Climate Change

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02/05

ISSN 1611-8855

Options for the second commitment period of the Kyoto Protocol

Umwelt Bundes Amt

Für Mensch und Umwelt

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

Research Report 203 41 148/01
UBA-FB 000771

Climate Change
02/05
ISSN 1611-8855

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

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Telefax: +49/30/8903 2285
Internet: http://www.umweltbundesamt.de

Edited by: Section I 4.1
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Berlin, February 2005

1. Berichtsnummer UBA-FB	**2.**	**3.**

4. Titel des Berichts
„Kyoto-Protokoll: Untersuchung von Optionen für die Weiterentwicklung der Verpflichtungen für die 2. Verpflichtungsperiode“.

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Postfach 33 00 22
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8. Abschlussdatum
12. November 2004

9. Veröffentlichungsdatum

10. UFOPLAN-Nr.
203 41 148/01

11. Seitenzahl
192

12. Literaturangaben

13. Tabellen und Diagramme
36

14. Abbildungen
37

15. Zusätzliche Angaben
-/-

16. Kurzfassung
Diese Studie untersucht Optionen für die Weiterentwicklung der Verpflichtungen des Kyoto-Protokolls für die 2. Verpflichtungsperiode. Die Studie umfasst die folgenden inhaltlichen Kapitel: eine Einführung, einen Überblick über Regimevorschläge und den Aufbau eines Netzwerkes, Analyse von Länderinteressen, beispielhafte Länderstudien, einen Überblick über die zu beachtenden Themen, Optionen zur Anpassung an den Klimawandel, ein neuer Vorschlag „Common but Differentiated Convergence“, eine Überarbeitung des Triptych Ansatzes, ein umfassender Kompromissvorschlag, der Vergleich von Emissionsberechtigungen unter verschiedenen Ansätzen und eine Verhandlungsstrategie für die EU und Deutschland in den internationalen Verhandlungen.

17. Schlagwörter
Klimarahmenkonvention, UNFCCC, Kyoto-Protokoll, zukünftige Verpflichtungen, internationale Klimapolitik, Gerechtigkeitsprinzipien, Mehrstufenansatz

18. Preis	**19.**	**20.**

1. Report No. UBA-FB	**2.**	**3.**

4. Report Title
Options for the second commitment period of the Kyoto Protocol

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8. Report Date
12. November 2004

9. Publication Date

10. UFOPLAN-Ref. No.
203 41 148/01

11. No. of Pages
192

12. No. of Reference

13. No. of Tables, Diagrams
36

14. No. of Figures
37

15. Supplementary Notes
-/-

16. Abstract
This study assesses available options for the second commitment period of the Kyoto Protocol. The study includes the following sections: An introduction, an overview of proposals and establishing a network, analysis of interests of countries, selected country case studies, an overview of the issues to be considered, options for adaptation to climate change, a new approach “Common but Differentiated Convergence”, an update of the Triptych approach, a comprehensive compromise proposal, the comparison of emission allowances under various approaches and a negotiation strategy for the EU and Germany.

17. Keywords
Climate Change Convention, UNFCCC, Kyoto Protocol, future commitments, international climate policy, equity principles, multistage

18. Price	**19.**	**20.**

SUMMARY

1. Introduction

With the long awaited entry into force of the Kyoto Protocol on 16 February 2005 there is hope that the deadlock in international climate negotiations can be overcome. Still, the USA, as the largest emitter, has rejected emission reductions and developing countries will not act before industrialized countries (including the USA) have demonstrated substantial action. It is the general understanding that the first commitment period of the Kyoto Protocol is only a first step. Reaching the ultimate objective of the climate convention (UNFCCC), "to achieve … stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" is only possible, if emission reductions are intensified and participation in those reductions is broadened.

This project "Options for the second commitment period of the Kyoto Protocol" was commissioned to ECOFYS GmbH by the German Federal Environmental Agency (UBA) in June 2003. Building upon the previous ECOFYS study on "Evolution of commitments under the UNFCCC: Involving newly industrialized economies and development countries", the project aims at identifying possible options of a post 2012 commitment period of the Kyoto Protocol.

