%
All options	952	774	-178	-19%

Electricity is the analysed sector with the highest totalised GHG emissions. The perspective of an around 20% reduction potential is encouraging. The relative high costs induced may be compensated through co-benefits. Indeed mitigation in the electricity sector is projected to generate considerable co-benefits, especially for renewable energies. Examples of co-benefits may be creation of new jobs in rural areas, thereby decrease of migration flows from rural populations to urban areas and reduction of India's rural poverty. Some domestic policy options which could be implemented to achieve these goals are subsidies and tax credits.

Cement

Advanced policy options scenario	2020 BAU emissions ($MMTCO_2$)	2020 emissions considering policy options ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
< \$ 0 / tCO_2	334	324	10	-3%
< \$ 5 / tCO_2	334	-	n/a	n/a
< \$10 / tCO_2	334	-	n/a	n/a
All options	334	324	10	-3%

At first sight, results obtained for the cement sector appear quite surprising. Reason for this low deviation potential from BAU is the modernity of the existing cement plants. Indeed 99% of Indian cement is produced in plants that are no more than ten years old. Plants therefore already possess modern efficient technologies. The remaining potential to further improve them is consequently modest.

Iron and steel

Advanced policy options scenario	2020 BAU emissions ($MMTCO_2$)	2020 emissions considering policy options ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
< \$ 0 / tCO_2	317	-	n/a	n/a
< \$ 5 / tCO_2	317	-	n/a	n/a
< \$10 / tCO_2	317	-	n/a	n/a
All options	317	285	-32	-10%

The CCAP only considers one mitigation option in the iron and steel sector: building new Blast Furnace-Basic Oxygen Furnace instead of Direct Reduced Iron- Electric Arc Furnace. This option has an estimated potential of reducing emissions for this sector by 10%. If further policies to promote fuel-switching or increase scrap supplies may be envisaged, emissions could even be strongly reduced. The costs of such measures remain however to be evaluated.

Transportation

Advanced policy options scenario	2020 BAU emissions ($MMTCO_2$)	2020 emissions considering policy options ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
< \$ 0 / tCO_2	644	-	n/a	n/a
< \$ 5 / tCO_2	644	-	n/a	n/a
< \$10 / tCO_2	644	-	n/a	n/a
All options	644	465	-179	-28%

Transportation is a promising sector as it contains the fastest growing GHG emissions of all sectors analysed. Measures like fuel economy improvements, electrification of rail systems, increasing the shares of freights and passengers by rail, increasing the share of passenger road travel by public transport and fuel switching to biofuels could be implemented at low cost. Most of the listed measures are even estimated to generate savings instead of costs. Reduction of congestion, noise and improved safety due to increase in public transport and rail mode shares, improvement of country's energy security by reducing its dependence on

imported oil and lowered emissions of pollutants due to reduced use of motor fuel as well as decreased particulate emissions from diesel fuel are examples of co-benefits generated by mitigation measures. These co-benefits may further reinforce the attractiveness to mitigate emissions from the transportation sector. The CCAP study estimates the opportunity for emission reductions at 28% below BAU by 2020, i.e. around 179 $MMTCO_2$.

All sector mitigation options for India

Advanced policy options scenario	2020 BAU emissions ($MMTCO_2$)	2020 emissions considering policy options ($MMTCO_2$)	2020 emissions deviation from BAU ($MMTCO_2$)	2020 emissions deviation from BAU (%)
< \$ 0 / tCO_2	2,352	2,304	-49	-2%
< \$ 5 / tCO_2	2,352	2,281	-72	-3%
< \$10 / tCO_2	2,352	2,258	-95	-4%
All options	2,352	1,959	-394	-17%

If all mitigation measures suggested by the CCAP would be implemented in all sectors analysed, a significant total deviation from BAU for 17% could be achieved. To be noticed is however that only the costly measures could provide such a mitigation potential. This is notably due to the high cost of mitigating emissions from the electricity sector.

MEXICO

The Government of Mexico has a very detailed view on which measures should be achieved in which sectors and how many $MtCO_2$ could thereby be reduced. All the mitigation measures foreseen and their estimated impacts are consigned in an official governmental document: the National Strategy on Climate Change (Mexico, 2007). The National Strategy contains very detailed descriptions of all mitigation actions to be implemented by 2014 or sometimes 2012.

ENERGY SECTOR OPPORTUNITIES FOR GHG MITIGATION TO 2014

Sectors	**Area of activity**	**Measures**	**Estimated reduction in $MtCO_2e$**
Energy efficiency	Standards and programs of the National Commission for Energy Conservation	Continue application of current energy efficiency standards (see subchapter 4.2), develop and implement new ones.	24 $MtCO_2e$
Energy efficiency	Energy efficiency and savings programs of the Trust Fund for Energy Saving (FIDE)	See subchapter 4.2.	3.9 $MtCO_2e$
Subtotal energy efficiency			***27.9 $MtCO_2e$***
Mexican Oil Company	Combined Heat and Power (CHP) in PEMEX	Install CHP plants in facilities of the National Refining System	7.7 $MtCO_2e$

(PEMEX)		and in other PEMEX facilities.	
Mexican Oil Company (PEMEX)	Centralised power supply to offshore platforms	Substitute individual generation plants for a 115 MW combined cycle plant connected to offshore platforms.	1.9 $MtCO_2e$
Mexican Oil Company (PEMEX)	Improvement of energy performance in refineries	Increase PEMEX's energy efficiency target by 5%.	2.7 $MtCO_2e$
Mexican Oil Company (PEMEX)	Fugitive emissions of methane	Reduce fugitive methane emissions from natural gas production, transportation and distribution; increase efficiency of flares on offshore platforms.	2.4 $MtCO_2e$
Subtotal PEMEX			***14.7 $MtCO_2e$***
Power generation and distribution	Power transmission and distribution	Increase the efficiency of transmission and distribution lines by 2%.	6.0 $MtCO_2e$
Power generation and distribution	Thermal efficiency in fuel oil-fired thermoelectric plants	Increase thermal efficiency of fuel oil-fired thermoelectric plants by 2%.	0.7 $MtCO_2e$
Power generation and distribution	Conversion to natural gas and repowering of thermoelectric plants of the Pacific coast; modernisation of the facilities of the National Refining System	This proposal requires simultaneous action: phase out and reorient fuel oil production incentives; install on the Pacific coast a gasification terminal for imported liquefied natural gas and convert fuel oil-fired thermoelectric plants to combined cycle.	21 $MtCO_2e$
Subtotal power generation and distribution			***27.7 $MtCO_2e$***
Industrial sector	Combined Heat and Power (CHP)	Develop the CHP potential of the national cement, steel and sugar industries, among others.	>25 $MtCO_2e$
Subtotal industrial sector			***>25 $MtCO_2e$***
Renewable energy	Power generation from renewable energy sources	Install 7,000 MW of renewable energy capacity to generate 16,000 GWh per year (additional to hydroelectric plants).	8.0 $MtCO_2e$
Renewable energy	Biofuels	Introduce sustainably produced biofuels.	Not available
Subtotal renewable energy			***8.0 $MtCO_2e$***
Transport	Vehicle replacement	Replace freight trucks and diesel busses more than 10 years old from 2008 onwards.	2.0 $MtCO_2e$

Transport	Freight by rail	Increase rail coverage for freight transportation by 10%.	1.5 $MtCO_2e$
Subtotal transport			***3.5 $MtCO_2e$***
Total energy sector			**>106.8 $MtCO_2e$**

In order to successfully develop these mitigation opportunities in the energy sector, the Government of Mexico has defined the following priorities (Mexico, 2007):

1. Establish performance standards and GHG emissions' baselines for major activities and emissions sources.
2. Ensure accounting and reporting of GHG emissions and identification of emission reductions projects in private and public companies under the Clean Development Mechanism (CDM) and other carbon markets.
3. Carry out an economic assessment of the costs of climate change and the benefits of actions to address it, along the lines of the "Stern Review".
4. Establish fiscal and financial incentives for investment in sustainable energy projects.
5. Design and implement measures to ensure that PEMEX has sufficient resources to improve its energy efficiency.
6. Eliminate subsidies for fossil fuel energy consumption and production.
7. Involve new stakeholders and initiatives in government energy efficiency and savings programs, particularly in thermal efficiency and solar energy use.
8. Implement compulsory and voluntary standardisation of equipment, vehicles, power generation systems and consumption in homes, offices and industry.
9. Reduce the use of fuel oil.
10. Promote renewable energy sources and low carbon technology.
11. Repower thermoelectric plants with combined-cycle technology.
12. Facilitate connection of independent suppliers to the national grid.
13. Encourage the regulated participation of private enterprise in low carbon energy generation (particularly in CHP and renewables).
14. Promote research on low carbon technologies and renewables.
15. Increase the performance of the motorised transport fleet by promoting the acquisition of vehicles with low GHG emissions.
16. Implement policies to promote low carbon emissions in public transport and increased use of rail for freight.

FOREST AND LAND USE OPPORTUNITIES FOR GHG MITIGATION TO 2012

Carbon Conservation in forests to 2012

Remark: the $MtCO_2$ indicated in this subchapter are the $MtCO_2$ potentially conservable by forests and not the $MtCO_2$ reduced if measure x is applied as in most of the other subchapters.

Area of activity	**Measures**	**Carbon conservation in $MtCO_2e$**
Sustainable forest development	Increase the area under sustainable forest management by 2.6 million	6,000 – 12,000 $MtCO_2e$

	hectares per year.	
Payment for environmental services	Expand coverage of current programs of payment for environmental services to cumulatively reach 2.49 million hectares by 2012 (direct payments to landowners with primary forest cover given at the end of the year, once it has been proven that the forests were not deforested).	1,500 – 3,100 $MtCO_2e$
Conservation of forest ecosystems in Protected Areas	Increase coverage of Protected Areas by 500,000 hectares per year to accumulate 3 million hectares in the National Protected Areas System.	500 – 1,000 $MtCO_2e$
Wildlife Management Areas	Integrate approximately 6 million hectares of tropical, temperate and arid zone ecosystems within Wildlife Management Areas.	3,000 – 4,250 $MtCO_2e$
Forest health	Carry out phytosanitary diagnosis and treatment in approximately 640,000 hectares of forest per year.	1,800 – 3,000 $MtCO_2e$
Total of $MtCO_2$ conserved		**12,800 – 23,350 $MtCO_2e$**

Mitigation of GHG emissions in forestry and land use to 2012

Carbon capture

Remark: the $MtCO_2$ indicated in this subchapter are the $MtCO_2$ potentially sequestrable by forests and not the $MtCO_2$ reduced if measure x is applied as in most of the other subchapters.

Area of activity	**Measures**	**Carbon capture in $MtCO_2e$**
Reforestation and recovery of lands apt for forestry	Reforest 285,000 hectares a year through the "ProÁrbol" Program (see subchapter 4.2), to accumulate 1.71 million hectares by 2012.	10 – 20 $MtCO_2e$
Soil restoration with reforestation	Restore and reforest degraded soils in an area of 115,000 hectares annually, through ProÁrbol, to accumulate 690,000 hectares.	5 - 15 $MtCO_2e$
Commercial forestry plantations	Expand the area in commercial plantations at a rate of 100,000 hectares per year, to accumulate an additional 600,000 hectares.	3 - 7 $MtCO_2e$
Forest CDM	Identify opportunities for carbon capture projects in forest ecosystems under the CDM.	To be instrumented
Total of $MtCO_2$ sequestered		**18 - 42 $MtCO_2e$**

Emission reduction

Sectors	Area of activity	Measures	Estimated reduction in $MtCO_2e$
Forest derived bioenergy	Forest derived biofuels	Introduce 500,000 high efficiency wood burning stoves in rural communities.	2.5 $MtCO_2e$
Subtotal forest derived bioenergy			***2.5 $MtCO_2e$***
Crop production	Land use reconversion	Promote the reconversion of agricultural land to perennial and mixed crops in 900,000 hectares, through the Program for Direct Support to Agriculture.	4.2 $MtCO_2e$
Crop production	Efficient use of chemical fertiliser	Develop standards for fertiliser use according to region and crop; produce a Manual for best practices and assess alternative options.	Not available
Crop production	Prevention of forest fires from cropland burning	Promote alternatives to slash and burn agriculture in 100,000 hectares, to reduce from 50% to 35% slash and burn related forest fires.	Not available
Crop production	Conservation tillage	Employ conservation tillage and foster cover crops in 200,000 hectares.	0.9 $MtCO_2e$
Subtotal crop production			***5.1 $MtCO_2e$***
Livestock production	Rehabilitation of grazing and rangelands	Rehabilitate 450,000 hectares of grazing and rangelands through the Program for Support for Cattle Production.	4.6 $MtCO_2e$
Subtotal livestock production			***4.6 $MtCO_2e$***
Total of MtCO2 reduced			**12.2 $MtCO_2e$**

The Government of Mexico has again defined priorities which should guide public policies. These priorities are specific to the vegetation and LULUCF sector (Mexico, 2007):

1. Articulate the implementation of the Ecological Land Use Planning Program with actions for GHG emissions mitigation.
2. Promote and maintain the functional integrity of ecosystems and their environmental goods and services, by reducing deforestation to minimise GHG emissions from this source; conserving the cover of primary ecosystems and by expanding the capacity for gross primary production by capturing carbon through reforestation, afforestation and ecological restoration.
3. Consolidate the Mexican Carbon Program to foster scientific research into the carbon cycle and the creation of human resources in this field.
4. Promote applied research, innovation and technological development for carbon conservation and GHG emission reductions in agriculture.

In the Third National Communication some mid-term goals for 2020 are also set (Mexico, 2006). Examples for the transport sector are:

- Increase in the energy efficiency of light vehicles
- Introduction of the European Norm for gasoline vehicles (see footnote, p.37)
- Introduction of hybrid vehicles
- Use of 10% ethanol in gasoline in 2020
- Use of 10% biodiesel from oleaginous plants in diesel in 2020.

REPUBLIC OF KOREA

The Republic of Korea has launched a very ambitious long-term program called “Green Growth” which aims at achieving economic growth while maintaining environmental integrity (Republic of Korea, 2009a). Green Growth will be the major driver of change for the next 60 years and bring a new paradigm to economic development by interlinking performance and sustainability. The harmony of ”Green” (environment) and “Growth” (economy) will be achieved through the concretisation of two implications: the so called “Green Growth 1” and “Green Growth 2”. “Green Growth 1” denotes the way from the economy to the environment, meaning that “economic growth does not harm but improves the environment” (Republic of Korea, 2009b). The second implication characterises the other way, from environment to economy, meaning that “environment conservation can be the new growth driver of economy” (Republic of Korea, 2009b). Decoupling economic growth and environmental pollution is the overarching goal.
Green Growth aims also at changing the life styles of Koreans. Public campaigns to enhance green values in the society (so called eco-living) will be launched. Special programs will further promote Green Growth at primary and secondary school to bring up Green citizens. The idea of Greenness will also be the centrepiece of culture and tourism. Analogue to the “Saemaul” Movement which triggered the miraculous economic growth since the 1970s, the “Green Growth” Movement should revolutionise the Republic of Korea.
Since the Green Growth vision was launched in 2008, many green initiatives have already been implemented (Republic of Korea, 2009a). Three of them are: the 1st National Basic Energy Plan (2008-2030) and Comprehensive Plan on Combating Climate Change, the Green New Deal Stimulus Package and the Comprehensive R&D Plan on Green Technology. The 1st National Basic Energy Plan (2008-2030) has set the ambitious target of increasing the share of renewable energy to 11% by 2030. Korea’s strategy to combat the current global economic recession focuses on Green Growth with an investment of 38.5 billion US$ for the next four years on nine key green projects. The nine projects include: 1. revitalisation of four major rivers, 2. building green transportation, 3. building database on national territory and resources, 4. water resources management, 5. green car and cleaner energy program, 6. resource recycling program, 7. forest management and biomass program, 8. green home, office and schools, 9. greener landscape and infrastructure. The Comprehensive R&D Plan on Green Technology calls for a doubling of R&D spending on Green Technologies by 2012 already (769 million US$ in 2008). For that purpose 27 key technology areas were indentified: climate change prediction and modelling, photovoltaic solar panel, waste regeneration, carbon capture and storage are just a few of them. New instruments are further planed to be introduced: a new Framework Law on Green Growth (should encompass all related issues on energy, climate change and sustainable development), a new form of governance for Green Growth (will bring together all stakeholders from national & local governments and private sectors), a National Strategy on Green Growth, etc.

The Republic of Korea wants to show leadership on combating climate change as underlined by the President Lee Myung-bak at the G8 Summit in Toyako in 2008. For that purpose, the Republic of Korea has already taken concrete steps towards a long-term Green Growth by setting targets for 2012 (Republic of Korea, 2009a):

Sectors	**Key indicators**	**2007 (reference)**	**2012 (target)**
Green industries	Share of renewable energy (%)	2.24%	11%
Green industries	Solar power (global market share)	0.3%	5%
Green industries	Green car related jobs (thousand workers)	260	300
Green industries	Green homes (households)	14,500	>100,000
Green industries	Share of Light-Emitting Diode (LED, %)	<1%	30%
Green industries	Share of nuclear energy (in terms of capacity)	26%	41%
Green industries	Fuel economy for vehicles (< 1,600cc)	12.4 km/l	14.45 km/l
Enhanced quality of life	Co-generation facilities	47	78
Enhanced quality of life	Energy efficiency certification for buildings	Public buildings	All buildings
Enhanced quality of life	Hybrid vehicles	1,386	30,000
Enhanced quality of life	Waste regeneration (%)	1.8%	31%
Enhanced quality of life	Expansion of carbon sinks (million m^2)	625	779
Enhanced quality of life	Public participation on climate action (%)	23.6%	60%
Global leadership	GHG emission (tCO_2e)	591.1	See target for 2020
Global leadership	Climate change plans by local governments (% of local government)	<10%	100%

The Republic of Korea is also working on its mitigation capabilities to set its voluntary mid-term target and thereby be one of the first non-Annex I Parties to do so. Three scenarios for 2020 mid-term GHG mitigation targets are currently in consultation (Republic of Korea, 2009c):

- scenario 1: goal of 21% reduction from "business as usual" (BAU), which still corresponds to an 8% increase from 2005 level. Measures implemented are described as measures with short-term cost and potential long-term benefits. Exemplary mitigation options are: promotion of green homes and green buildings, rapid penetration of efficient electric equipments and lightings (LED), shift of low carbon high efficient transportation system, innovation in manufacturing processes into green process, promotion of renewables and nuclear power as well as introduction of smart-grid.
- scenario 2: more ambitious goal of reducing 27% from BAU, which means a stabilisation at 2005 level. Next to the measures implemented in scenario 1, additional actions are foreseen: destruction of F-gases, promotion of hybrid cars, increase in use of biofuels, application of Carbon Capture and Storage (CCS) in power plants. These additional measures are estimated to be achievable at a cost less than 50 US$ per ton of CO_2e.
- scenario 3: implementation of aggressive measures with high mitigation cost to reach a 30% reduction from BAU, equivalent to a 4% reduction from 2005 level. Additional

mitigation options are: introduction of electric and fuel cell vehicles as well as state of the art efficiency technology and equipments in households.