The objective of this final report thus is to provide an overview of the issues, to further develop approaches and to discuss a possible negotiation strategy related to the design of the second commitment period after 2012. The findings of this report intend to facilitate any discussion on the future of the international climate change regime.

The scope of work of the project included the following modules:

- To establish an international network of experts active in future climate change activities and post-2012 discussions and dialogues;
- To review possible options how to design a second commitment period;
- To further develop selected available approaches for a second commitment period;
- To quantify and to assess effects of approaches for selected countries and regions; and
- To provide some recommendations of how to develop a negotiating strategy for Germany and the EU.

The key findings are presented in Chapter 2 to 11 of the final report. The results of each chapter are outlined below.

2. Network and overview of proposals

The project team set up the website on "Future international action on climate change (www.fiacc.net) that serves since December 2003 as an information platform pooling information on active players discussing future international action on climate change, approaches, tools supporting quantification of future commitments, contributions and actions. An online discussion forum has been used as a platform to discuss various topics related to future action on climate change together with experts and an interested audience. The website has achieved a substantial level of interest among the climate change community and is consulted frequently by individuals to retrieve information and read about recent developments.

The online discussions included the following topics: “converging per capita emissions”, “the role of the USA and its re-engagement in climate policy debates”, “interpreting Article 2 of the Convention, dangerous anthropogenic interference with the climate system” and “costs of mitigation and its calculation by utilising Integrated Assessment Models”. 230 individuals registered and followed discussions.

The website will remain active and discussions will continue on further topics also after this project terminates, then funded by the European Commission.

3. Interest of countries

Chapter 3 identifies different expectations of selected countries or country groups towards a future international climate regime. First a detailed list of criteria was developed against which various approaches can be checked. The checklist developed differentiates between environmental criteria, economic criteria, technical/institutional criteria and political criteria.

Starting from the identified criteria, selected country perspectives (EU, USA, Advanced Developing Countries & Least Developed Countries) were then summarized (Table A) and possible areas of conflict between different groups of countries studied in greater detail.

Table A. Assessment of countries’ perceived emphasis on criteria for future climate regimes

Category of criteria Sub-criteria	EU 25	USA	Advanced developing countries (ADCs)	Least developed countries (LDCs)
Environmental criteria				
(1) Putting emphasis on environmental effectiveness	**YY**	**N**	0	Y[1]
(2) Participation of industrialized countries	Y	0	**YY**	**YY**
(3) Encouraging Early Action	Y	Y	0	0
(4) Involvement of developing countries	Y	**YY**	**N**	**N**
(5) Comprehensiveness of system	Y	Y[2]	Y	Y
(6) Avoiding leakage effects	Y	Y	?	?
(7) Avoiding unintentional “hot air”	0	0	0	0
(8) Integrating adaptation and sustainable development	0	0	**YY**	**YY**
(9) Promoting ancillary benefits	Y	0	Y	Y
Economic criteria				
(1) Minimizing negative economic effects	Y	**YY**	Y	Y
(2) Generating positive economic side effects[3]	Y	Y	Y	Y
(3) Promoting growth of developing countries	Y	0	**YY**	**YY**
(4) Stimulating technological change and providing incentives for technology spill-over	Y	**YY**	Y	Y
(5) Accounting for structural differences between countries	Y	Y	Y	Y
(6) Certainty about costs	Y	**YY**	Y	0
Technical and institutional criteria				
(1) Can build upon and use many agreed elements of the existing Kyoto system	**YY**	**N**	0	0
(2) Moderate political requirements for the negotiation process	Y	?	?	?
(3) Moderate technical requirements	Y	Y	Y	Y

Political criteria				
(1a) Meeting equity principle "Needs"	Y	Y/0[4]	**YY**	**YY**
(1b) Meeting equity principle "Capability"	Y	0	**YY**	**YY**
(1c) Meeting equity principle "Responsibility"	Y	0	**YY**	**YY**
(1d) Meeting equity principle "Equal rights"	0	**N**	Y	Y
(1e) Meeting equity principle "Comparable efforts"	**YY**	Y	Y	Y
(1f) Meeting equity principle "Sovereignty"	?	**YY**	?	?

YY: "Fulfilment of the criterion is very important for the player"
Y: "Fulfilment of the criterion is important for the player"
0: "Player is indifferent towards this criterion"
N: "Fulfilment of the criterion is not desired by the player"
?: "Position of the player is not known"
[1]: most vulnerable countries (e.g. small island states) would urge emission reductions
[2]: USA was a main proponent of 6-gas basket, probably rather to increase flexibility than to be inclusive
[3]: all countries would welcome if the regime had positive economic side effects for them.
[4]: "Y" for needs of the USA, "0" for developing countries' needs

General points of agreement can be observed. Several criteria seem to be important for all major players considered here. Such criteria should be fulfilled by any future regime; they are uncontroversial. The uncontroversial environmental criteria include the comprehensiveness of the systems, and the less important avoiding leakage effects and unintentional "hot air". Many countries would also subscribe to most of the economic criteria such as minimizing negative economic effects, generating positive economic side effects, stimulating technological change and providing incentives for technology spillover, accounting for structural differences of countries and certainty about costs. The equity principles "capability" and "comparable efforts" are also generally accepted. As long as these criteria are formulated in such general way, they are generally acceptable. But it depends on the details of the future regime, whether countries will view these criteria as fulfilled or not.

Potential conflicts lie in other criteria. Countries or country groups have different potential expectations of a future commitments regime and for some criteria views strongly oppose, a "YY" usually is opposed by a "N" in Table A. From the assessment presented, we extracted four major conflicts that need to be addressed with care in future climate negotiations (see Figure A).

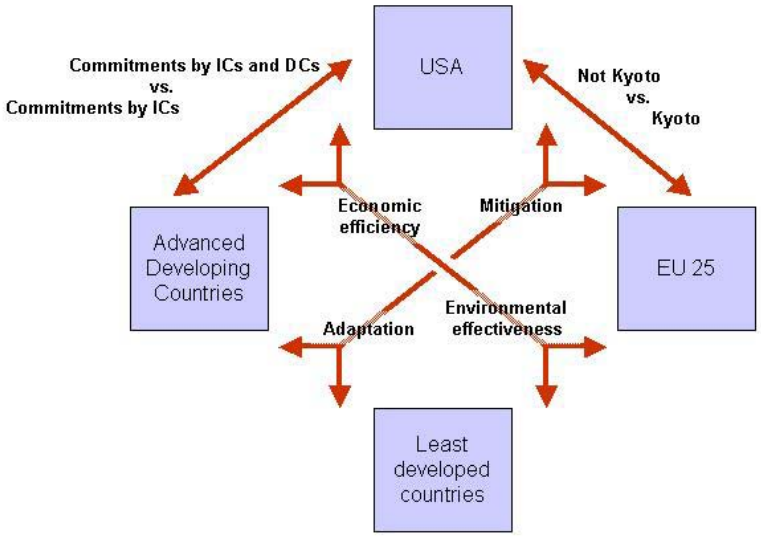


Figure A: Simplified conflict areas between selected countries / groups

Future consultations and negotiations should focus on the major conflict areas identified here. We observe that several fundamental conflicts involve only a limited group of countries. E.g. the question of using the structure of the Kyoto Protocol and to a large extent the divergence on the issue of economic efficiency versus environmental effectiveness are essentially disputes between the EU and the USA. Involvement of developing countries in a future climate regime needs agreement between the USA and advanced developing countries. This may point towards a strategy that these major conflicts are addressed first between the players most concerned.

Another observation is that individual countries within the group of developing countries have very diverse and often conflicting positions. For example, the group of developing countries is split on the issue of economic efficiency and environmental effectiveness. Least developed countries would opt for stringent global emission reduction efforts, while advanced developing countries would (and currently do) resist this. The way the group of developing countries operates would be an important element to consider for the negotiation strategy.