Impacts of the three mentioned scenarios on GDP are estimated at: -0.29% for scenario 1, -0.37% for scenario 2 and -0.49% for scenario 3 (Republic of Korea, 2009c).

BRAZIL

In its National Plan on Climate Change, the Government of Brazil recognises climate change to be a strategic issue: "*Climate change is a strategic issue for both the present and the future of national development. It is not just a question of productive and technological choices, but also the preservation and whenever possible, the increase in the competitiveness of the economy and of the Brazilian products in a globalised world*" (Brazil, 2008). Two main challenges are identified: reducing emissions from land use change and continuously increasing efficiency in the use of the country's natural resources. To tackle these challenges, the Government of Brazil has defined seven specific objectives, the first five concerning mitigation and the last two ones adaptation:

1. Stimulate **efficiency** increase in a constant search for better practices in the economic sectors. Thereby achieved should be a more efficient use of natural, scientific, technological and human resources on a sustainable basis. Efforts should also be consented to improve energy efficiency and energy conservation. The implementation of a National Energy Efficiency Policy should reduce electricity consumption by 10% in 2030. Concrete ***actions*** to achieve these goals are: charcoal (sustainable form of coal to replace classical coal), fridges (replacement of one million old fridges per year, for ten years to avoid CFCs emissions), solar heating (to heat water and thereby reduce electricity consumption by 2,200 GWh per year by 2015), urban solid waste (20% increase in recycling by 2015), sugarcane (replace use of fire for clearing and cutting of sugarcane by harvesting mechanisation), agricultural and cattle raising integrated systems (incentives for sustainable practices, like recovering of degraded pasture, agro-forestry, reduction on the use of nitrogenous fertilisers).

2. Keep the high share of **renewable** energy in the electric matrix, preserving thus the important position Brazil has always held in the international scenario. Due to spread hydroelectric plants, Brazil already has a large part of its energy produced by renewables. Growing demand in electricity and limited possibilities to expand hydroelectric power generation requires an expansion to other renewable energies like cogeneration with sugarcane or other biomasses, wind and solar energies. Another issue is to reduce energy wastage. Non-technical energy losses are estimated to 22,000 GWh per year. Main ***actions*** proposed are: cogeneration (increase energy produced by cogeneration to 11.4% of the total supply in 2030, corresponding to 136 TWh), reduction of non-technical losses in the electricity production at a rate of 1,000 GWh per year over the next ten years, hydroelectricity (34,460 MW from new hydropower plants), energy from wind and sugarcane (more than 7,000 MW of renewable sources by 2010).

3. Encourage the sustainable increase in the share of **biofuels** in the national transport matrix and also work towards the structuring of an international market of sustainable biofuels. Brazilian biofuels are described in the National Plan as incontestable sources of wealth for the country. Hoped is to progressively replace fossil sources by biofuels to reach an annual increase of 11%. Expanding the supply of ethanol to international markets should guarantee a stable demand and thus increase export revenues. Concrete ***actions*** proposed are: ethanol (annual consumption increase of 11% in the next ten years), biodiesel (add 5%

of biodiesel to conventional diesel), agro-energy (implementation of the National Agro-Energy Plan focused on research, development, innovation and transfer of technology), stimulate an international ethanol market (through technical cooperation with other countries).

4. Seek for sustained reduction **deforestation** rates, in all Brazilian biomass, in order to reach zero illegal deforestation. Deforestation is one of the most important sources of GHG emissions in Brazil, together with land use change (see subchapter 3.1). Two of the seven objectives of the National Plan are devoted to deforestation (objectives four and five). The specific objective for deforestation is a reduction of 40% in the average deforestation rate by 2006-2009 in regards to the reference period defined in the Amazon Fund (1996-2005). Avoided emissions are estimated to around 4.8 billion tons of carbon between 2006 and 2017. To control deforestation, two specific action plans have been implemented: the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon Region and the Sustainable Amazon Plan. Further concrete ***actions*** described in the National Plan on Climate Change are: implementation of the National Public Forests Register (identification of public forests to be protected, preserved and managed); territorial and land organisation, monitoring and control as well as incentives for sustainable productive activities; high precision monitoring (implementation of the Brazilian biomass satellite monitoring program); strengthen the environmental enforcement (increase the technical team responsible for the enforcement); Amazon Fund (further develop it); Climate Fund (submitted to the National Congress, aimed at financing actions concerned with preventing deforestation) and non-timber forest products (promote products issued from sustainable exploitation of native forests).

5. Eliminate the net **loss of forest coverage** in Brazil by 2015, with the specific objective of doubling the area of forest plantation from 5.5 million hectares to 11 million hectares in 2020, of which two million hectares of native species (great intrinsic value due to their incalculable genetic heritage). Next to their carbon reservoir role, forests plantations create a considerable added-value as they preserve water flows, reduce rivers and lakes siltation, improve the micro-climate and allow the preservation of native fauna species. Prioritised areas for reforestation are degraded pastures. Concrete ***actions*** to achieve this objective are: revision of current banking requirements to make forestation and reforestation more attractive, stimulation of the recovering of degraded areas that belong to legal reserves or areas of permanent preservation, national forest inventory, development of forestry products for fuel applications by means of the energetic forests program which covers the entire productive chain, forestry grant in form of a concession of public forests for the management and exploitation of forestry products and services in a sustainable way, prevention of the use of illegal timber in the building industry by obliging building companies to prove the origin of timber.

6. Strengthen **inter-sectoral actions** concerned with the reduction of the **vulnerabilities** of populations. This adaptive measure should promote an integrated and interdisciplinary approach to better analyse the relations between social, economic, biological, ecological and physical systems and their relations with climatic alterations. This process should enhance the resilience of vulnerable groups against climate change consequences. Main ***actions*** foreseen are: expand knowledge about the impacts of climate change on human health, strengthen environmental sanitation measures, strengthen communication and environmental education measures, identify vulnerabilities and resources for better prevention, preparation and response plans for public health emergencies, improve the technical capacity of professionals in the Public Health System in relation to health and climate change, create an alert system for harm and damage related to climatic events, create an information panel and indicators for the monitoring of climatic events and their impacts on health as well as implement sustainable educational rooms involving the adaptation of buildings.

7. Identify **environmental impacts** resulting from climate change and stimulate scientific research to elaborate a strategy that minimise the socio-economic costs of the country's **adaptation**. Concrete ***actions*** foreseen are: carry out scientific studies on the impacts of climate change, expansion of the development and assessment capacity of regional climate change scenarios using the supercomputers of the National Space Research Institute, creation of a partnership between the Ministry of the Environment and the National Space Research Institute for the implementation of the Alert System for Droughts and Desertification as well as the development of hydro-climatic models.

This National Plan on Climate Change is planed to be progressively implemented. The first phase is described as the operational one: organise actions, reinforce existing measures and allow an exchange of experiences. The following phases should include mechanisms to evaluate the performance of ongoing actions and the results obtained. Additional measures should be further presented and introduced. A national policy on the management of environmental services is recognised as necessary. How this new policy should be created and implemented is however not described.

To be noticed is that the inter-sectoral approach described in target 6 should not be limited to adaptation actions. An understanding of the socio-economic context and factors as well as the economic forces at work is fundamental to address all challenges linked to climate change and its impacts, as underlined by McKinsey&Company (McKinsey&Company, 2009).

A concrete tool of implementation of the above described National Plan on Climate Change is the **Amazon Fund** (Amazon Fund, 2009). The Amazon Fund is a Brazilian initiative aiming at collecting funds to combat deforestation and promoting sustainable use of the Amazon biome. It is a private fund managed by the Brazilian Development Bank, a state-owned and state-controlled financial institution created in 1952 to sustain the Brazilian economy. The Amazon Fund is a mechanism complementary to the existing governmental initiatives. It should especially contribute to fulfil target number four of the National Plan on Climate Change. The eligibility of projects for receiving financial support from the Amazon Fund is regulated by very strict rules. Detailed information about the project itself, its goals, explanations, etc. must be furnished as well as a table containing the project's main expenses & funding and estimates of potential effects and results achieved by the project. Minimal criteria for projects must also all be fulfilled. Criteria cover all elements of a project, from the requirement of measurable result indicators to the need for coherence with the state plans for prevention and combat of deforestation or the involvement of traditional communities and indigenous people. Transparency and sustainability are further important criteria that must be respected. Once a project is accepted, detailed reports are then to be delivered at regular intervals.

Projections for 2030 realised by McKinsey&Company (McKinsey&Company, 2009) shows that the implementation of all identified initiatives to mitigate Brazil's GHG emissions by 2030 by 70% would require an investment of 5.7 billion Euro annually. Thereby, the Amazon Forest could be preserved .This investment of 5.7 billion Euro correspond to roughly 1% of the total GDP of Brazil (see subchapter 3.2).

CHILE

As mentioned in subchapter 4.2, Chile is still working on its National Action Plan for Climate Change. This Plan should be the first one in Chile to encompass actions regarding all fields

related to climate change. Before the implementation of this National Action Plan, sectoral actions described in subchapter 4.2 are going to be pursued.

In its National Communication to the UNFCCC, Chile publishes some projections for 2020 with and without the implementation of mitigation actions (Chile, 2000). The methodology used corresponds to the revised IPCC guidelines. The projected scenarios contain economic, demographic, trade and technological indicators, as well as potential sectoral policies and energy reforms. For the energy sector, detailed figures are provided for the following subsectors: energy industries; manufacturing and construction; transportation; commercial and residential sector; burning wood and institutional sector. The non-energy sector comprises forestry, agriculture and land use change. As the LULUCF sector also acts as a sink, values representing the non-energy sector may sometimes be negative. This is the case when the carbon sequestration effect dominates the carbon release effect. Below are the estimates published in the National Communication (Chile, 2000). The first table represents figures under the assumption of a 30% import substitution for the agricultural sector, the second one a 50% import substitution.

Table 22: Aggregate emissions balance for the year 2020 under the assumption of a 30% import substitution, baseline and scenario with adoption of mitigation measures

Scenario	Sector	CO_2	CH_4 (in CO_2e)	N_2O (in CO_2e)	Total (in CO_2e)
Baseline	Energy	96,122.95	1,442.65	6,006.4	103,572.0
	Non-Energy	-27,840.69	9,444.27	9,958.4	-8,438.02
Total baseline scenario		***68,282.26***	***10,886.92***	***15,964.8***	***95,133.98***
With mitigation	Energy	83,113.99	1,364.99	5,152.0	89,630.98
	Non-Energy	-35,668.14	8,014.49	8,483.2	-19,170.45
Total mitigation scenario		***47,445.85***	***9,379.48***	***13,635.2***	***70,460.53***

Source: Chile, 2000.

Table 23: Aggregate emissions balance for the year 2020 under the assumption of a 50% import substitution, baseline and scenario with adoption of mitigation measures

Scenario	Sector	CO_2	CH_4 (in CO_2e)	N_2O (in CO_2e)	Total (in CO_2e)
Baseline	Energy	96,122.95	1,442.65	6,006.4	103,572.0
	Non-Energy	-28,806.75	9,542.72	9,251.2	-10,012.83
Total baseline scenario		***68,282.26***	***10,886.92***	***15,964.8***	***95,133.98***
With mitigation	Energy	83,113.99	1,364.99	5,152.0	89,630.98
	Non-Energy	-36,454.53	8,123.83	7,878.4	-20,452.3
Total mitigation scenario		***46,659.460***	***9,488.82***	***13,030.4***	***69,178.68***

Source: Chile, 2000.

Table 24: Mitigation potential for the year 2020 under the assumption of a 30 or 50% import substitution

Sector	CO_2	CH_4 (in CO_2e)	N_2O (in CO_2e)	Total (in CO_2e)
Energy	13,008.96	77.66	854.4	13,941.02
Non-Energy 30%	7,827.45	1,429.78	1,475.2	10,732.43
Total mitigation potential under 30% assumption	***20,836.41***	***1,507.44***	***2,329.6***	***24,673.45***
Energy	13,008.96	77.66	854.4	13,941.02

Non-Energy 50%	7,647.78	1,418.89	1,372.8	10,439.47
Total mitigation potential under 50% assumption	***21,622.8***	***1,398.1***	***2,934.4***	***25,955.3***

Source: own calculation, based on figures of tables 22 and 23

The mitigation potential demonstrated by the models used by Chile for its National Communication is quite impressive. Implementing the mitigation measures assumed in the model would lead to an around 30% reduction from BAU. The Achilles' heel is however how such measures could be implemented, what the corresponding legal instruments may be. Indeed the figures in the table above were published in 2000. Nine years later, the National Action Plan on Climate Change, which is the only potential instrument to achieve such ambitious goals, is still not entered into force. Meeting the mentioned 30% reduction from BAU in 2020 already, seems therefore quite challenging.

INDONESIA

A new financing mechanism, the ***Indonesia Climate Change Trust Fund*** (ICCTF), should open innovative ways to bridge international financial sources with national investment strategies. The specific objectives of the ICCTF are to accelerate investment to move towards a low carbon economy, to reduce GHG emissions and sustain economic growth in energy and forestry sectors, to accelerate priority investment in mitigation and adaptation, to support actions which cannot be supported by the Indonesian government itself, to accelerate priority investment for the preparation and implementation of a comprehensive policy framework for mitigation and adaptation, as well as to facilitate private sector investment. In a first phase the ICCTF will operate as an Innovation Fund to conduct among others vulnerability assessments to climate change. In a later stage the ICCTF may act as a Transformation Fund "which *may* aim at mobilising investment in low-carbon economic activities which will be derived through the *emerging* Indonesian policy framework" as written in the official information flyer provided by the State Ministry of National Development Planning. The conditionality used in the wording (*may, emerging*) demonstrates the uncertainties related to the process. Some initial priority areas are proposed by the ICCTF: for adaptation: agriculture, water, coastal zones, cross-cutting assessments, infrastructure and safety; and for mitigation: energy and forestry. On energy a focus on renewables and energy efficiency is foreseen, on forestry an enhancement of carbon stocks, REDD and peat lands. Field surveys, spot checking, mid-term and final evaluation should guarantee the seriousness and efficiency of the whole process. The ICCTF is planed to be operational by the end of 2009.

This centralised Fund strongly contrasts with the previous way of functioning. Currently, countries and institutions like the World Bank or the Asian Development Bank (see subchapter 4.2) directly invest in concrete projects. A national coordination between these investments by diverse bodies does not exist. This decentralised way of functioning has the advantage of being very close to the operational part. The proximity with the population and the direct financing for targeted projects are considerable advantages that may be less prominent with the implementation of the new financial mechanism, the ICCTF. Indeed time and money may be wasted for bureaucracy rather than for concrete actions. Even if the willingness to increase coordination may be an encouraging sign, efficiency may still be lost. Quite surprising is the willingness of the Government to create a centralised funding mechanism, while they are simultaneously decentralising power to local government (see subchapter 4.2, Regional Autonomy Law and Fiscal Autonomy Law).

4.4 Long-term vision

Long-term vision is a concept widely spread when debating climate change and setting mitigation objectives. Parties like the EU and the US propose to include in the Post-Kyoto Protocol this notion of a long-term strategy by each Party as well as a common overarching shared vision statement (UNFCCC, 2009b). Long-term strategies should guide the efforts of Parties, coordinate all sectors concerned with climate change to propose a coherent vision, integrate specific mitigation actions in the broad sustainable development framework as well as inscribe short- and mid-term targets in a consistent long-term vision. Long-term strategies should deal as an overarching and coordinating mechanism to win in efficiency and transparency. More specifically the EU submits the concept of "Low-Carbon Development Strategies" (LCDS) as "*the structure for developing countries to indicate their contribution to the global mitigation effort and to describe the NAMAS they intend to undertake in order to realise this contribution, as well as to indicate what support would be necessary to enable these NAMAS*" (UNFCCC, 2009b). Furthermore "*such integrative LCDS would allow the international community to have a full picture of the actions that would be proposed and of the overall pathway in which these actions would be embedded*" (UNFCCC, 2009b). The concept of LCDS is more extensively described in subchapter 5.1, MRV, National Climate Actions Plans.

The importance of setting long-term goals is supported by world leaders, like the members of the G8 as emphasised during their 2009 summit in L'Aquila, Italia (G8, 2009).

The leaders of the Major Economies Forum (MEF) also underline the need to set ambitious long-term objectives and thereby "*to identify a global goal for substantially reducing global emission by 2050*" (MEF, 2009). They further emphasise that "*low-carbon development is indispensable to sustainable development*" (MEF, 2009).

A long-term strategy would further help to identify when a country plans to reach its emission peak. Emission peaks and their predictability are a highly debated topic.

5. Analysis of key parameters

5.1 Key drivers

UNFCCC KEY DRIVERS

Sustainable development

The Brundtland Commission was created in 1983 by the UN General Assembly to address growing concerns "about the accelerating deterioration of the human environment and natural resources and the consequences of that deterioration for economic and social development." The Brundtland Commission defined for the first time the term of sustainable development (Brundtland Report, 1987):

> *development that "meets the needs of the present without compromising the ability of future generations to meet their own needs"*.

Agenda 21 is the first broad program of the UN entirely dedicated to sustainable development, intended to involve action at international, national, regional and local levels. Agenda 21 was adopted by the governments at the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992. Local Agenda 21 (see subchapter 4.2: China's Agenda 21, 1994; Agenda 21 for Mexico,1997; etc.) were established in many countries as recommended in Chapter 28 of Agenda 21.

Sustainable development is still today the main concern of many countries of the world, especially of the developing countries. The concept of sustainability is present in most of the articles of the Convention, Kyoto Protocol and Bali Action Plan, especially where developing countries are mentioned. NAMAs themselves are defined as "Nationally Appropriate Mitigation Actions by developing country Parties in the context of sustainable development..." according to article 1(b)(ii) of the Bali Action Plan (UNFCCC, 2007). Sustainable development remains the first priority for developing countries as stipulated in article 4.7 of the Convention: "*economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties*" (UNFCCC, 1992). Sustainable development is in no way in contradiction with the priority for environmental concerns. Indeed environmental sustainability is one of the cornerstones of the Section II of the Agenda 21: Conservation and Management of Resources for Development.

Equity

Equity is the principle according to which fairness and impartiality should guide every action, decision. Each Party should therefore receive as much consideration and advantage as another one. Climate change has implications for equity and justice because the impacts of climate change and resources for addressing these impacts are unevenly distributed.
Equity could be interpreted in many ways. In the context of mitigation actions, equity means for most of the developed countries, that developing countries should, as developed countries, participate in mitigation efforts. They should however act in an adapted way according to their national circumstances. By contrast, the developing countries understanding of equity is a redistributive social justice: impacts of climate change and related adaptation costs are disproportionate to causal responsibilities. Developed countries should therefore carry the costs of mitigating emissions as they are historically responsible for the emissions in question. Equity is often also related to the "polluter pays" principle: the one who emits or has emitted the most, should assume its responsibility and pay for the

damages caused. Mitigation targets should therefore be most ambitious for those who historically and currently pollute the most.