4. Country Case Studies

Following the criteria analysis and assessment of how selected countries and country groups would position themselves towards these criteria, a closer look was taken at some countries namely Mexico, India, China and the USA to study their implemented climate policies, their emission profiles and projections, vulnerability and key incentives to participate in a climate regime. In terms of incentives for participation in future climate change regimes the following observations can be made:

Mexico has demonstrated a positive position towards combating climate change. Two conditions were informally mentioned by Mexico's government under which it would be willing to support further actions on climate change. First, future actions on climate change would need to be explicitly linked to visible progress by industrialized countries to reduce emissions. This could be achieved by making a "condition for action by developing countries" that the global average per capita emissions or global average emission intensity decreases. Second, further action is taken through a broadened CDM, which could be applied to sectors and policies.

There are two major forces outside the climate regime that could influence Mexico's participation on future action on climate change. One is its global commitment as an OECD country and the other one is the future negotiation to continue with NAFTA and the EU-Mexico treaty.

India had a very clear and strong position and has played a very active role right at the beginning of the negotiation process by e.g. being a spokesperson for the G77/China. India has stated that emissions will grow as the country seeks to expand its economic growth. India thus has a position that no further commitments are accepted until developed countries have demonstrated to take the lead in combating climate change.

At COP8 in New Delhi 2002, Prime Minister Vajpayee described the call for developing country commitments "misplaced" and said that the only equitable form for the future would be one based on equal per capita rights. A per-capita approach, where emission levels from different countries converge at a common per capita level, is the preferred approach, since India's per-capita emissions are only one third of the world's average. Due to India's current firm position on future commitments, it is difficult to believe that it will accept any absolute emission target in the near term. Choosing an approach that clearly incorporates the element of per-capita emissions could open the door for possible acceptance by India.

Nevertheless, based on how AIJ issues developed in India and its priority for economic growth, the position may change. If India perceives that taking a commitment could contribute to economic growth, it would be open to change its position.

China is experiencing a remarkable growth in GDP (9% in 2003). The short and medium-term, China takes economic development as its top priority. The severe environmental problems and

unfavourable energy resource endowment are forcing China to take some measures to maintain its economic growth, including encouraging energy saving, the use of clean energy and supporting the development of energy efficiency and renewable energy.

Even without external pressure and support, China has some initiative to improve its energy utilization efficiency, a side effect of its various related measures and policies.

China has played an important role in G77/China and takes a proactive attitude towards the global efforts for climate change control. However, it reiterates that as a developing country, its should focus on economic development and reducing the number of people living in poverty and not be subject to binding emission reduction obligations under world climate change framework.

As expressed in the National Coordination Committee for Climate Change's paper on global climate change (June 2001), China's position remains one where developed countries should take the lead in combating climate change. These countries have been responsible for the bulk of emissions to date and a large disparity in per capita emissions continues to this day. Developing countries, like China, must be able to increase their emissions to meet their social and developmental needs. As the paper concludes, "*the attempt to impose emission reduction or limitation obligations on developing countries is neither fair nor realistic and is in breach of the basic principles of the Convention.*"

China may only be convinced to take further action, if the obligation is perceived as not capping economic growth or being economically beneficial for China. Increased participation in the CDM could generate revenues. "Positively binding" or "no lose targets" could be applied that allow the sale of excess emission credits, if the target is overachieved but that imply no penalty if not achieved. Or rate based targets (e.g. as a function of kWh or tonne of steel produced) could take away the fear of capping economic growth.

The USA takes a unique position with respect to engagement on future climate change actions. American policy on climate change is less consistent and is greatly influenced by the flavour of the ruling administration.

Presidential candidate John Kerry recently commented that "because of the Bush Administration's inaction, the binding targets set in the Kyoto Protocol are no longer achievable;" he would therefore "immediately reengage the international process [that would lead to] a strong, effective, and meaningful international agreement."

Notwithstanding this issue, there remains an interesting option in engaging the US in a more multilateral approach to greenhouse gas mitigation through the involvement of individual states. There is a history of states taking the lead in environmental policies (such as the Regional Clean Air Incentives Market operating in Southern California and the US Clean Air Act), which in turn become matters of federal concern. Individual states have also been pressing the Bush Administration to regulate emissions of greenhouse gases. State action has a tendency to replicate itself across other states and could form the catalyst to building sufficient political will in establishing a mandatory national greenhouse gas policy. Given the recent defeat of the Lieberman-McCain bill to cap greenhouse gas emissions within the USA by a narrow margin of 55 to 43, a "bottom-up" approach could well serve as the catalyst to ensure federal acceptance of a more active international role in greenhouse gas mitigation efforts.

5. Issues to be considered

Issues to be considered to design a full international regime on climate change are discussed in Chapter 5, summarized here in Figure B. In the chapter, for each issue the proposed options are presented and discussed.

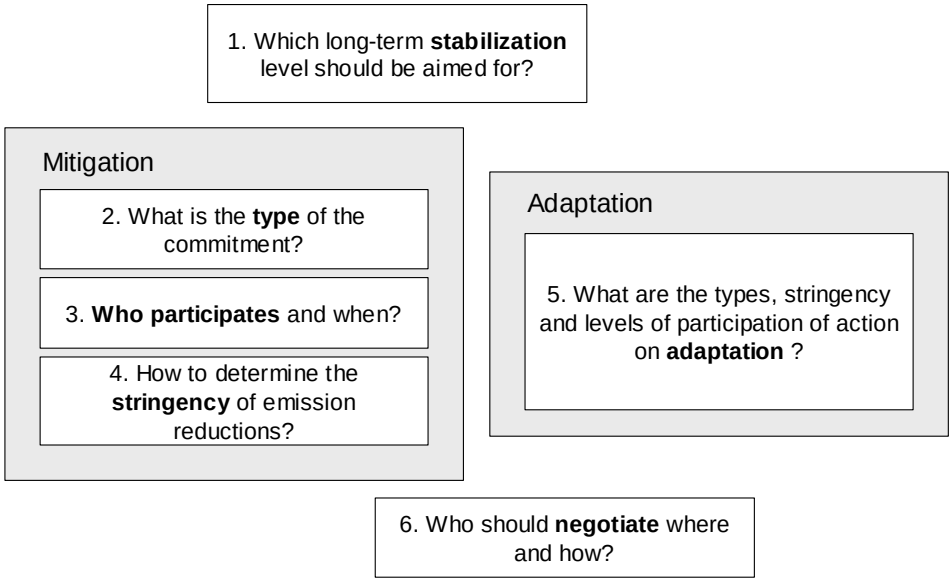


Figure B. Overview of issues to be addressed

The final conclusion drawn from the analysis is that the negotiations on future international action on climate change will be very complex and have to be conducted on many dimensions. The issues are diverse and inter-linked. However, the large number of options can be broken down into the categories such as those discussed above. Most proposals on future international actions on climate change cover different elements and are therefore difficult to compare. Such division into separate issues can be useful for categorizing and discussing the isolated options and proposals.

6. Adaptation

Adaptation to climate change is one of the key issues of concern for developing countries, who perceive that although much is being done in the way of mitigation for addressing the climate change issue, adaptation has received insufficient attention.

Despite of the recognition that adaptation is a major key to a solution to the problem of climate change and the impasse of the negotiations, concrete steps to incorporate ‘adaptation’ in the international climate negotiations are still very rare.

We identified the following possible actions to advance discussion on adaptation that could be further discussed at the policy level (Table B).

Table B: Summary of possible actions to advance adaptation

Category	Action	Committed actors	Commitment	Forum
Anticipatory of expected changes	Implementing first adaptation projects identified in NAPAs* and national communications	Annex II countries	Provide co-funding	UNFCCC
Damage repair, restoration and compensation	Designing insurance schemes	Developed country governments	Provide guarantees	UNFCCC possibly ISDR**
	Mainstreaming adaptation into international disaster relief	Developed country governments	Provide co-funding	ISDR
Enhancement of adaptive capacity	Mainstreaming adaptation into sustainable development efforts	Developed country governments	Commit a percentage of GDP for climate change related development aid	To be discussed
		Developing country governments	Commit to include adaptation into their sustainable development strategies	

*: National adaptation programmes of action
**: United Nations International Strategy for Disaster Reduction

Adaptation covers a broad range of considerations from immediate measures against expected changes in climate via strengthening adaptive capacity (i.e. development) to damage repair and compensation.