The UNFCCC takes standpoints regarding equity and justice when it makes distinctions among Parties and differentiates between responsibilities of the Parties as described by the principle of “common but differentiated responsibilities”.

Common but differentiated responsibilities

The principle of common but differentiated responsibilities is one of the foundation pillars of the concept of sustainable development. It finds its origins in equity considerations and equity principles in international law. Its first formulation is to be found in the Rio Declaration, Principle 7 (UN, 1992):

> "*In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command*."

This principle was then extended to the climate regime: firstly in 1992 in the preamble and articles 3.1, 4.1 and 7.2b of the Convention, then in 1997 in the Kyoto Protocol and finally in 2007 in the Bali Action Plan. In the negotiation processes it is considered as one of the most important basic principles and is still today at the front of the negotiations. Especially debated is the application of the article 3.1 of the Convention (UNFCCC, 1992):

> *“The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof.”*

Historical versus current responsibility

The concept of historical responsibility is derived from the principle of differentiated responsibilities (see above). It was introduced by Brazil in May 1997 as part of the negotiations on the Kyoto Protocol. The Brazilian Proposal suggests a new approach to allocate the reduction goals among OECD countries and economies in transition based on the effect of their cumulative historical GHG emissions from 1840 onwards on the global-average surface temperature (UNFCCC, 1997). Even if frequently mentioned in the discussions, this concept is not consigned in any official documents adopted by the Parties. The Third Conference of the Parties requested however the Subsidiary Body for Scientific and Technological Advice (SBSTA) to study the methodological and scientific aspects of this concept. Continued analysis and debates took then place, with among others a discussion around the moral responsibilities for climate change (Müller, 2007).

The concept of historical responsibility particularly finds support among developing countries. They like to remind this principle when the allocation of GHG emission reduction targets is debated, especially when GHG emission reductions targets for non-Annex I Parties are discussed. Underlining the article 3.1 of the Convention, they remind developed countries about their responsibilities (see figure 5).

In response to the concept of historical responsibility, developed countries elaborated the concept of current responsibility. Considering the current GHG emissions in absolute values (see subchapter 3.1, GHG emissions without LULUCF, 2005), the most emitting country is a developing country: China. India, a further non-Annex I country, is part of the top five of the most emitting countries (see subchapter 3.1 as well).

According to these statistics current responsibilities lie strongly on the shoulders of the developing countries. This straightforward statement must however be nuanced. Indeed it may be worth to consider the origin of the GHG emissions in the developing countries. Like all countries of the world, developing countries are consuming energy for maintaining or improving the daily life of their population.

Figure 5: Cumulative emissions 1850-2005

Source: WRI, 2009

But most of their GHG emissions come from the energy consumption in the industry sector. These emissions are due to the relocation of industries from developed to developing countries inducing thereby the relocation of GHG emissions from developed to developing countries. Under this consideration, developing countries may not be the “bad players” pointed out by developed countries. Developing countries are, from an environmental point of view, suffering from the so called **pollution haven hypothesis**. This theory postulates that polluting firms will find more profitable to relocate their production to countries with lax environmental standards, i.e. developing countries. Developing countries are therefore expected to become dirtier with increased international trade. In other words, inward FDI (an indicator for trade) are associated with high level of pollution. China best supports this hypothesis: with FDI inflows much higher than the six other countries analysed (see subchapter 3.2, FDI), China is also by far the country with the highest GHG emissions (see subchapter 3.1, GHG emissions without LULUCF, 2005). High FD inflows in China are mostly due to the relocation of numerous European firms. This example illustrates the conclusions of Bernauer’s publication about globalisation, democracy and the environment (Bernauer, 2009b).

National circumstances

How to share global emission reduction objectives across countries in an appropriate and equitable manner is one of the challenges of the Bali Action Plan. Differentiation across countries is needed in order to ensure an equitable burden of the costs induced by climate change mitigation policies. Indicators to differentiate countries are needed, but also indicators that reflect national circumstances pertinent to climate change. An important point to be considered is that national circumstances change over time. Flexibility is therefore a key issue both for the indicators as for the mitigation action process itself. Indicators for national circumstances, as detailed in chapter three of this study, may be:

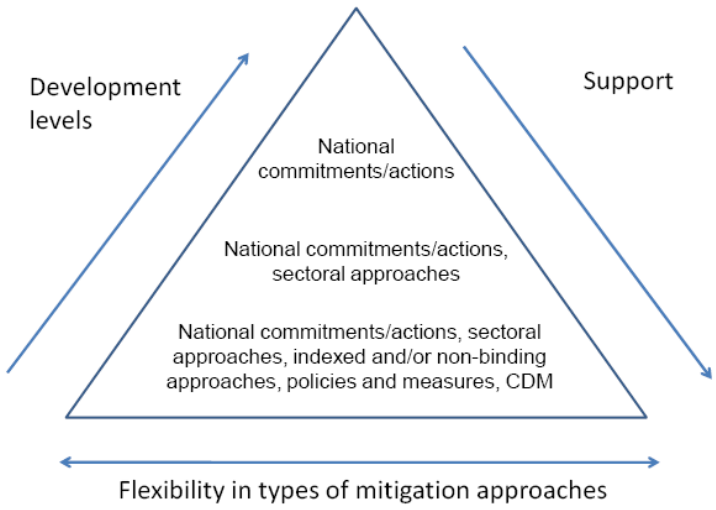
- environmental indicators: total GHG emissions, GHG per capita, emissions growth rate, share of global emissions, emissions per sector, energy consumption mix and emissions per GDP (carbon intensity of economy)
- economic indicators: total GDP, GDP per capita, GDP per km2, growth rate, GDP by sector, trade indicator and FDI
- political and institutional indicators
- demographic indicators

The main difficulty is data availability at the national level, as well as consistency and comparability both within the data set of a country as across countries. This is mainly due to differences in data quality and methodology.

The indicators listed above reflect national circumstances in a quite appropriate manner. Ideal in the context of climate change mitigation would further be indicators for mitigation potential, mitigation effort and mitigation costs & benefits.

Differentiation

Figure 6: Changing National Circumstances, Mitigation and Support



Source: Karousakis, 2008

As national circumstances evolve over time, mitigation commitments should follow this evolution. Karousakis et al. (Karousakis, 2008) suggest in their study a triangle solution: the level of mitigation actions as a function of three parameters: development levels, support and flexibility in types of mitigation approaches. As development levels improve (left arrow, figure 6), countries would engage in taking more ambitious actions.

As higher development levels are characterised by higher economic level, countries would be less dependent on support when their level of development improves (right arrow). This schematic view covers appropriately the principles of equity, differentiation and flexibility.

POST-KYOTO KEY DRIVERS

Emergency to act: the sectoral approach as bridge strategy

The earlier mitigation actions are taken, the more adverse effects due to climate change would be avoided or at least minimised. Due to this emergency to act, ways to rapidly and efficiently mitigate GHG emissions are to be found. One possibility may be provided by the sectoral approach (CCAP, 2008). A sectoral approach may help developing countries to concentrate on specific sectors, like energy intensive industries, and prioritise actions with high mitigation potential which could be achieved within the next few years. Examples of promising sectors are transport and electricity in all the seven countries analysed, the cement and oil refining sectors in Mexico (CCAP, 2009), the cement sector in China (CCAP, 2006a), etc. A performance-based sectoral approach may be an interesting option to accelerate developing countries emission reduction as emphasised by Helme et al. (Helme, 2009). This sectoral approach may induce further benefits in the short-term as it could create jobs and opportunities to access new-growing markets and accelerate the deployment of

advanced technologies. The sectoral approach may act as a bridge strategy until absolute emission reduction cuts may become achievable for developing countries. This bridge strategy could enter into force for the next commitment period which may be 2012-2020. It would encourage developing countries to already take some actions in the near-term, even if the whole necessary institutional, financial and technological framework may not be fully established. This bridge strategy could then be integrated in a long-term vision as suggested in subchapter 4.4.

Incentives for developing countries to act: international recognition and co-benefits

Key parameter in the success of the negotiations is the willingness of Parties to cooperate. This willingness may depend on national circumstances, but also on the real incentives for Parties to act. The Prisoner's Dilemma illustrates the decisive role played by incentives in cooperation processes. According to this Dilemma, cooperation will happen only if incentives to act are stronger than incentives to cheat. Another aspect to be taken into account is the shadow of the future. The longer the game period and thereby the shadow of the future, the more likely it is that cooperation takes place. Indeed high valuation of the future encourages long-term actions and long-term cooperation. Countries behaving in an inappropriate way today may carry the resulting costs in the future. Fearing this shadow of the future, countries will tend to behave better and enhance cooperation.

One important incentive for developing countries is international recognition. Some developing countries have already taken numerous measures to combat climate change (see subchapter 4.2), but are often not rewarded for it. Gaining international recognition by developed countries may be a considerable source of motivation for developing countries. This point is well illustrated by the submission of the Republic of Korea (UNFCCC, 2009b).
Co-benefits provided by climate change policies may represent a further non-negligible interest for developing countries. Co-benefits are indirect benefits resulting from the implementation of climate change policies. Examples of co-benefits are multiple: reduction of outdoor local air pollution (Bollen, 2009), thereby improvement of life quality and public health, enhancement of energy security, more efficient use of resources, additional net employment and much more (Jochem, 2003).

Financial and technological support

Support is an important part of the mitigation process, as for instance described in the figure 6. The concept of support encompasses both financial and technological support. Support plays an especially crucial role for developing countries, as they lack the necessary resources. The Convention strongly emphasises the role of developed countries in providing support to developing countries (UNFCCC, 1992):

Art. 4.3 *"The developed country Parties and other developed Parties included in Annex II shall provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations under Article 12, paragraph 1. They shall also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of implementing measures that are covered by paragraph 1 of this Article..."*

Art. 4.5 *"The developed country Parties and other developed Parties included in Annex II shall 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 developing country Parties, to enable them to implement the provisions of the Convention."*

Art. 4.7 *"The extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology..."*

This support is particularly important to allow developing countries to:
- continuously collect and archive data
- establish and maintain stable national institutions to dispose about reliable and effective GHG database system
- improve the quality of sectoral data: availability, accuracy and reliability
- build the necessary infrastructure for implementing mitigation and adaptation measures
- enhance the institutional framework for more regulatory measures, laws, etc.
- finance policy implementation
- accelerate the liberalisation of advanced technologies, especially those one who would not be cost-effective without support
- bring down the cost of advanced technologies, for instance renewable energies technologies
- overcome domestic barriers (see subchapter 5.3)
- etc.

Financial and technological support will also strongly encourage developing countries to act, as they would feel recognised for the efforts consented so far. This support will further be a sign for developing countries, that developed countries are assuming their historical responsibilities.
Technology transfer is an important element of the global support, as stipulated in art. 1 d) of the Bali Action Plan (UNFCCC, 2007): "... *enhanced action on technology development and transfer to support action on mitigation*...". Technology transfer would allow developing countries to dispose about advanced technologies and facilitate their entry into local market of developing countries. For example, most of the technologies first require long R&D before they can become economically attractive. The access to the technologies developed by industrialised countries would help developing countries to bridge the gap between themselves and industrialised countries. Developing countries would thus be able to rapidly implement efficient technologies and therefore efficiently participate in mitigating climate change. Further support for the implementation of regulatory processes, like subsidies, would help these technologies to even strongly compete in the market, as their price would be adjusted to reflect the environmental externalities of their GHG emissions. Not to be forgotten is the specificity of each sector in the way the technology fits into the economy, as noted by Barton et al. (Barton, 2008). Each sector therefore requests different technology development, technology transfer and investments concerns.

If the need for financial and technological support is obvious for all Parties, views strongly diverge when discussing which financial mechanisms should be implemented, how this financing mechanism could work, who would benefit from this support, how the support would be distributed among the Parties, etc. Issues about these concerns would necessitate a study in itself and therefore go behind the purpose of this study.

Measurable, Reportable, Verifiable (MRV)

The Bali Action Plan calls in its paragraph 1(b)(ii) for "*nationally appropriate mitigation actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable, verifiable manner*" (UNFCCC, 2007).
The measurable, reportable, verifiable (MRV) process applying to both actions by developing countries and support by developed countries should provide incentives for developing countries to quantify mitigation actions and thereby gain, among others, international recognition. Further aims of the MRV process are to catalyse coordination and planning both within and between Parties, to better match mitigation actions by developing countries with support by developed countries, to improve the availability of information about countries' mitigation actions as well as to assess in a second step their impacts and cost-effectiveness.
While some requirements and mechanisms have already been established for some Parties under the UNFCCC and the Kyoto Protocol (Annex I Emissions Inventories, National Communications), a significant retrofit will be needed to meet the obligations envisioned in the Bali Action Plan: more frequent and complete GHG inventories for developing countries with significant emissions, an instrument to recognise and verify NAMAs, etc. Indeed assessing GHG mitigation actions as defined in the Bali Action Plan, qualitatively and/or quantitatively, may be a quite challenging and demanding task, as different types of mitigation actions may be adopted by different groups of countries and as the translation from qualitative to quantitative may be in many cases all but not straightforward.
Critical to master this challenge is the balance that is to be found between the need for rigor and confidence on the one hand and the institutional and economic constraints faced by developing countries on the other hand. Indeed, the ideal of a quantitative MRV process contributing to a global emission goal could take significant resources to set up. Part of the balance are also the fundamental principles set by the Convention (UNFCCC, 1992): "*common but differentiated responsibilities", "specific national and regional sustainable development priorities", "national circumstances and capabilities".*
The provision of finance and technology by developed countries as stipulated in the art. 4.3, 4.5 and 4.7 of the Convention may play a further decisive role in the elaboration and application of the MRV process. Especially because developing countries may not dispose about sufficient financial and technological resources to fulfil these costly MRV requirements.

MEASUREMENT
As mentioned by Ellis et al. (Ellis, 2009) many ways of assessing GHG mitigation actions exist: measurement of qualitative or quantitative input to such actions (for instance, regulation processes like establishment of energy efficiency regulations), intermediate output (for instance, numbers of energy efficient appliances installed) and/or outcome of such actions expressed in GHG or non-GHG terms (non-GHG terms for example: MWh of renewable electricity supply). Other scientists like Winkler et al. (Winkler, 2008) argue that it is the outcome only that needs to be measured. National legislation or regulations for example are necessary frameworks for mitigation actions, but hardly quantifiable.
Parties would therefore have to agree on common guidelines, rules and methodologies, (including unit(s) of measurement and way of calculation) to be applied when assessing the impacts of mitigation measures. These processes may also vary according to the type of actions undertaken: unilateral, supported or for emissions crediting actions.
In case of actions supported by developed countries, the most important challenge will be to measure technology. Measuring technology may be complex in that it is broader than technology transfer: it also encompasses the diffusion of technology, as well as long-term R&D. Regarding the financial support, the difficulty may be to ensure that financial flows actually occur, more than to measure financial flows themselves.

REPORTING

All Parties have existing reporting commitments under the Convention in form of national communications or inventories. The frequency and degree of details of these reports are to be intensified for (at least some) developing countries. An interval of two to three years between detailed reporting of GHG inventories may realistically be asked for non-Annex I Parties, as suggested by Winkler et al. (Winkler, 2008).

Successful reporting is a function of mainly three factors: the accuracy of the reported information, its reliability and its presentation in a transparent and standardised manner in order to allow comparison between different reports of the same Party as well as between different Parties.

To achieve this challenge, Parties may agree to a common framework, guidelines and reporting format (units, timing, content of report, etc.). Relevant information to be reported could be: national circumstances to provide background and context, government policies and measures with direct or indirect effects on the environment even if hardly quantifiable, data on emissions, technology and financial investments as well as environmental results like emissions levels and changes in environmental quality.

VERIFICATION

If emission reductions are to be effective, long-term and quantifiable, then verification is inevitable. Aim of the verification process is to independently check the accuracy and reliability of reported information, to control the procedures used to generate information in order to ensure that parties are conforming to the measurement and verification guidelines they received. Agreement will be previously needed on who the verification body/bodies is/are (national, international, independent, part of the UNFCCC, etc.), on what should be verified (mitigation actions in GHG-terms only, mitigation actions supported by developed countries, ...), on what the verification process should include and on which frequency the verification process should take place. Verification may be based on on-site inspections (similar to that provided by the International Atomic Energy Agency or the Convention on International Trade in Endangered Species), on-site monitoring or remote monitoring (especially useful for hardly accessible area like forests or mountains and for large surface assessment). In all cases, common international standards between Parties would be needed in order to provide a common understanding between the diverse actions and set of actors.

EXISTING MECHANISMS UNDER THE UNFCCC AND KYOTO PROTOCOL

Experiences to date with reporting and reviewing under the Convention, notably with National Communications and Inventories, may serve as basis for the design of MRV for the post-2012 period. If some current procedures work well like Annex I Inventories, others need to be strongly revised and intensified, as for example those for non-Annex I. Deficits are especially important in assessing Parties' mitigation actions as well as financial and technological support for developing countries which are two key points of NAMAs. Some valuable experience from the CDM mechanism may also contribute to the establishment of the post-2012 MRV framework.

National Communications report on a wider range of activities related to climate change. If Annex I are asked, but not required to quantify the expected impact of each measure or policy, non-Annex I are only asked to report in a general manner on programs related to the implementation of the Convention. National communications for non-Annex I neither provide standardised indicators or methodologies for measuring mitigation actions, nor a standardised reporting format, nor a regular expert review or verification (Fransen, 2009).

India, for example, has chosen not to discuss mitigation actions explicitly, but rather describes a set of programs related to sustainable development: the eight national missions (see subchapter 4.2). China lists its mitigation actions by sector, but does not systematically

quantify their impact neither in GHG nor non-GHG terms. A resource guide was elaborated by the UNFCCC to help non-Annex I Parties preparing their National Communications (UNFCCC, 2009c). A Consultative Group of Experts (CGE) was even established in 1999 by the COP to facilitate the preparation of non-Annex I Communications. This group provides technical support to non-Annex I Parties, identifies barriers and capacity building needs and advises the Subsidiary Body for Implementation (SBI) on ways to improve non-Annex I National Communications.

National Inventories are more specific and contain quantitative information on GHG emissions. To be noticed is the considerable difference between Annex I and non-Annex I Inventories, according to the principle of "common but differentiated responsibilities". Annex I must report GHG emissions annually. Non-Annex I do not submit a separate Inventory, but include it in National Communications on a non-frequent or uniform basis. An extensive body of guidance for National Inventory preparation has been developed by the IPCC (IPCC, 2006), including specific guidelines for quantifying emissions from industrial processes, energy, agriculture, forestry and land use (IPCC, 2003). This IPCC methodology is mandatory for Annex I and optional for non-Annex I.
National Inventories implicate the mobilisation of considerable resources. Ellis et al. (Ellis, 2009) give an example of an estimate of the resource cost of establishing a country's emissions inventory: developing Brazil's GHG Inventory for its initial National Communication involved 150 entities (government institutions, research centres, industry, NGOs, ...) as well as 700 experts. Addressing the far most ambitious goals of the Bali Action Plan will require a further significant increase in human capacity.

CDM may be a further source of inspiration in establishing the post-2012 MRV framework. Even if CDM activities are project-based and not at a national scale, they may provide interesting information concerning methodologies. The degree of rigor in the measurement and verification of CDM projects is substantial. Detailed methodologies derived from the IPCC and outlining how to estimate baselines, monitor and report different types of activities have been developed. To date more than 120 baseline/monitoring methodologies have been validated by the Executive Board of the CDM. A greater standardisation of the monitoring/reporting methodologies would however improve the efficiency of the process as well as facilitate its implementation. Third Parties experts are involved in the CDM process to assess project eligibility and verify performance. These high standards guaranty high quality projects and demonstrate the seriousness of the whole process. The experience gained by CDM could be especially valuable for NAMAs eligible for credits. The CDM approach may also be extended for crediting specific sectoral policies like emission reductions from deforestation (REDD).

NATIONAL CLIMATE ACTIONS PLANS

The European Union has submitted to the UNFCCC the concept of "Low-Carbon Development Strategies (LCDS) as the structure for developing countries to indicate their contribution to the global mitigation effort and to describe the NAMAs they intend to undertake" (see subchapter 4.4 and UNFCCC, 2009b). The EU further suggests in its submission that LCDS could include:

- description of a long-term strategy, including emissions pathways, for its low-carbon development in the context of its broader sustainable development
- description of all NAMAs part of the long-term strategy (autonomous actions, actions that requires assistance and actions for credits)
- identification of barriers to the implementation of autonomous actions
- type of support required: financing, technology, capacity-building
- outcomes of the NAMAs in terms of emission reductions for several horizons (2020, 2030 and 2050) and the methodologies used to calculate these estimations.

The EU perceives LCDS as an opportunity for developing countries to indicate how they intend to reconcile emission mitigation actions with their broader sustainable development strategies, including poverty eradication.

These LCDS could carry several benefits like more coherent, coordinated and effective domestic policies on climate change in a long-term perspective. They should also allow developing countries to better integrate the measures they plan to fulfil the Convention in their global national development strategies. However LCDS necessitate the mobilisation of important resources, financial, institutional or technological ones, and will be consequently very time-consuming. As LCDS are "only" a pre-step to concrete mitigation actions, these resource and time constraints may be too important in comparison with the potential benefits of such a framework and therefore considerably handicap its application. National Climate Actions Plans remain however an important part of the policy process of a country and should not be neglected. They could also facilitate the identification of potential NAMAs within a country. The most advanced developing countries, like the seven countries analysed within the framework of this study, all possess such a National Climate Strategy (see subchapters 4.2 and 4.3).

The concept of LCDS is not contradictory with the concept of the Registry submitted by the Republic of Korea and South Africa (see next paragraph). The EU envisages indeed in its submission that NAMAs and corresponding support would be inscribed in a register. The registration of NAMAs is seen as complementary to the submission of LCDS.

A NEW MECHANISM: THE REGISTRY

The concept of a Registry for NAMAs was originally submitted by two countries: the Republic of Korea and South Africa. Today the idea of a Registry as institutional framework for NAMAs and the related MRV process is gaining unanimity among the policy makers. If the role of the Registry as facilitator for matching actions and support is broadly accepted, Parties have different opinions on the aim and content of the Registry. According to the submission of the Republic of Korea (UNFCCC, 2009b), a Registry should be established, "*with the aim of recognizing the actions* (NAMAs) *as part of the global efforts to combat climate change...*". The Republic of Korea especially attaches importance to the need for international recognition for all the actions undertaken by developing countries (also the unilateral ones), as emphasised by H.E. Mr. Rae-Kwon Chung Ambassador for Climate Change of the Republic of Korea during the sessions of the subsidiary bodies taking place in June 2009 in Bonn (Germany). The Registry should be a tool to improve the transparency of the MRV process, an incentive for more actions by developing countries. The Republic of Korea is also in favour of international verification, as it is the only way for developing countries to gain international recognition in a transparent manner. The registration process should be on a voluntary basis and open to unilateral actions as well as to actions receiving support by developed countries.

One of the differences between the submission of the Republic of Korea and the submission of South Africa, is the type of actions that should be registered. South Africa wishes only mitigation actions receiving support to be registered. Unilateral mitigation actions should be, according to this submission, reported in National Communications only. South Africa wishes verification for NAMAs supported by developed countries "*through modalities and procedures to be established under Convention and according to multi-laterally agreed guidelines*" (UNFCCC, 2009b).

According to both submissions, the following elements could be registered: type and scope of support needed (financial, technological and/or capacity-building), expected quantity of GHG emissions mitigation as well as timeframe for implementation of actions and for expected results.

The concept of a Registry is not completely new. A similar approach is currently employed under the Montreal Protocol Fund, which supports actions by developing countries to phase out ozone-depleting substances as required under the Montreal Protocol (McMahon, 2009). Part of the "registry" are the specific actions proposed by developing countries with an assessment of financial needs as well as performance objectives. Based on this information, the executive board of the Fund approves or rejects to support the actions submitted. To further receive funds, developing countries must prove through annual reporting that their performance objectives have been met.

Experience in examining past performance and existing mitigation support is also provided by Global Environment Facility (GEF) instruments. The GEF is the main current financial mechanism under the UNFCCC. The GEF invests through specific mitigation program areas: promoting renewable energy, reducing costs of low GHG emitting technologies, overcoming barriers to energy efficiency and supporting sustainable transport. All GEF programs are evaluated at regular interval of four years. A strict project-by-project performance assessment is however still missing.

If the Registry as instrument to link actions with support is not put into questions, many questions concerning its application remain, as argued by Kim et al. (Kim, 2009):

- how to ensure that NAMAs deliver cost-effective, measurable and additional GHG mitigation?
- what support does "country x" need to implement "mitigation action y"?
- what eligibility criteria and priorities for deciding where to invest?
- what considerations should influence decision-making about how to direct mitigation support? Cost-effectiveness? Promptitude of mitigation results expected?

If the Registry is open to all mitigation actions by developing countries, as suggested by the Republic of Korea or even if the Registry should be more restrictive as proposed by South Africa, some criteria would be required to allocate the financial and technological resources. Transparency is in any case the key driver of a successful process: transparency to limit political influence, transparency to avoid corruption, fraud and mismanagement of funds. An international harmonised system with clear guidelines adopted by all parties is the further necessary condition to deal with this considerable challenge.

EXAMPLES FROM NATIONAL CLIMATE POLICIES

In subchapter 4.2 many existing policies are described. If several may be more difficult to fit within the MRV framework, others could perfectly match it. Policies with easily measurable, reportable and verifiable results are, for example:

- the reduced VAT and income tax for wind energy projects in China,
- the top ten energy conservation program in China,
- the efficient light bulb subsidy program in China,
- the natural forest protection program in China,
- the solar power generation based incentive in India,
- the national auto fuel policy in India,
- the green India program,
- the official Mexican norms in energy efficiency,
- the program for the use of renewable sources of energy in Mexico,
- the large scale renewable energy project in Mexico,
- the national reforestation program in Mexico,
- the program for commercial forest plantations in Mexico,
- the ProÁrbol reforestation program in Mexico,
- the energy efficiency labelling program for buildings in the Republic of Korea,
- the promotion of efficient transport mode sharing in the Republic of Korea,
- the promotion of forest tending projects in the Republic of Korea,

- the program for incentive of alternative electric energy source in Brazil,
- the Amazon regions protected areas project in Brazil,
- the efficient energy use program in Chile.

More details on the listed policies are available in subchapter 4.2 of this study.

5.2 Reduction potential in key emitting sectors

As demonstrated in chapter four of this analysis, developing countries have already taken numerous measures to mitigate GHG emissions. A question which drives discussions and negotiations is the potential of these countries. Which deviation from “business as usual” scenarios is possible, realisable? Answering this question is a quite difficult and complex task as the data availability and quality is limited in most developing countries. A possible indicator may be a comparison between economic and environmental indicators, for instance a GHG-GDP comparison within and between countries or regions and their evolution path over time. “Environmental Kuznets Curve”, expressing environmental pollution as function of per capita income, is a corresponding theoretical approach as described in subchapter 3.2. A further approach may be a sectoral one: the evolution over time of GHG emissions for the main emitting sectors, energy, industrial processes, transport or agriculture.

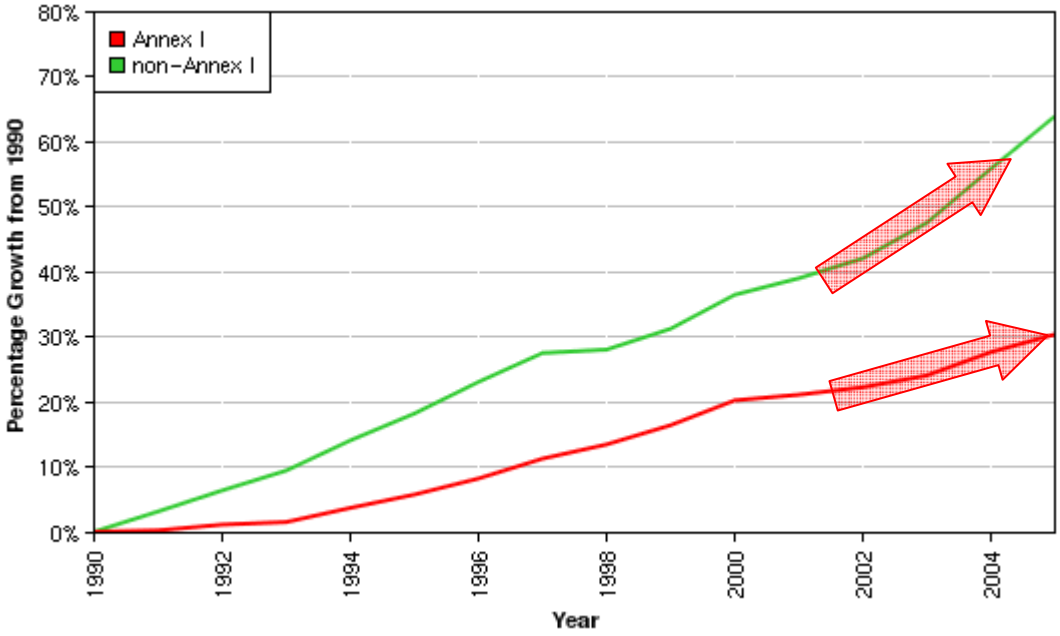
To introduce this subchapter, an overview of four key economic and environmental indicators for Annex I and non-Annex I is provided. Once this broad context defined, economic and environmental indicators are detailed for four countries, the four countries with broad and detailed policy framework (see subchapter 4.2): China, India, the Republic of Korea and Mexico. Finally the evolution of GHG by sector is analysed for the same four countries as well as Annex I and non-Annex I for comparison purposes.

COMPARISON OF ECONOMIC AND ENVIRONMENTAL INDICATORS BETWEEN ANNEX 1 AND NON-ANNEX I PARTIES

An overview of the global situation in Annex I and non-Annex I Parties may be provided by the four following graphs. Illustrated in the graphs is the evolution of key economic and environmental indicators between 1990 and 2005. Represented is not the absolute value of the parameters, but their percentage growth from 1990. Positive values express an increase of the parameter in question, negative ones a decrease.

GDP per capita

Figure 7: GDP per capita 1990-2005

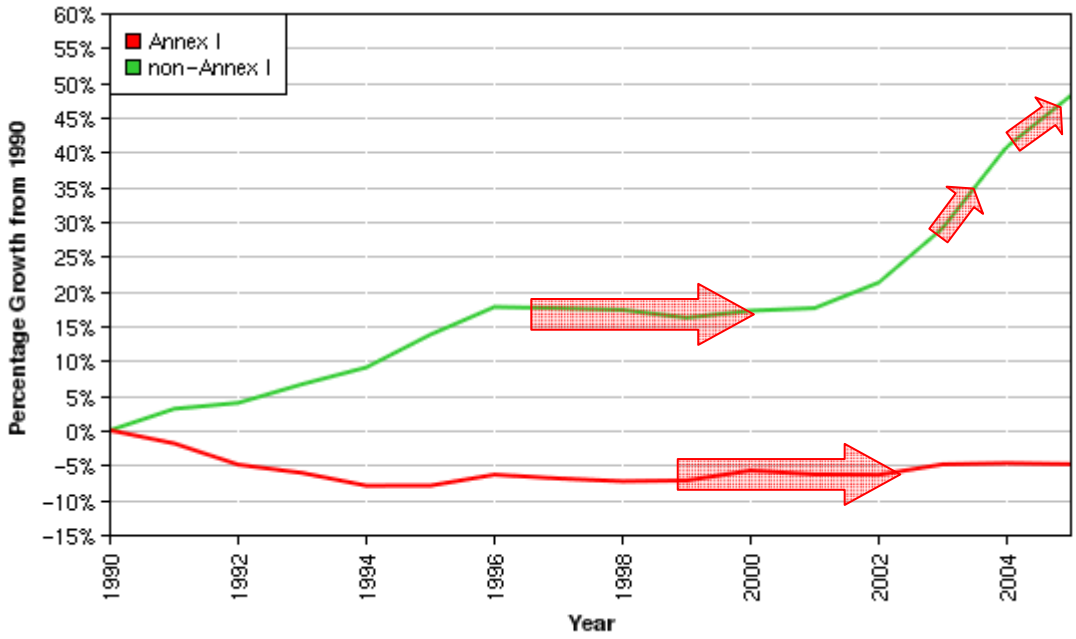


Source: WRI (2009) and own configuration

Both Annex I and non-Annex I experienced a significant economic growth during the last decades. The beginning of the 21st century marks the beginning of a phase of fast and consequent economic growth for developing countries, especially for advanced ones like China or India. Indeed their GDP per capita increased, relative to their 1990 level, from 37% in 2000 to 64% in 2005.

CO_2e emissions per capita

Figure 8: CO_2e emissions per capita 1990-2005



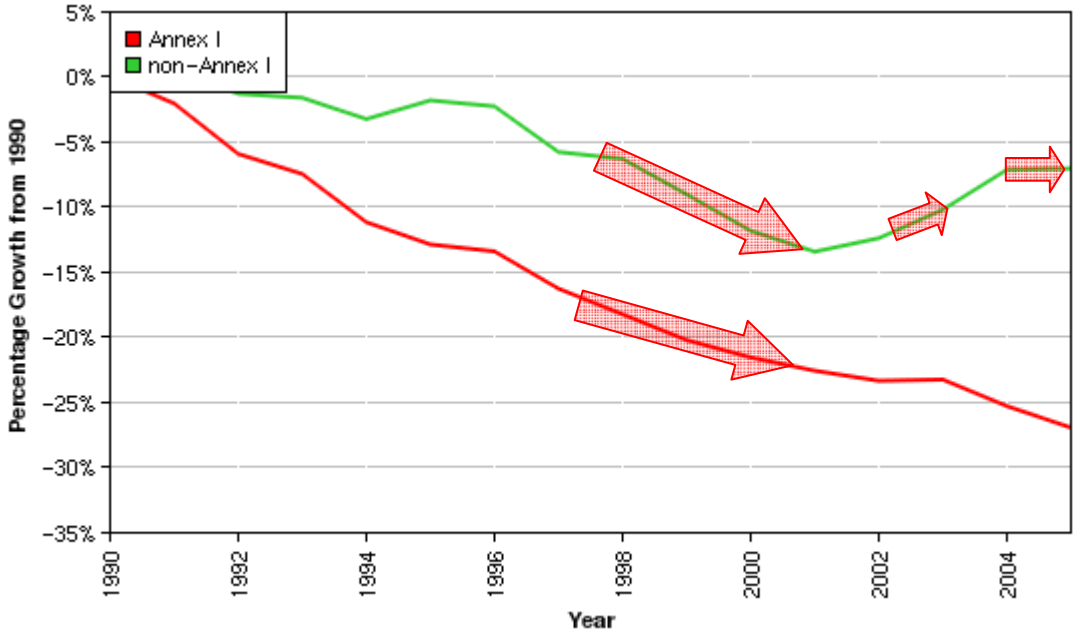
Source: WRI (2009) and own configuration

If CO_2e emissions per capita of Annex I and non-Annex I Parties had a similar evolution path at the very end of the 20th century, they strongly differ between 2001 and 2005. Annex I countries have stabilised their emissions at a level next to the one of 1990, as aimed by the Kyoto Protocol. In contrast, non-Annex I Parties are not subject to any legally binding agreement that would enforce them to lower their GHG emissions to a certain level. The result is unequivocal: a significant increase in GHG emissions since around 2002 for non-Annex I Parties. The relocation of numerous firms from developed to developing countries explains a consequent part of this increase, as detailed in subchapter 5.1 (historical versus current responsibility).

CO_2 intensity of economy

The CO_2 intensity of the economy is mainly based on two factors: the GDP and GHG emissions.
With increasing GDP and stabilised GHG emissions, Annex I Parties achieved during the last decades a decrease of the carbon intensity of their economy. If non-Annex I Parties gave the illusion of successfully managing the carbon intensity of their economy between 1996 and 2001, the disillusion came rapidly. From 2001 to 2004, the decoupling between economic growth and environmental pollution was no more achievable. Signs of a stabilisation of the carbon intensity of economy are however observable for the years 2004 and 2005. Decisive would be the evolution within the next years, with the long-term objective of stabilising the carbon intensity of the economy in non-Annex I Parties.

Figure 9: CO_2 intensity of economy 1990-2005



Source: WRI (2009) and own configuration

Energy use per capita

Figure 10: Energy use per capita 1990-2005

Source: WRI (2009) and own configuration

Energy use is often positively correlated with economic growth. Non-Annex I Parties are no exception to this rule. Statistics of Annex I Parties demonstrate however that economic development without a significant increase in energy consumption is possible. To be noticed is nevertheless the structure of the economy. Annex I Parties mostly have a dominating services sector, whereas non-Annex I Parties still have an important share of their economic activity covered by industry (see subchapter 3.2). The energy consumption induced by these

two sectors strongly differs, therefore partly explaining the difference in energy use between non-Annex I and Annex I Parties. The shift is particularly strong since the beginning of the 21st century. Extension of the electricity network in China and India are important actors of the exponential increase in energy consumption experienced by non-Annex I Parties.