Many of these issues are broader than what the UNFCCC regime could cover. Of the four options presented above the most powerful ones are likely to be the mainstreaming adaptation into development and disaster relief. But the effective implementation would occur outside of the UNFCCC regime. As a consequence a separate adaptation protocol under the UNFCCC may not seem adequate. The issues are too broad to be covered only under the UNFCCC. In addition, it could distract attention from the urgent need to address mitigation.

On the other hand, the issue of damage repair and restoration is clearly a matter related to climate change and the UNFCCC. Within the UNFCCC regime, narrowly defined adaptation projects could be implemented through the available funds. In addition, a clear commitment of developed countries could be voiced to support adaptation activities outside of the UNFCCC.

7. Common but differentiated convergence

Within the framework of the project, we developed a new approach called “Common but Differentiated Convergence” approach (CDC). With the CDC approach we have provided a new concept for an international climate regime. On the one hand it could be acceptable to a wider range of countries and on the other hand it could ensure stabilization of greenhouse gas concentrations. It is based on the principle that Annex I countries’ per capita emissions converge within several decades to a low level. Individual non-Annex I countries also converge to the same level within the same time period years but starting when their per capita emissions are a certain percentage above global average. Until then they may voluntarily take on “positively binding” targets.

This approach is almost as simple as the Contraction & Convergence (C&C) approach but eliminates two concerns often voiced in relation to C&C: Under CDC, advanced developing

countries start reducing emissions at a later point in time compared to Annex I countries (see Figure C). In addition, CDC avoids the political problems related to the resource sharing concept and financial transfers, because it does not provide excess emission allowances to low emission countries as C&C does. It thus might be more acceptable to major developing countries than C&C and possibly also the USA (taking into account that the current administration of the USA is very reluctant to agree to any proposal on further international action on climate change).

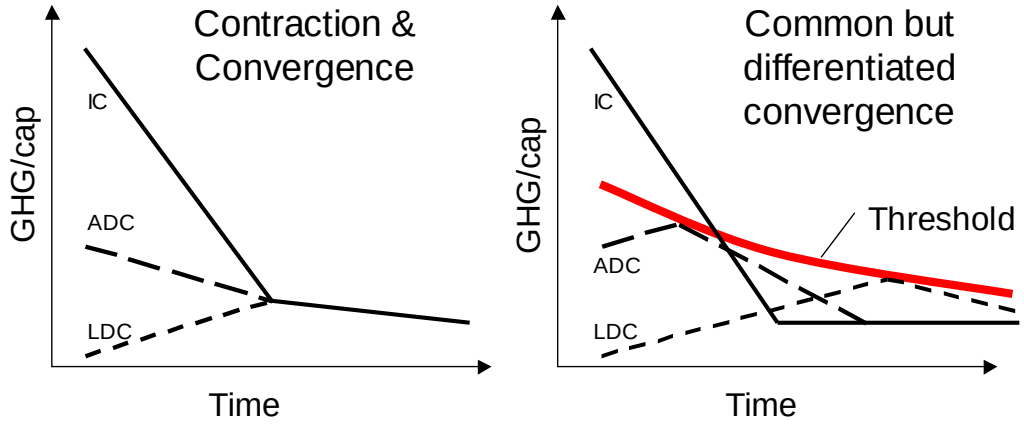


Figure C. Schematic representation of greenhouse gas emissions per capita for three countries (an industrialized country (IC), an advanced developing country (ADC) and a least developed country (LDC)) under Contraction & Convergence (left) and under Common but Differentiated Convergence (right)

With quantifying the resulting emission allowances, we have shown that with the CDC approach stabilization at 550 CO_2eq. and 650 CO_2eq. in 2100 and 2150 can be reached with participation threshold at roughly 0% and 50% above global average and a convergence level of around 3 and 4.5 tCO_2eq./cap within 40 years.

It is recognized that under the CDC approach, additional mechanisms have to be implemented that can accommodate the need for vulnerable developing countries to adapt to climate change.

We think that the global community will probably adopt a climate regime in step-by-step decisions, the rules will not be fixed for the next century. Even if the CDC approach is not implemented in its entirety, we strongly believe that these step-by-step decisions can be guided by the principles provided in the CDC approach: That developed countries per capita emissions converge and that developing countries do the same but delayed and conditional to developed country action.

8. Triptych Version 6.0

On the basis of a review of earlier version of the Triptych approach, we developed a new version of the approach, Version 6.0.

The Triptych approach is a method to share emission allowances among a group of countries, taking into account main differences in national circumstances between countries that are relevant to emissions and emission reduction potentials. The Triptych approach as such does not define, which countries should participate. It was originally developed as an approach to share emission allowances for the first commitment period under the Kyoto Protocol within the European Union.

In the original Triptych approach, three broad categories of emissions were distinguished: The power sector, the group of energy-intensive industries and the 'domestic' sectors. The selection of these categories was based on a number of differences in national circumstances raised in the negotiations: differences in standard of living, in fuel mix for the generation of electricity, in economic structure and the competitiveness of internationally-oriented industries. For each of the categories a reasonable amount of emission allowances is calculated by applying a defined set of rules to all countries. The allowances for each category are added up to a national target for each country. Only one national target per country is proposed, no sectoral targets, to allow countries the flexibility to pursue any cost-effective emission reduction strategy.

The main differences between the Triptych version 6.0 and the previous Triptych versions are:

- The harmonised data set and clear data hierarchy based on the IPCC SRES scenarios
- Calculation on the basis of 192 individual countries
- The (possibility of) inclusion of the 6 Kyoto gases and sinks
- Expansion to 2050 (and beyond)
- Variable base year between 1990 and 2010
- The use of normative but scenario-derived growth rates for electricity demand and industrial production based on GDP per capita levels

Resulting emission allowances under the Triptych approach for an example setting aiming at stabilization at 450 ppmv CO_2 are provided Figure D and Figure E

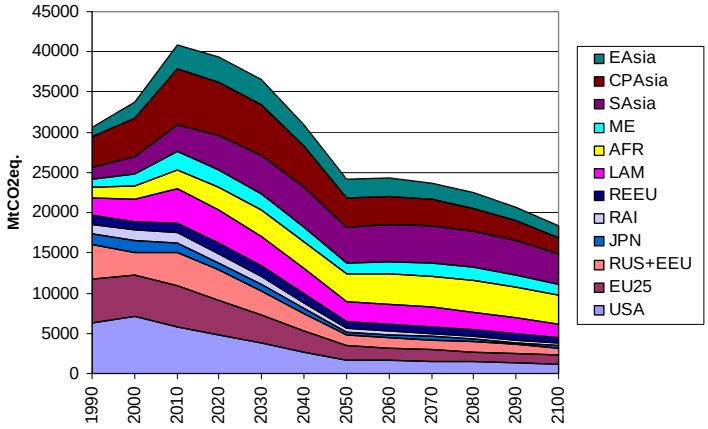


Figure D. Regional emissions under the Triptych approach for the A1B scenario for the 450 ppmv CO_2 case

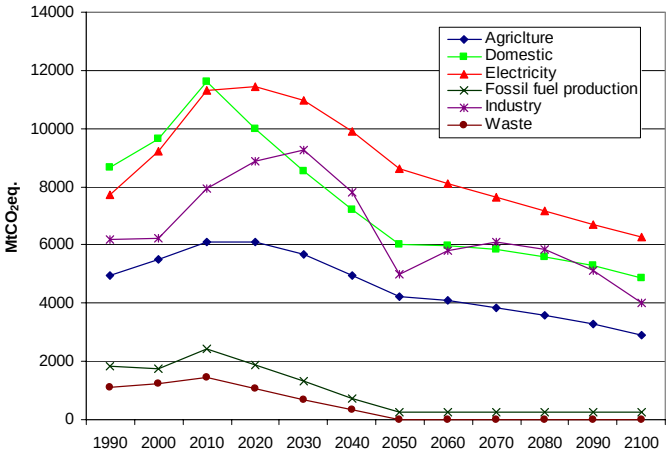


Figure E. Global sectoral emissions under the Triptych approach for the A1B scenario for the 450 ppmv CO_2 case

The Triptych approach (here described in its Version 6.0) is the most sophisticated approach to share emission allowances between countries based on sectoral considerations. It can be applied globally to all countries or to any subset of countries. An earlier version has already been applied successfully within the EU, when sharing the Kyoto targets for individual countries within the EU.