COMPARISON OF ECONOMIC AND ENVIRONMENTAL INDICATORS WITHIN FOUR NON-ANNEX I PARTIES

The following graphs describe the evolution of main economic and environmental indicators over time, from 1990 to 2005, in four high emitting developing countries. The focus on four countries only and not on the seven ones analysed within the framework of this study, is due to the very limited policy framework in Brazil, Chile and Indonesia for the period 1990-2005 (see subchapter 4.2). Trying to draw some parallels between economic, environmental indicators and policies in force only makes sense for the four countries with broad and detailed policy framework: China, India, Mexico and the Republic of Korea. Indicators for non-Annex I and Annex I Parties are also provided in order to compare the evolution of developing countries to the one of developed countries.

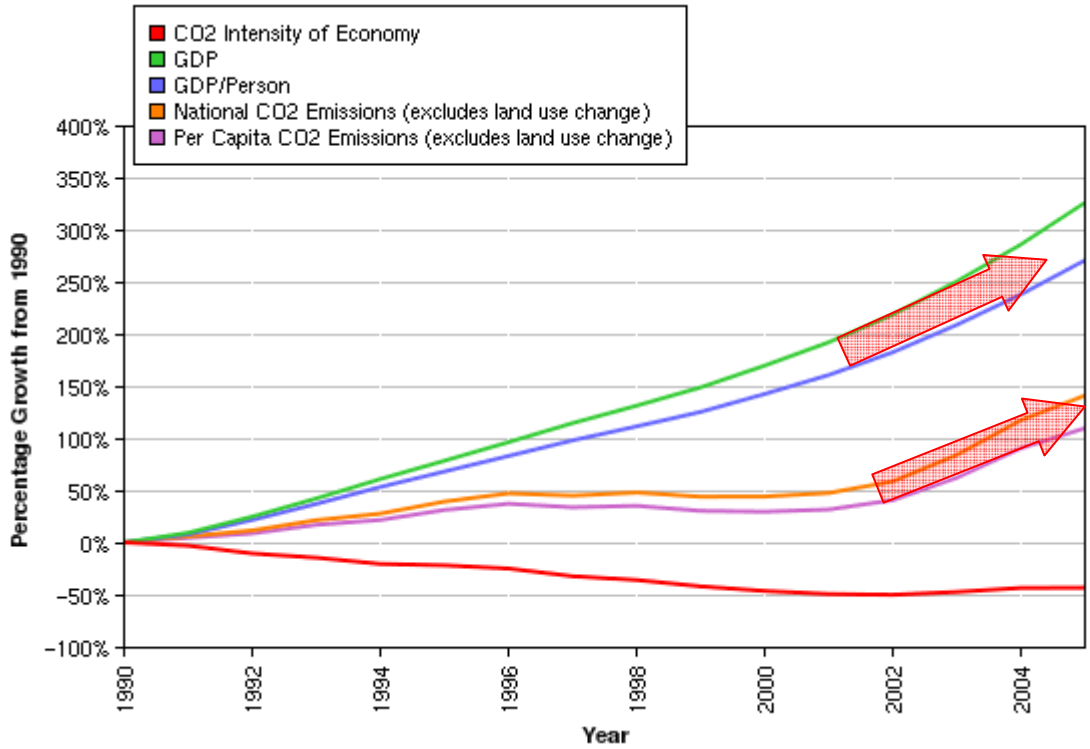
The selected indicators are:

- GDP per country or region: total GDP and GDP per capita
- GHG emissions expressed in CO_2 equivalent per country or region: total CO_2e emissions and CO_2e emissions per capita
- CO_2e intensity of economy

Represented in the graph is again not the absolute value of the parameters, but their percentage growth from 1990. Positive values express an increase of the parameter in question, negative ones a decrease.

China

Figure 11: China, economic and environmental indicators, 1990-2005

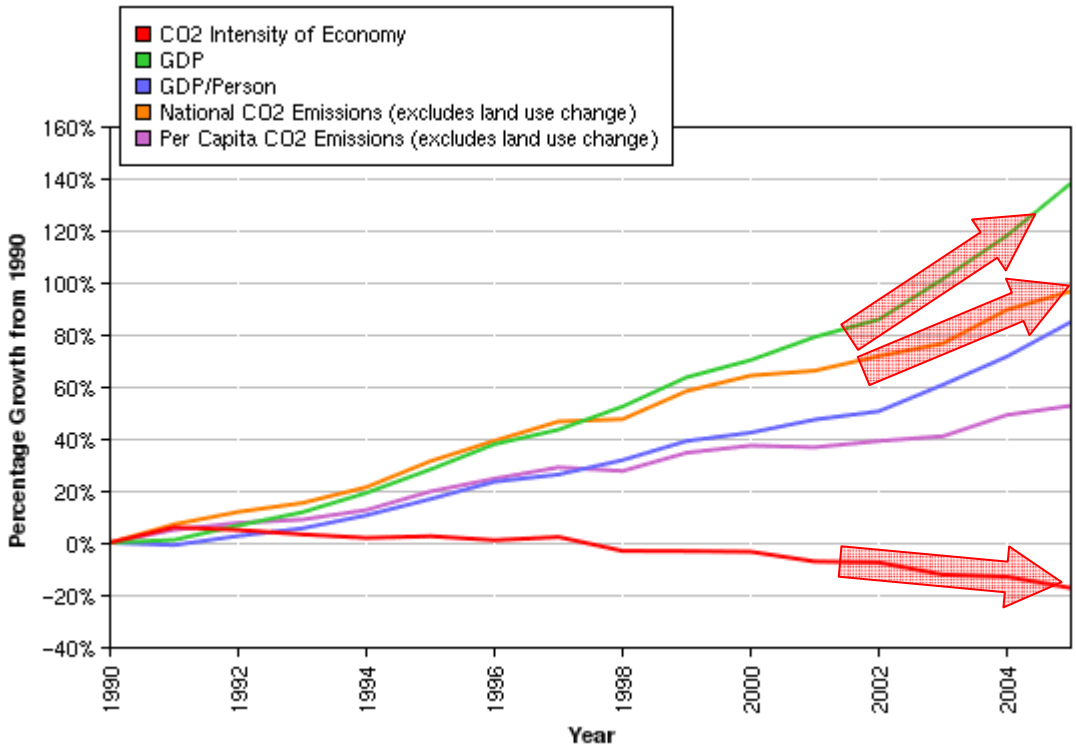


Source: WRI (2009) and own configuration

China is by far the non-Annex I Party experiencing the strongest economic growth with a percentage growth from 1990 level of 325% in 2005. Such an increase is inevitably followed by a parallel increase in GHG emissions. Both absolute values and values per capita show the same trend.

India

Figure 12: India, economic and environmental indicators, 1990-2005



Source: WRI (2009) and own configuration

India, the second most important non-Annex I country in terms of population and economic growth, shows a similar pattern to China. India however experiences, in percentage growth, a more moderate economic growth than China. GHG emissions consequently follow a more moderate increase. To be noticed is the difference between absolute value and value per capita. If the trend is similar, the level of percentage growth is clearly lower when considering per capita value instead of absolute value. This is due to the high population of this country (see subchapter 3.4).

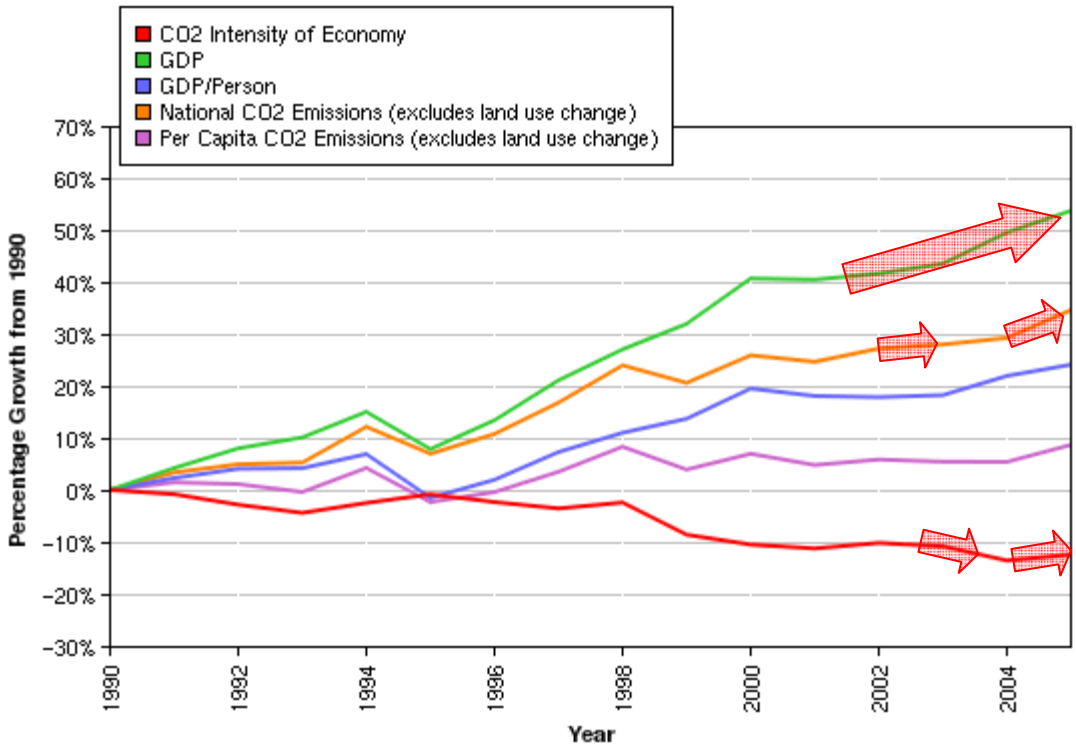
Mexico

Mexico's evolution path is more chaotic than the ones of the previous countries discussed. The trend towards an increase of GDP and GHG emissions is however quite clear.

The 1994 break is known as the Mexican peso crisis, an important economic crisis due to the sudden devaluation of the Mexican peso in December 1994. The end of the year 1994 was

also a period of election in Mexico, with the election of a new president, Mr. Ernesto Zedillo, succeeding to Mr. Carlos Salinas de Gortari. Thanks to a rapid and consequent rescue package by the US, the Mexican economy did not suffer for a too long time from this financial crisis. The 2000 peak may be the consequence of another election. In 2000 the Institutional Revolutionary Party lost for the first time in its history the presidential election to the opposition party called National Action Party.

Figure 13: Mexico, economic and environmental indicators, 1990-2005



Source: WRI (2009) and own configuration

The 1998-1999 break has other causes than political ones. The stabilisation of GHG emissions may indeed be attributed to various environmental policies which entered into force in 1997: Agenda 21 for Mexico, Program for Industrial Environmental Regulations, Specific Programs 1997-2000 to improve Air Quality on the Metropolitan Areas, etc. (see subchapter 4.2).

If a stabilisation of the GHG emissions was further achieved between 2000 and 2003, it is certainly due to the parallel stagnation of the economic growth. The rebound of the economy in 2003 causes a slightly delayed increase in GHG emissions of about one year.

Significant differences between absolute and per capita values are again the propriety of a high populated country (see subchapter 3.4).

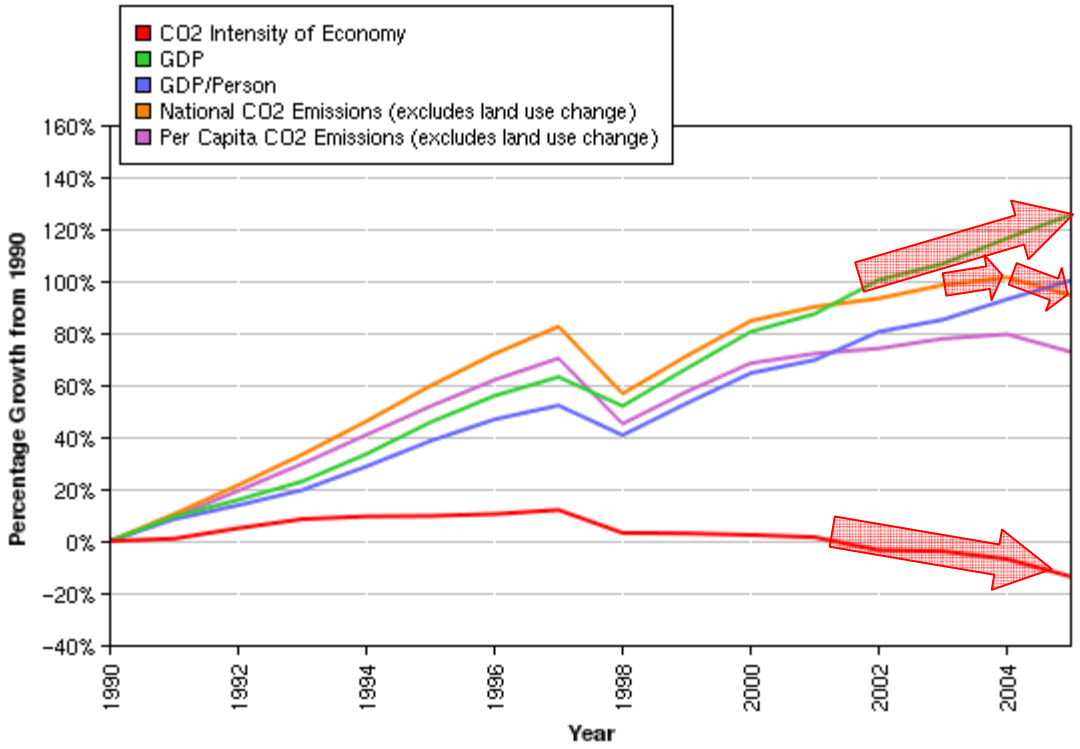
Republic of Korea

The Republic of Korea is one of the rare non-Annex I Parties with quite stabilised GHG emissions after the year 2000. If like most of non-Annex I Parties the Republic of Korea

experienced a parallel increase of its GDP and GHG emissions until the end of the 20th century, the year 2004 was a successful turning point with for the first time slightly decreasing GHG emissions conjoined with increasing economic growth. The Republic of Korea may thereby be on a positive track to decouple economic growth from GHG emissions and could serve as example for other non-Annex I Parties. These positive results may be the fruit of the implementation of the so called "Comprehensive National Action Plans against Climate Change" (see subchapter 4.2).

Not to be forgotten is the quite high level of development of this country in regards to other non-Annex I countries. This is symbolised by the membership of the Republic of Korea to the OECD.

Figure 14: Republic of Korea, economic and environmental indicators, 1990-2005



Source: WRI (2009) and own configuration

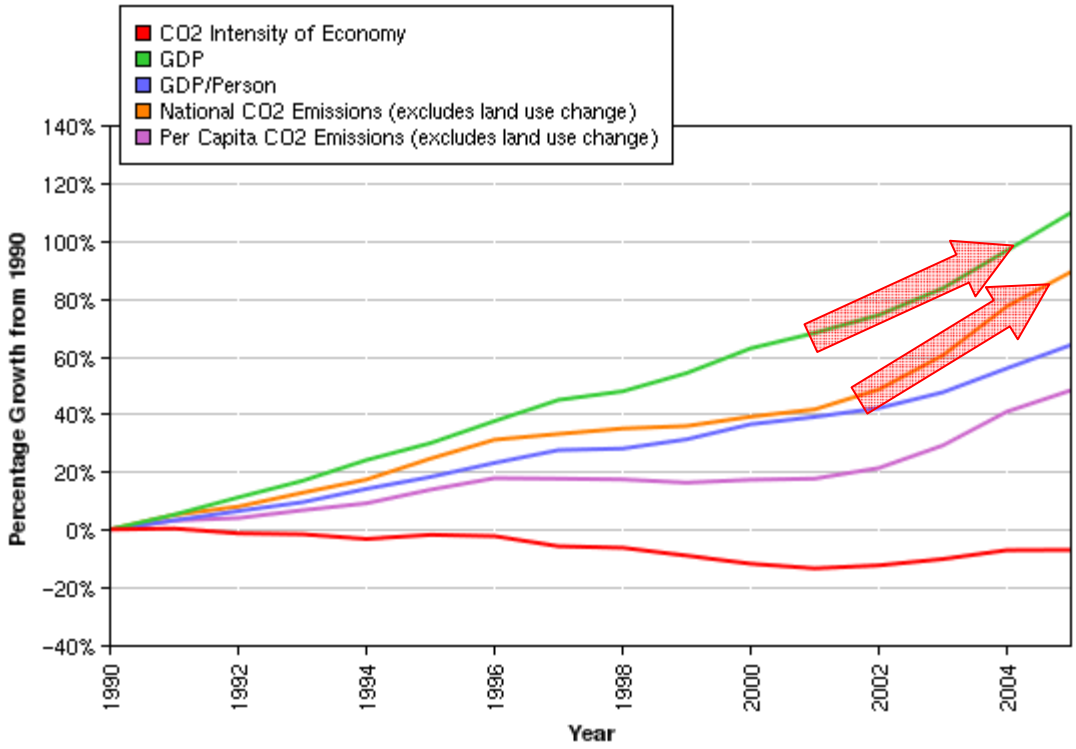
The prominent break in the year 1997 is due to the Asian Financial Crisis of the same year. This Crisis adversely affected all Asian countries. The Republic of Korea was however able to quickly recover from this Crisis and regain an economic growth already one year later.

Considering absolute or per capita value do not provide significant differences, except slightly lower values of percentage growth when considering per capita values instead of absolute ones.

Non-Annex I

Non-Annex I Parties shows a quite different pattern than Annex I Parties. They experience an unbelievably strong economic growth, especially when considering total GDP. To be noticed is that the very high population rate of most of the non-Annex I Parties, especially China and India, smothers the growth rate of GDP per capita. In contrast to Annex I Parties (see figure 16), non-Annex I Parties experience a growth in GHG emissions parallel to the one of the economy. The CO_2e intensity of the economy remains therefore in average stable, even if a slight decrease was observed at the very end of the 20th century. The decoupling of the GHG emissions from the economic growth is a considerable challenge for developing countries, but the only hope to achieve efficient mitigation worldwide.

Figure 15: Non-Annex I Parties, economic and environmental indicators, 1990-2005

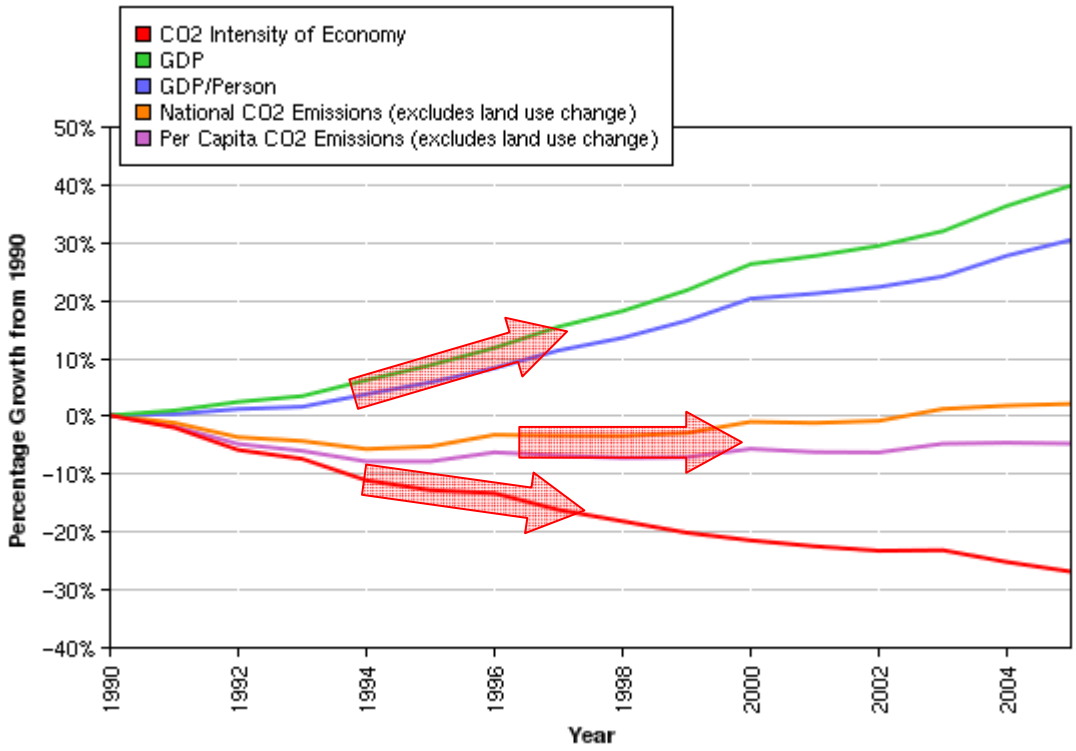


Source: WRI (2009) and own configuration

Annex I

This graph shows that Annex I Parties are aware of the environmental problem and have taken consequent measures to stabilise their GHG emissions without compromising their economic growth. Stabilised GHG emissions combined with increasing GDP results in a decrease of the carbon intensity of the economy. Considering total indicators or indicators per capita show almost the same trends. In the two last decades, Annex I Parties have successfully managed to decouple economic growth from GHG emissions. However it does not mean that Annex I have already reach their mitigation goals. Annex I still have non-negligible mitigation potential and should further adopt ambitious goals.

Figure 16: Annex I Parties, economic and environmental indicators, 1990-2005



Source: WRI (2009) and own configuration

GHG EMISSIONS BY SECTOR: EVOLUTION 1990-2005

Interesting is also to compare the evolution over time of the GHG emissions by sector. GHG emissions are divided into four main sectors, according to the World Resource Institute classification (WRI, 2009): energy (included energy consumed for industry), industrial processes, transport and agriculture.

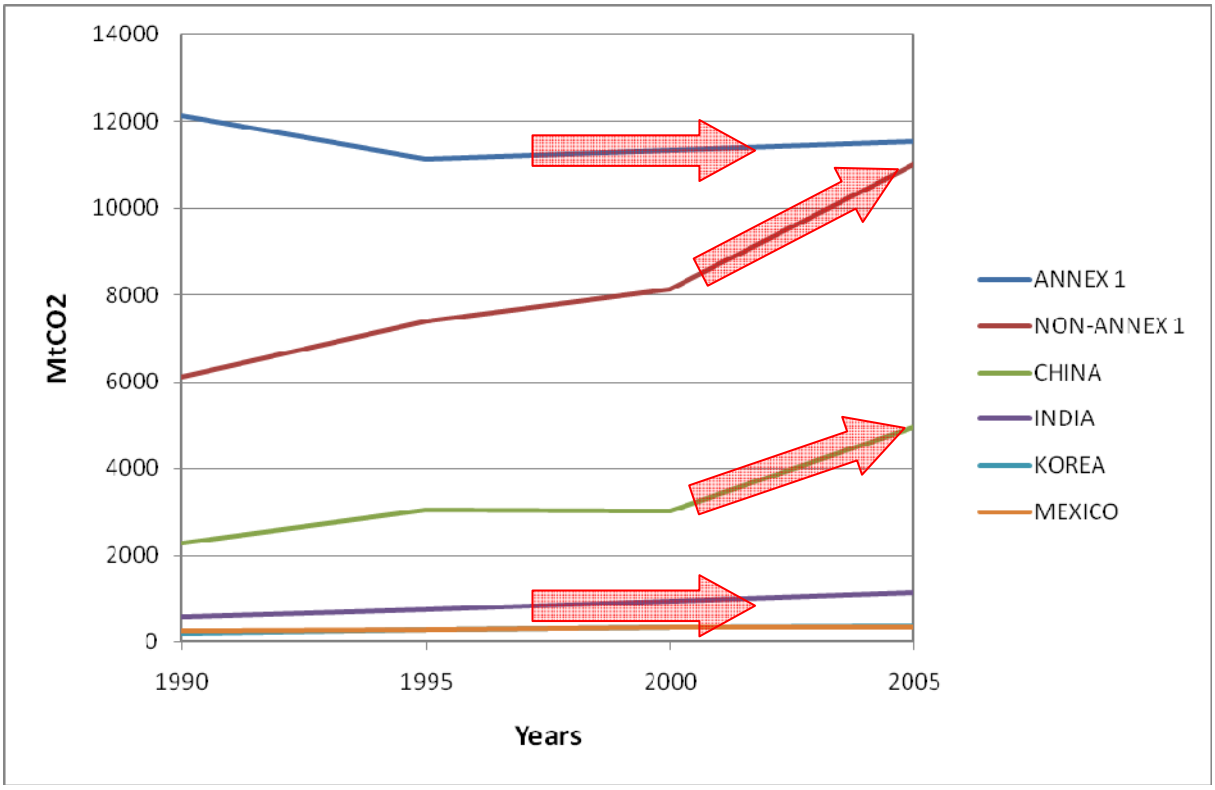
Values provided are absolute values, given in $MtCO_2e$, over the time period 1990-2005. Compared countries or regions are as in the previous graphs: Annex I and non-Annex I Parties as well as four high emitting developing countries: China, India, Mexico and the Republic of Korea.

Energy

If GHG emissions of Annex I Parties were two times bigger than the ones of non-Annex I in the early 1990s, they reach comparable values in 2005. The stabilisation of GHG emissions from the energy sector in Annex I Parties can be explained by the constancy of the energy demand and the absence of a strong shift in energy sources. Non-Annex I experience in contrast many revolutions: the extend of the electricity grid to rural population (particularly significant in China and India), a strong industrialisation phase with the relocation of numerous firms from developed to developing countries, the demand for higher life standard by the middle class, etc. All these changes induce higher energy consumption, with consequently higher GHG emissions from this sector. China is the best illustrator of this

trend, with nearly a doubling of GHG emissions within five years (2000-2005). India, the Republic of Korea and Mexico show a less alarming trend with though increasing GHG emissions, but in a moderate manner.

Figure 17: GHG emissions by sector, energy, 1990-2005



Source: WRI (2009) and own configuration

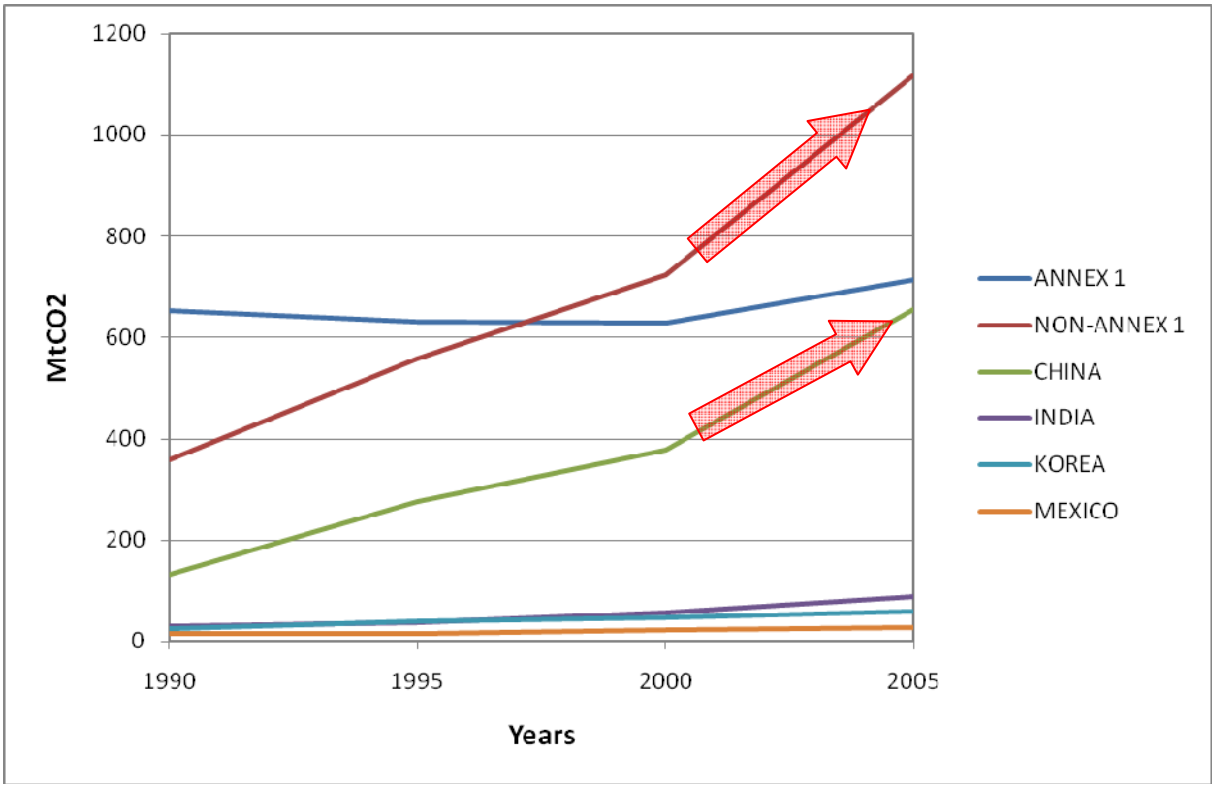
Industrial processes

Emissions from industrial processes clearly illustrate the relocation of many industries from Annex I to non-Annex I Parties. At the beginning of the 1990s, most of the non-Annex I Parties were at a very early stage of their economic development, with domination of the agriculture sector over the industry one. This situation rapidly changes to evolve towards a strong domination of the industry sector, expressed by strongly increasing GHG emissions from this sector. This inversion can be observed in the graph at the very end of the 20th century.

China is the most manifest example of the growth of the industry sector, with a path parallel to the one of the average of non-Annex I Parties. For the three remaining countries (India, Mexico and the Republic of Korea), emissions from industrial processes are much less significant.

To be noticed is the difference of magnitude between emissions from industrial processes and the one from the energy sector. Non-Annex I emissions from industrial processes are consequent, however ten times lower than the one from the energy sector. Not to be forgotten is that the energy consumption from the industry is considered by the WRI under the energy sector and not under industrial processes.

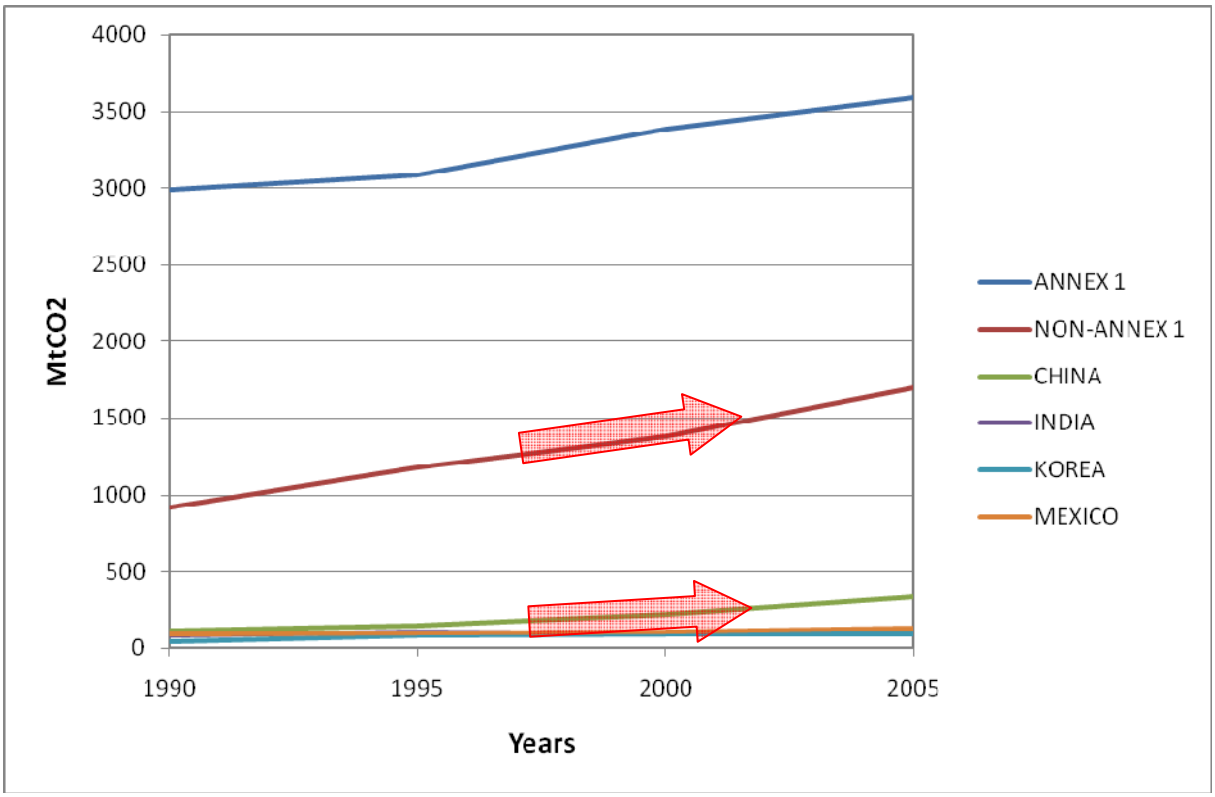
Figure 18: GHG emissions by sector, industrial processes, 1990-2005



Source: WRI (2009) and own configuration

Transport

Figure 19: GHG emissions by sector, transport, 1990-2005



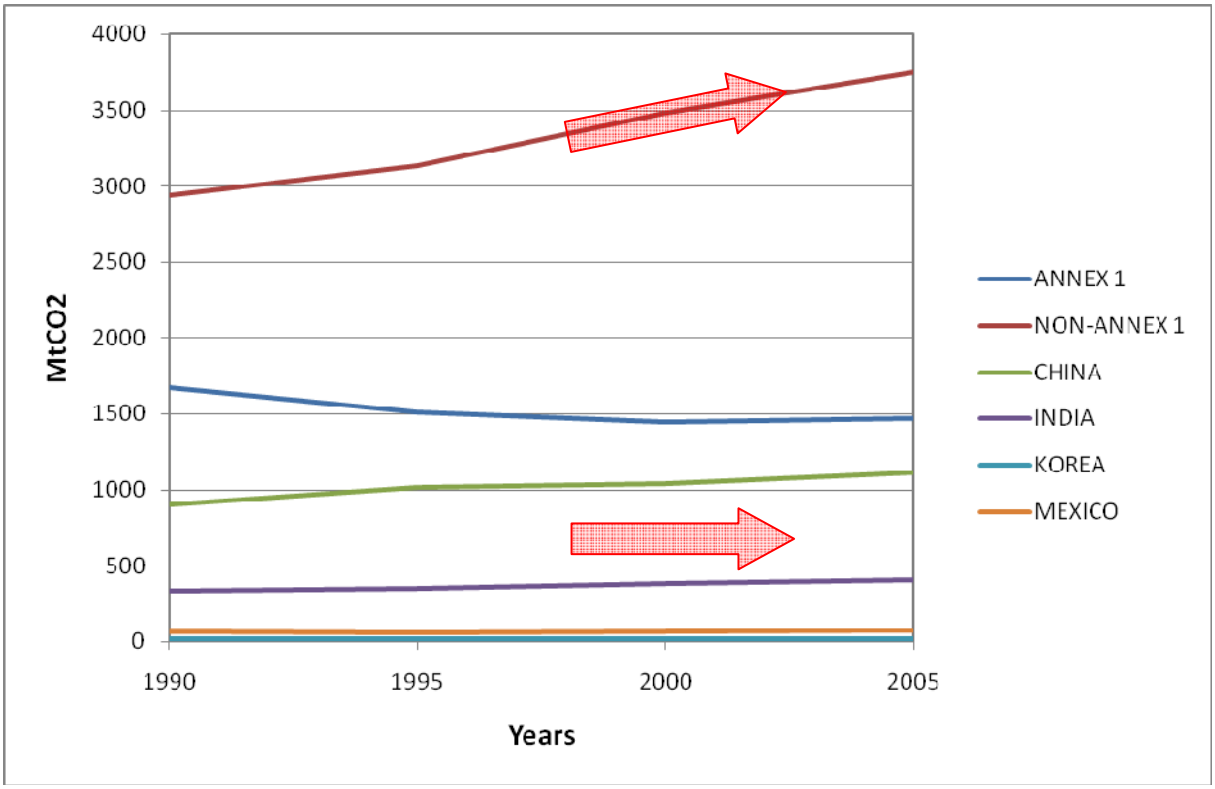
Source: WRI (2009) and own configuration

Emissions from the transport sector are strongly the prerogative of Annex I Parties. Even if emissions from non-Annex I are not so significant, they should not be underestimated. Indeed this sector may experience a consequent increase in the future for many reasons. Countries like China or India cover enormous land surfaces (see subchapter 3.4). With increasing trade and economic growth, people will frequently have to commute from one city to another. A better economic situation also implies higher life standards which may be expressed by the willingness to possess a car, still a symbol of prosperity in many societies. Transportation means are furthermore underdeveloped in many developing countries and are probably going to be expanded within the next years. More transport facilities will inevitably induce higher transport rate, causing higher GHG emissions from this sector. This predictable increase in transportation may also be seen as a chance to shift from individual transport towards public one, from polluting means of transport to green ones.

Agriculture

If agriculture is loosing in importance in developed countries, it remains a central economic activity in developing coutries (see subchapter 3.2). Related to the level of activity are the GHG emissions. To be noticed is that the most developed countries among developing countries, like the four one analysed within the framework of this study, have already experienced the shift towards an industry and services oriented economy. Their GHG emissions from agriculture are therefore constant at a quite low level.

Figure 20: GHG emissions by sector, agriculture, 1990-2005

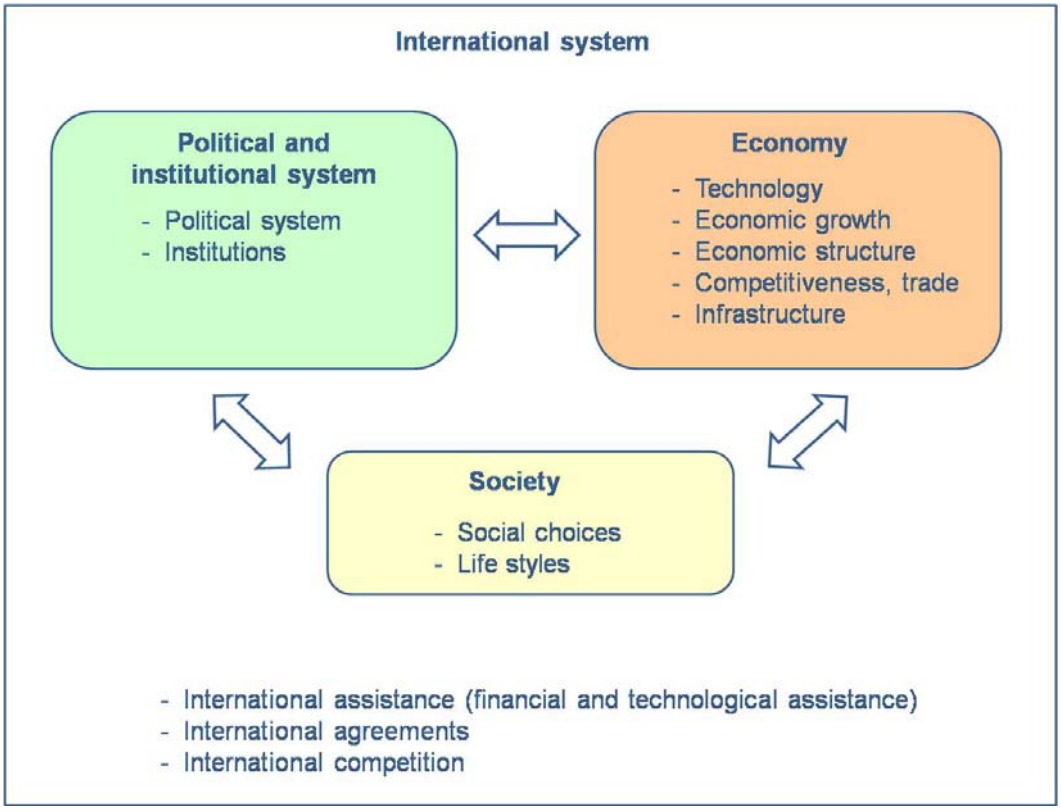


Source: WRI (2009) and own configuration.

5.3 Barriers

Tackling climate change is one of the most ambitious and significant challenge of the 21st century. In the way to success stands a wide range of barriers. The figure below illustrates entities which can either act as push or pull factors: political and institutional system, economy, society and international system. As the push side have already been discussed in previous chapters, the pull side only will be considered in this subchapter.

Figure 21: Interaction between political and institutional system, economy, society and international system



Source: own configuration

Political and institutional barriers, technological and infrastructural barriers, structural and behavioural barriers are all examples of how the mentioned entities may act as pull factor on the way to implementing a new policy or technology. Some factors like political ones are endogenous, i.e related to the country endowments, while others like the lack of international assistance are exogenous, i.e. generated by entities external to the country.

The identification of barriers is an important step which allows to develop different forms of intervention and thus win in efficiency and rapidity when implementing new policies and technologies or improving existing ones. Because barriers evolve over time, intervention mechanisms should be flexible enough to avoid inconsistencies due to time lag, as underlined in chapter 5 of the IPCC Third Assessment Report of the Working Group III (IPCC, 2001).

Political and institutional system

The ***political system*** and the quality of the ***institutions*** are two factors influencing the

successful implementation of a new policy or technology. In democracies, citizens have the right to publicly declare their interests and desires for changes. They could for example incentivise governments to care about the environmental quality by adopting GHG mitigation measures (Bernauer, 2009b). While democracies may act as push factor within this context, dictatorial regimes may be considered as pull factors. By limiting the civil liberties of its citizens and thereby their access to information and their freedom of speech, dictatorial regimes do not offer the possibility to its citizens to express their ideas and thus put pressure on the government. Next to the political systems, the quality of institutions plays a decisive role. Corruption, low government effectiveness, political instability are widespread barriers in countries of the Third World (see subchapter 3.3). The successful entry into force of policies, for instance policies regulating new technologies, may strongly depend on the quality of the institutions of a government. The political system is furthermore decisive for the global and specific policy framework that surrounded the development and deployment of new policies and technologies.

The existence and implementation of ***unfavourable fiscal policies*** is a further barrier. Fiscal policies should act as adequate instruments to favour a particular technology area or to overcome market failure. One difficulty provides from the time lag between technologies and legal processes: technologies can evolve at a very fast rate, anyway at a much quicker rate than fiscal instruments do. This time lag may lead to outdated fiscal policies, with the consequence of favouring undesired technologies. This phenomenon is especially visible in developing countries where policy processes are significantly slower than in developed countries. Common examples are subsidies for fossil fuels, as in Indonesia. Fertiliser subsidies in India are a further example of a fiscal instrument in favour of polluting and non-sustainable technologies.

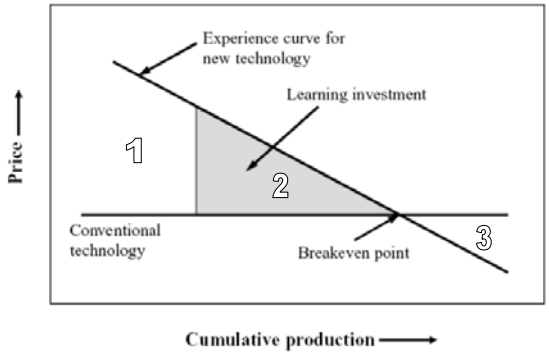
Economy

Technological barriers cover a broad palette of barriers: high costs, technical risks, market risks and intellectual property are few examples, as stipulated by Brown et al. (Brown, 2008).

High costs induced by the development and entry into the market of new or emerging technologies are a widespread barrier. High costs result from many aspects. A first one is the long time period capital investments take to be paid off. A further reason is the high cost of capital because of technical and market risks and uncertainties. Another point is characterised by the high operation & maintenance costs due to their early phase of development.

New technologies follow a typical learning slope illustrated in figure 22. Three phases of development can be distinguished: phase 1 is characterised by high costs and low production compared to conventional technologies (bottom line, stabilised price and production rate). Phase 2 is typified by decreasing costs and increasing production level until the breakeven point is reached. The breakeven point is the turning point after which a technology begins to be profitable. Phase 3 is the profit phase with production costs lower than sale benefits. The new technology has reached its maturity stage.

Figure 22: Evolution path of technologies



Source: Brown, 2008

As new technologies and already existing ones compete in the same market, the high costs of emerging technologies are a particularly strong obstacle. Appropriate regulatory mechanisms like subsidies for new technologies as well as financial support may help new technologies to be competitive and thus successful.

Technical risks are associated with the performance uncertainties of new technologies. Insufficient validation of the performance of a technology as well as lack of monitored demonstrations make the attraction of investment capital difficult. A vicious circle begins as the mentioned lack of capital obstructs the improvement of the technology leading. Technologies with high technical risks may be hardly competitive in a market where incumbent technologies (low risk and attractive prices) are available.

Low demand for emerging technologies and uncertain costs of production are the two main *market risks*. When a new technology enters the market, a few early adopters will begin to consume the technology. If these adopters are convinced from the new technology, they may give incentives to further customers to adopt the technology. With increasing awareness of the technology and decreasing uncertainties, the demand for the technology may conquer a significant market share. With increasing market share, the chances for the long-term viability of the technology will increase and finally contribute to the success of the technology. This ideal development path is however often disturbed by many more or less predictable factors like customer preferences. Critical is the way until the reach of the point of profitability. Uncertain costs of production reinforce the described problem. The energy sector is especially concerned by this barrier as energy prices are volatile. Renewable energies are more expensive than fossil fuels. Their competitiveness therefore depends on the price of fossil fuels which may strongly vary within a short time period. The moment of the entry into the market of a new renewable energy may therefore be decisive in the success of the technology. Periods with high fossil fuels prices are for instance propitious to launch new renewable technologies. An example may be, as underlined by Brown et al. (Brown, 2008), the rise in oil prices in 2004 and 2005 which gave entrepreneurs the possibility to successfully commercialise bioethanol fuels.

Intellectual property is a key link in the chain of technology transfer. The weak international patent protection may infringe firms to deploy their technologies in developing countries. The high transaction cost related to intellectual property may be a further barrier, especially for firms with limited capitals.

The ***lack of financial resources*** due to either low economic growth or investment in other high-priority sectors strongly limits the capacity of implementing new technologies. This barrier is often advanced by developing countries as the most important one, together with the lack of technological knowledge. The international community can highly contribute to help developing countries overcoming these barriers by investing in such countries and intensifying technology transfer.

Under ***economic structure*** barriers, two barriers can be distinguished: one related to natural monopolies and the other to fragmented industries. Under some natural monopolies like the electric power sector, small-scale competition can not take place as close substitutes for the dominating technology do not exist. No innovation, no competition are possible, thus letting no place for new technologies. Fragmented industries face another problem: technological change is slowed down by the fragmentation of the industry and the resulting dispersion of infrastructure and working forces. Coordination efforts are consequently very complicated. All these factors lead to limited investment capital which reinforces the slowness of technological diffusion. Typically fragmented are agriculture and building industries.

For ***competitiveness*** purposes, countries may not be willing to introduce regulating instruments in favour of a better environment but penalising their export sector (see

subchapter 3.2). Economic growth, which is partly a function of ***trade***, is often the overarching priority of industries and governments.

Infrastructure limitation is a further considerable barrier. Inadequate physical systems and facilities that are critical to the success of a new technology like electric transmission capabilities, shortage of key complementary technologies that improve the functionality of a new technology as well as insufficient supply and purchasing channels are all examples of infrastructure barriers, as underlined by Brown et al. (Brown, 2008). Complementary technologies play an important role as they achieve benefits that would not be possible if technologies would be considered separately and as they strongly enhance the efficiency of the primary technology. Examples are: energy storage technologies; sensors, communications and controls; innovative catalysts, membranes and distribution; low loss-power transmission and distribution; etc.

The ***lack of specialised working forces*** affects the implementation, operation and maintenance of a new technology and thereby the efficiency of this new product. The lack of technical knowledge reflects itself in unskilled workers which may install, operate and maintain the technology, leading thus to failure(s) of the system. Inappropriate or unavailable training program are often a reason for the lack of qualified working forces. To be noticed is the specificity of the working programs according to the technology and location in question.
The lack of specialised working forces also affects the process of policies implementation. This is especially visible in decentralised governments like Indonesia (see subchapter 4.2).

Society

Social choices and ***life styles*** are critical parameters for the successful implementation of a new policy or technology. Indeed it is often consumers who finally decide to adopt a new product or not, for instance green products. Even if social choices may strongly depend on political and institutional structures, inhabitants of a country could for example mobilise themselves to encourage governments to adopt green energies, at least in non-autocracies. The ambassador for climate change in the Republic of Korea illustrates the power of social choices with the increasing number of private cars in his country. Cars represent the ideal of the west, are a symbol of material prosperity. How to convince people to go back to their bicycle at the moment where they just had a taste of west is a very difficult task. Especially challenging is to convince developing countries to adopt green lifestyles and thereby renounce to cars for example while developed countries enjoy car driving for decades. Changing the attitude of customers of both developed and developing countries is an important step on the road to success. The Republic of Korea is for instance showing leadership with the introduction of the concept of “Green Growth” (see subchapter 4.3).

International barriers

While most of the previous barriers described are endogenous to country endowments, some barriers can also be exogenous, i.e. generated by entities external to the country.

The ***lack of international assistance*** is one considerable exogenous barrier. It manifests itself mostly in a lack of financial and technological fluxes. Efficient renewable energies are known in developed countries and already implemented, even if only at small scale. The need to discover new technologies must therefore not be the first priority for developing countries. Trigger points are technology transfer from developed to developing countries, from Annex I to non-Annex I Parties as well as the deployment of these technologies in non-

Annex I Parties. Barriers to the deployment within a country, so called endogenous barriers, have largely been discussed in the previous subchapter. As already underlined in subchapter 5.1 (financial and technological support) developed countries should play the key role in providing support to developing countries. This technological and financial support is clearly consigned in articles 4.3, 4.5 and 4.7 of the Convention (see subchapter 5.1). The first step, recognition of need for support, is thereby achieved. Still to accomplish is its implementation. The Post-Kyoto Protocol should play a decisive role in the implementation of these principles, as mandated in the Bali Action Plan (UNFCCC, 2007). As already mentioned in subchapter 5.1, new instruments for the technology transfer are to be developed, new financial mechanisms to be created.

International agreements may be a powerful instrument to incentivise countries to more actions. However international agreement may also generate the opposite effect. Free riders, like the United States of America who have not ratified the Kyoto Protocol, may encourage other Parties to follow the same track. If the biggest polluters of the World do not agree to some common ambitious targets, some Parties may further be discouraged to undertake actions. A successful global GHG mitigation therefore requires the active participation of all Parties of the World. Up to date, Annex I Parties only are obliged to meet quantitative emission reduction targets. As Annex I Parties do not include the biggest polluters of the World (US, China, India, …), an efficient global mitigation can not be achieved. This consequent barrier may be partly overcame by the Post-Kyoto agreement which may commit non-Annex I Parties to mitigation measures, however in an adapted way in regards to their national circumstances. NAMAs may be the concrete instruments to reach this ambitious goal. Cooperation among all Parties is the only way to success.

If all Parties adopt some GHG emission restrictions, a further problem may be avoided: the ***pollution haven hypothesis***. This hypothesis is described in subchapters 3.2 and 5.1, historical versus current responsibility. However, it might not be possible to completely eradicate this phenomenon, as some Parties may still decide to provide preferential treatment for sectors strongly exposed to ***international competition,*** as underlined by Reinaud et al. (Reinaud, 2009). Furthermore, as not all Parties may be submitted to the same grade of commitments, disparities may still remain. The asymmetry of domestic climate policies at the international level may reinforce these disparities. If the pollution haven hypothesis may therefore not completely disappear, a strong attenuation of this difficulty may still be achieved.

SOME BARRIERS SPECIFIC TO THE SEVEN COUNTRIES ANALYSED

A common barrier to the seven countries analysed is the difficulty in implementing adopted policies. If some countries have setting ambitious target and adopted corresponding policies, means how this goal should be achieved are often not specified. Setting goals without concrete measures to reach them is not the best way to successfully accomplish them. This difficulty in implementing policies may be due to inefficient institutions, a lack of political willingness as well as inadequate and/or missing infrastructures, as underlined by Barton et al. (Barton, 2008).

Brazil

Brazil perfectly illustrates the implementation problem aforementioned. Particularly striking is the difference between the description of the broad concepts and the suggested main actions. If the declarations are meaningful, pointing out the right problems, the concrete actions to encounter them are less convincing. Most of the actions are not quantified, not precisely defined or not ambitious like the solar heating action described in subchapter 4.3.

As already mentioned, this problem is not specific to Brazil, but to most developing countries and sometimes developed countries.

Chile
A consequent problem identified in Chile is the low awareness of the population regarding climate change. Once people will become aware of this challenge and the related urgency to act by mitigating GHG emissions and adapting to the consequences of climate change, the willingness for a better environment will increase. Aware of climate change, citizens may therefore progressively adapt their life styles to more sustainable ones. Increasing scientific knowledge about climate change and its impact for Chile may further contribute to a better comprehension of this phenomenon and help to act in a targeted and efficient way. Understanding the impacts of climate change in Chile, especially the ones on precipitation pattern, may for example help to better plan hydroelectric generation plants.

China
The main barrier in China is currently the fear of loosing competitiveness by introducing regulatory instruments on production. Trade represents a consequent part of the GDP in China: exports generated 37% of the GDP for the year 2005 and imports 32%, which gives a total of 69% of the GDP engendered by trade (see subchapter 3.2). The very high rate of FDI further demonstrates the interest of other countries to invest in China. If international firms invest in China, it is partly due to favourable policies or even the absence or weakness of regulatory mechanisms. Introducing a tax on GHG emissions in China would immediately negatively affect Chinese industrial activities and thereby economic growth.

India
A considerable pull factor is the position of India in international negotiation. Arguing and demonstrating that their per capita emissions will never exceed the ones of developed countries, India is not in favour of ambitious emission reduction goals for developing countries. Recently, the Environment Minister of India however nuanced this position “simply because we need to mitigate in self-interest” (India, 2009).
High poverty rate and considerable development challenges do further not facilitate the mobilisation of financial means for environmental purposes.

Indonesia
An inadequate policy and regulatory framework for environment and natural resources management is the most important barrier identified by the Asian Development Bank (Asian Development Bank, 2005). The weak institutional capacity at regional level reinforces this barrier. Inefficient or missing infrastructures are a further obstacle on the way. High population growth and immigration rate push for the creation of new surfaces of habitation. Due to the particular geographical configuration of Indonesia, the preferred option is often to illegally fire forests. To be remembered is the massive part of GHG emissions which is attributed to deforestation and land use change in Indonesia (see subchapter 3.1).

Mexico
Mexico disposes about a quite advanced political and institutional framework, even if political changes at the head of the government had notable consequences on GHG emissions in the past (see subchapter 5.2). One difficulty faced by Mexico may be to meet basic needs of its broad population, thus limiting financial means available for environmental purposes. The general director for global issues of the government of Mexico emphasised during UNFCCC negotiations meetings that more actions in Mexico is only possible if more financial support is provided by the international community.

The Republic of Korea
Economic and political stability generally characterise the last decades of the Republic of Korea. Technological and financial difficulties are not the main issue in this country. But due

to this relative economic welfare, a “westernisation” of the population is observable: more cars, more electronic devices, etc. Achieving a change in social choices and life styles towards greenness is therefore one of the most important challenges faced by the Republic of Korea. The Republic of Korea has already recognised this challenge and immediately reacted by launching a new vision: the so called “Green Growth” (see subchapter 4.3). This program aiming at interlinking performance (economic growth) and sustainability (environmental quality) will further promote green values in the society and induce a change in human behaviour and preferences. “Green Growth” is thereby expected to revolutionise the Republic of Korea.

SOME POTENTIAL SOLUTIONS TO OVERCOME BARRIERS

Before analysing potential solutions to overcome the above identified barriers some fundamental questions must be answered, as noted by Brown et al. (Brown, 2008):

- How much of an impact does each barrier have in terms of hindering the deployment of GHG-reducing technologies and policies?
- Does the barrier have economy-wide impacts or does it affect only a narrow range and scope of technologies and markets?
- Is the barrier part of an interrelated system of factors or is it an isolated effect?
- How easily and effectively can each barrier be ameliorated or eliminated?

These analytical questions may be difficult to answer due to the lack of data. Trying to answer them is though an important step as it may then facilitate to act in a targeted way, thus allowing a considerable gain in efficiency.

Political and institutional barriers are hardly combatable on the short- to mid-term. They would involve changes of secular traditions and mentality. Such revolutions, like the abolition of corruption, are hardly imaginable in the near term even with interventions of third parties. Some solutions to improve the current situation may however be provided. In case of international financing, increased control by international bodies may limit the risk of misuse of international financial support due to high corruption rate. Governmental efficiency could further be gained by introducing a long-term common vision, like suggested by the concept of low-carbon development strategies (see subchapter 4.4). Bringing all policies, incentives, regulating instruments of all fields concerned by GHG emissions (energy, industry, transport, waste, sustainable development, etc.) under a common vision may further contribute to win in efficiency. Uniform national guidelines to regulate GHG-reducing policies may also facilitate this common vision approach.

Technological barriers like high costs barriers, which are often a function of technical risks, may be overcome by an enhanced public-private partnership for R&D. The performance of emerging technologies could thereby be rapidly and consequentially improved. A public-private partnership may also facilitate the attraction of capital. High costs are identified by Brown et al. (Brown, 2008) as one of the most important barriers with the broader effect and therefore, if overcome, the broader potential.

While economic structure, trade and competitiveness (at the national and international level) can hardly be influenced on the short-term, international cooperation and support by developed to developing countries may provide solutions to financial, technological and infrastructural barriers. This support should however be ruled by international agreements like the Post-Kyoto Protocol, as already discussed in subchapter 5.1. International cooperation in form of co-financing and technology transfer for the development of GHG emissions mitigation projects, like the development of renewable energies, may be a successful way to help developing countries contributing to the goal mitigation goal.

Education on climate change and its impact may further increase awareness at all levels, from the broad public to scientists. More specialised scientists in the field of climate change and all the related sciences, like for instance energy engineering, may improve the level of specialised knowledge and thus allow more precise understanding and thereby providing more accurate solutions.

Information barriers may be overcame by developing standard and centralised sample of data, thus increasing the circulation of data and information between parties. The international community could provide adequate instruments, like already the case under the UNFCCC processes.

Influencing social choices and life styles is a long-term process. The Republic of Korea wants for instance to demonstrate that developing a “Green Growth” is challenging but realisable. Fiscal incentives, like subsidies for green technologies, may contribute to accelerate the adoption of green technologies by the population. The availability of green energies at the same price than conventional ones is an example therefor.

How the international community could play a decisive role through technological and financial support is already mentioned in the previous paragraphs. The ratification of an ambitious Post-Kyoto Protocol by all UNFCCC Parties without exception as well as the establishment of nationally appropriate quantitative objectives for all UNFCCC Parties are both important steps on the road to success. A common international agreement adopted by all Parties would indeed weaken free riding incentives.

6. Proposals

GHG emissions are a very complex and global phenomenon as they are influenced by many factors: economic, political and societal ones:

GHG emissions = f (GDP; trade;
political system; institutions;
international assistance;
time)

International assistance comprises financial and technological flows (economic component) as well as international agreements (political component).

Based on this framework, the following issues are discussed in this chapter: the potential of the seven countries studied to implement any kind of NAMAS, the role of international assistance as well as the possibility to find common denominators between these countries.

Which of these countries have potential to implement any kind of NAMAs?

By already having implemented ***numerous policies*** regarding climate change mitigation (see subchapter 4.2), all the seven countries analysed have shown their willingness to participate in the global mitigation action. The seven countries have even adopted such measures without being obliged to fulfil quantitative reduction objectives, as Annex-I Parties are obliged to under the Kyoto Protocol. This reinforces the hope for a successful integration in the Post-Kyoto Agreement of non-Annex I Parties, at least advanced ones like the seven countries analysed.

Although the potential for the implementation of NAMAs is high, these countries may still not be able to reach this ambitious mitigation goal by themselves. Indeed two parameters are decisive on the way to implement policies, for instance mitigation policies: ***capability and willingness***. Capability is a question of economic capacity: are all the necessary resources available? Under all resources are financial, technological, infrastructural and human resources to be understood. Willingness, on the other hand, depends on political and institutional factors. Civil liberties may be the most influent parameter. Indeed civil societies, if well informed, may influence political decisions by putting pressure on their political leaders. The awareness of the population is thereby a critical component. NGOs could play the role of educators if they inform citizens in an honest and scientific way and not by means of propaganda. Increasing awareness of citizens may be the beginning of a wind of change, even in autocracies like the People's Republic of China.

While Chile, China and the Republic of Korea have the capability to implement NAMAs, they may still face diverse barriers (see subchapter 5.3): low awareness of the population regarding climate change and its consequences in Chile, the political system in China and the “westernisation” of the citizens of the Republic of Korea.
Mexico has also the basic capability to implement NAMAs. Financial means may however not be sufficient to cover all costs needed to battle climate change and its impact. To be noted is that Mexico is particularly vulnerable to natural catastrophes like hurricanes, which may be strongly intensified with increasing air and water temperature. While the general economic situation in Mexico is good (see subchapter 3.2), its economic growth rate is three times lower than the one of China or India and even lower than the one of Chile or Indonesia.
Regarding its economic growth rate, India disposes about a propitious basis for NAMAs. The GDP per capita is however extremely low. India has therefore a less favourable economic situation than China, but still a better one than Indonesia for example. India further

possesses technologies. The main problem in India is however the missing willingness to act based on the argument that their GHG emission per capita will never reach the one of developed countries, even when considering all possible development scenarios.
A considerable advantage of Brazil regarding renewable energies is the availability of corresponding natural resources on its territory, mostly abundant water resources. Brazil may however suffer from low civil society involvement and not so efficient institutions. The difficulty of implementing adopted policies and achieving concrete results well illustrates this political and institutional problem (see subchapter 5.3).
Indonesia presents a quite different situation than the six other countries studied. While the lack of capability in terms of financial, technological, infrastructural and human resources is not the main concern of the six countries previously mentioned, it is a considerable barrier for the implementation of NAMAs in Indonesia. The political system and the quality of the institutions may further not contribute to a successful implementation. Both economic and political difficulties may only be overcome with strong international assistance.

To be concluded is that all countries, except Indonesia, in general dispose about the necessary resources to implement NAMAs. Some specific and targeted international assistance may however be requested, as for example in Mexico. A difficulty almost faced by all the seven countries is implementing adopted policies. The transition “words/deeds” is indeed a critical step which is not always successfully passed and may therefore endanger the implementation of NAMAs.

In view of the COP15 some countries have even officially confirm their willingness to contribute to the global mitigation action by making announcements regarding their mid- and long-term emission reduction objectives: Brazil has announced a reduction of 36 to 39% below BAU by 2020, China a reduction of 40-45% by 2020 from the 2005 level, India a reduction of 20 to 25% by 2020 from the 2005 level and the Republic of Korea a reduction of 30% below BAU by 2020. These encouraging signs demonstrate the increasing willingness of developing countries to contribute to the global mitigation objective.

Which role could be played by international assistance?

Most advanced in the discussions about international assistance in developing countries are the following two barriers: ***finance and technology***. If this is valid for the least developed countries of the world, a generalisation to all developing countries may be somehow exaggerated.

Indeed the seven countries analysed within the framework of this study are all advanced developing countries. Chile, Mexico and the Republic of Korea even show some similarities with developed countries: economic and political stability, well developed legal framework, etc. China and India are two important players of the world economy, but still facing considerable development challenge like poverty eradication, health care and education. Brazil further disposes about a sufficient economic and political background. Indonesia is the only country with precarious political and economic conditions. Furthermore the seven countries, except Indonesia, all dispose about good, if not excellent technological knowledge. Lack of financial means and technologies, i.e. lack of capability, is therefore not the only explanation why more actions are not undertaken by developing countries, at least advanced developing countries.

Other dominating factors are the low awareness of the population regarding environmental issues, the lack of political willingness as well as the lack of incentives for undertaking more actions. Some efforts in this direction should be done by the international community.

Sensibilising the ***population*** to environmental issues, like climate change and its impacts, is a first important step mainly because of two reasons. The first one is that by buying goods and services, the population highly influences the economic viability of products, for instance green products. Firms produce what consumers want. If consumers want green products, firms will produce them. The second main reason is that citizens can put pressure on political leaders if they do not act in a way judged as appropriate by the population. Changing lifestyles and social choices is however a significant challenge which may take time. But despite the time it may take, this challenge is very promising. Indeed if the Chinese middle class opt for a green lifestyle for instance, it is around half of the Chinese population, i.e. around 600 millions people, who are changing their lifestyles. This may have a considerable direct impact on Chinese GHG emissions. Educating population is however a difficult task, as consumers behaviour sometimes follow subjective tracks. Educating people in non-democratic political system, like China, is a further very complicated task. Civil liberties in China are indeed estimated to be at the lowest rate possible (see subchapter 3.3). If politicians may not be willing to educate their citizens, other bodies like for example NGOs should play this role. However NGOs should do it in an honest and scientific way and not with propaganda.

One of the best ways to increase ***political willingness*** is to provide incentives for political leaders to act. Green technologies, green policies should not be seen as a constraint, but more as a chance to create new jobs, new opportunities and thereby additional economic growth.

Providing ***incentives*** to countries to mitigate their GHG emissions may happen on different ways. Some specific support may be a first way: support specific to the need of each country, like financial support for India or technological support in Indonesia. But what most advanced developing countries, like the seven ones studied, are looking for is ***recognition***: recognition for the efforts consented so far, recognition for their contribution to the global mitigation goal. China, for example, has already proved its economic capacity to the world. What they are waiting for is the corresponding prestige. The Republic of Korea also claims for international recognition of the efforts consented.

Further mechanisms like the introduction of common ***international standards*** for devices may contribute to the achievement of the global mitigation goal. The industry could thereby play a key role. Catalysers for cars may illustrate this purpose. Indeed while cars sell in the EU must afford some standards, like the obligation to possess a catalyser, cars sell in developing countries must not. Especially striking is that the same firm produce two kind of cars, for instance cars with catalysers for developed countries and cars without catalysers for developing countries. Developing countries could profit from the most advanced technologies already available in developed countries and thereby considerably win time. This is the principle of the ***leapfrogging*** concept. It makes no sense that developing countries have to research on technologies which have already been developed by developed countries. Technologies for renewable energies are for example already well developed in industrialised countries (see summary for policymakers, working group III, IPCC, 2007). The involvement of ***multi-national corporations*** in the Post-Kyoto regime may contribute to a successful technology transfer and diffusion from developed to developing countries. This way has been for example successfully passed within the framework of the Montreal Protocol, protocol regulating ozone depleting substances.

What about the possibility to establish a common framework?

Finding some common denominators between the seven countries in particular and non-Annex I Parties in general is difficult but achievable. However, these countries are so

different from another regarding their national circumstances but also their responsibility for current GHG emissions that they can not be committed to the same level and kind of actions. Barriers faced by these countries are furthermore very specific to each country. Actions and support must therefore be nationally appropriate. ***Nationally appropriate actions and support*** would consider the national circumstances of each country and also respect the important UNFCCC principle of common but differentiated responsibilities (see subchapter 5.1). While Annex I Parties all have quite similar economic and political structures, non-Annex I Parties are very different from one another, as demonstrated in chapter 3. Sources of GHG emissions furthermore strongly differ from one country to the other (see subchapter 3.2). Non-Annex I Parties are moreover not as politically and economically stable as Annex I Parties. ***Flexibility*** of actions to be undertaken by countries to achieve their mitigation goals is therefore especially important: flexibility according to the potential of each country, flexibility according to the potential of each sector.

A further decisive parameter, if not the most important one, is ***trust***. Developing countries will only accept quantitative emission reduction objectives if they feel sure that they are not going to be once more exploited by developed countries, like so often in the past. In the Asiatic culture, trust plays an even more important role. It is the key element which makes a policy maker adopting an agreement or not.

Some elements which could be part of the common framework are the following: schedule, registry, MRV system and carbon market.

A long-term emissions pathway with an assessment of when a country may reach its emissions peak, so called ***schedule***, may help gaining an overview of the situation of a country. It may also contribute to establish a long-term strategy corresponding to the foreseen evolution of GHG emissions. Furthermore it may improve transparency and comparability between countries. The difficulty may however be to find ways of comparison between the different methods used by countries. An international agreed procedure, like the one for registry for instance, may partly resolve this problem. This would however only be possible, if schedule and corresponding LCDS would be part of the post-kyoto agreement, as proposed by the EU (see subchapters 4.4 and 5.1, as well as UNFCCC, 2009b).

A further possible element of the common framework may be the ***registry***. This registry could serve as platform for all mitigation actions by developing countries. Developing countries would register the actions they intend to undertake with estimates of the costs and expected results. Developed countries would thereby be informed about the concrete needs of developing countries. This would contribute to a better match between actions by developing countries and support by developed countries.

Recognition of the actions undertaken is however only possible if there is a way to ***measure, report and verify*** (MRV) them. While common views are shared on the measurement and reporting process, the verification process is still under debate: national and/or international verification, which body responsible for which kind of NAMAs, etc. Some compromises are hereby to be reached. To be noticed is that credibility and international recognition are only possible, if a common international MRV instrument is accepted. A point which may however give rise to difficulties is for example how to compare emission reductions from sectors as different as industry and deforestation.

The ***carbon market*** could be a further part of the common framework. Indeed it provides both financial and technological support and offers at the same time a framework for mitigation actions. A further advantage is that this instrument already exists for CDM projects. If a new carbon market for NAMAs should be created or if the existing carbon market should be expanded to NAMAs, could be discussed. Utilising an existing instrument,

even if a few modifications and adaptations are necessary, allows a considerable gain of time and efficiency.

Nationally appropriate actions and support as well as flexibility should incentivise developing countries to more actions and provide them trust to engage themselves for an ambitious agreement. NAMAs is the adequate instrument to guarantee the transition between the Kyoto Protocol, where non-Annex I Parties are not committed to any quantitative emission reduction objectives, and a “post-post Kyoto Protocol” where non-Annex I Parties might be committed to the same level as Annex I Parties.

7. Conclusions

Brazil, Chile, China, India, Indonesia, Mexico and the Republic of Korea, seven countries classified as non-Annex I Parties by the UNFCCC, ***seven countries*** which are therefore not committed to any quantitative objectives under the Kyoto Protocol.
The seven countries representing together around half of the world population, one third of the world GHG emissions, one fifth of the world GDP; ***the seven countries*** all different regarding their environmental, economic, political, institutional, demographic background, but ***these seven countries*** all facing the same challenge, one of the most important challenges faced by the humanity for the 21st century if not for the following centuries: mitigating climate change.
The seven countries which hold, together with the United States of America and the European Union, the environmental destiny of the world in their hand, but which need incentives to act and also international assistance in form of financial and technological support to overcome barriers and thereby achieve this very ambitious goal in a common effort with all countries of the world.

While industrialised countries have all reach a comparable stage of development, developing countries are still very different from one another, regarding their economic, political, institutional or demographic development as demonstrated in chapter 3. Even if a common GHG emission mitigation potential may be identified, the level of action should be ***nationally appropriate*** as political and economic structures and thereby barriers are very different from a non-Annex I Party to another. Considering the diversity of these countries in determining mitigation objectives for non-Annex I Parties is a decisive step on the road to success. This point is consigned in the Bali Action Plan in paragraph 1(b)(ii) (UNFCCC, 2007) where Nationally Appropriate Mitigation Actions (NAMAs) as tool for enhanced mitigation actions by developing country Parties are proposed. Not only the level of action by non-Annex I Parties should be nationally appropriate, but also the financial and technological support they will receive from Annex I Parties according to art. 4.3, 4.5 and 4.7 of the Convention (UNFCCC, 1992). Respecting this point is also respecting principles of the Convention: equity and common but differentiated responsibilities.

Even if not committed to do so, non-Annex I Parties have already adopted ***numerous policies*** regarding GHG emissions mitigation in various sectors like energy, industry, transport and forestry, as underlined in subchapter 4.2, realised actions. They further plan to extend these policies as well as develop and implement new ones in the coming years (subchapter 4.3, projected actions). A particularly promising sector is the energy sector. Indeed the seven countries analysed like many developing countries are experiencing a massive growth in energy consumption and thereby need to considerably increase the amount of energy available. Increasing energy efficiency, expanding the production of existing energy sources and developing new ones have become priority of governments like China and India. The expansion of the energy sector is an opportunity for governments to switch to a sustainable development path by adopting renewable sources of energy and thereby to dispose about endogenous energy sources, increase their energy security and contribute to lower GHG emissions from this sector. Co-benefits generated by the energy sector may be a further chance to enhance the collaboration between private and public sectors.

Although the seven countries analysed have all taken many mitigation measures according to their national circumstances, they have not officially received ***recognition*** from the international community for the efforts consented. One instrument currently negotiated may help to bridge this gap: it is the introduction of an international ***registry*** for mitigation actions (subchapter 5.1). The Registry would serve as official internationally recognised institutional framework for NAMAs by developing countries and thereby improve transparency. The Registry would further aim at contributing to an improved match between NAMAs by

developing countries and support by developed countries. Details about the kind of actions to be registered (unilateral actions, actions receiving international support and/or actions for credits) are still under debate. To help identifying NAMAs and provide context to them, national plans in the form of low-carbon development strategies may be used as a complementary instrument.

International recognition is however non dissociable from verification processes. The idea of a verification system is introduced in the Bali Action Plan in paragraph 1(b)(ii) as part of the broader concept of ***Measurable, Reportable, Verifiable (MRV)***. Aim of the MRV process is to provide incentives for more action by increasing transparency and helping to identify barriers and gaps. To win time and efficiency, some instruments already in place under the Kyoto Protocol may thus be extended: for examples inventories as tool for measurement and national communications for reporting. If verification should be domestically or internationally realised, is essentially a political question as it raises issues of sovereignty and differentiation. For consistency purposes, NAMAs aiming at receiving international recognition should be submitted to international verification. Best suitable may thereby be a common verification process ratified by all UNFCCC Parties. To be noticed is that a common verification process does not necessarily mean that differentiation among developing and developed Parties may not take place. Compromise may be found by preferring a dual-track solution where actions supported by international entities may be internationally verified and unilateral actions domestically verified but then reported in a common instrument under the UNFCCC.

Potential for adopting ambitious mitigation policies is present in the seven countries analysed within the framework of this study. Willingness for more actions is also there, as proven by the announcements made by many countries in front of Copenhagen. Important ***barriers*** stand however on the way of national ambitious mitigation targets. The gap between “words” and “deeds”, between adopting and implementing policies, has many reasons which are country specific. For countries like Brazil, the main reason is the inefficiency of the institutions in place. For countries like Chile, it is the low awareness both at the political and civil level. For countries like China and India, it is the lack of political willingness. For Indonesia, it is the lack of financial and technological means as well as the decentralisation of the government. In Mexico insufficient financial resources are the main barrier. In the Republic of Korea the main challenge is to slow down the westernisation of lifestyles in favour of green ones.

Specific barriers, specific opportunities, specific national circumstances are all reasons why a ***flexible*** international agreement based on ***trust*** between all Parties, both non-Annex I and Annex I Parties, may be the only way to reach the UNFCCC objective of stabilising the GHG concentration at a level that would prevent dangerous anthropogenic interference with the climate system.

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