Due to the sectoral detail, it accommodates many national circumstances and concerns of many countries: Countries that rely on coal today may further use coal, but have to increase their efficiency. Countries that rely on the export of energy intensive goods may continue to produce those, but have to improve their efficiency. The general standard of living and individual consumption would converge.

Stabilization at 450 ppmvCO_2 or 550 ppmvCO_2 requires global emission growth to come to a halt. Consequently, the Triptych parameters have to be set in a relatively stringent way to leave room for production growth. Applying this approach leads to substantial reduction requirements for the industrialised countries, in particular those countries with carbon intensive industries such as in Central and Eastern Europe and the Russian Federation. In contrast, substantial emission increases are allowed for most developing countries, however, mostly below their reference scenarios.

The Triptych has several strengths: It is able to consider and accommodate national circumstances. It explicitly allows for incorporating economic growth and improving efficiency in developing countries. It has been successfully applied (on EU level) as a basis for negotiating targets.

On the other hand weaknesses exist: The approach in itself is rather complex and requires many separate decisions, requires much data on a sectoral level and may therefore be perceived as not transparent. In addition, projections of production growth rates for heavy industry and electricity are required. An agreement on all these issues on a global level may be difficult.

In sharing emission allowances, there is a general conflict of being simple and not able to accommodate many national circumstances and concerns (e.g. converging per capita emissions) on the one hand and being sophisticated and able to accommodate them on the other hand. The Triptych approach clearly belongs to the more sophisticated methods. The experience with sharing the EU Kyoto target among member states EU has shown, that also complex solutions can be the basis for an agreement. Hence, the Triptych approach can also in

the future provide the basis for the sharing of emission allowances between countries within a group.

9. A compromise proposal

Within this project, we developed a compromise proposal that combines many elements of the approaches previously discussed. This proposal aims to satisfy most demands and concerns, while still being able to meet the anticipated environmental goal. We believe that this overall concept could be a possible way forward in the multilateral international climate policy.

Reaching stabilisation targets such as 2°C will only be possible, if all considerable efforts are made on many levels to reduce emissions in industrialized countries and to keep emissions low in developing countries. Hence, the compromise proposal consist of four parts:

1. Multistage agreement on emission reductions
2. New technology development and implementation
3. Agreement on adaptation
4. Additional emission reduction efforts

The multistage setting would include 4 stages:

Stage 1- No commitments: Countries with low level of development do not have climate commitments. At least all least developed countries (LDCs) would be in this stage.

Stage 2 - Enhanced sustainable development: At the next stage, countries commit in a clear way to sustainable development. The environmental objectives are built into the development policies. Requirements for such a sustainable pathway could be defined, e.g., that inefficient equipment is phased out and requirements and certain standards are met for any new equipment or a clear deviation from the current policies depending on the countries. The implementation of such sustainable development pathway has to be monitored and verified. The additional costs could be borne by the country itself or by other countries, e.g. official development aid supplemented by additional climate related funds.

Stage 3 - Moderate absolute target: Countries commit to a moderate target for absolute emissions. The emission level may be increasing, but should be below a business as usual scenario. The target could also be positively binding, meaning that allowances can be sold, if the target is exceeded, but no allowances have to be bought, if the target is not achieved. An incentive to accept such target would be the possibility to participate in emissions trading.

Stage 4 - Absolute reduction: Countries in stage 4 have to reduce absolute emissions substantially until a low per-capita level is reached. As time progresses, more and more countries enter stage 4.

Countries move through these stages based on defined thresholds, e.g. their level of emissions per capita. Since “followers do better” (they benefit from technological developments of others), the threshold for entering the last group decreases with time.

In addition to immediate emission reductions, countries need to commit to develop and to implement new greenhouse gas mitigation technologies in a clearer sense as already with the Convention and the Kyoto Protocol (Part 2 of the compromise proposal). When negotiating the absolute emission reduction commitments, countries will be given the opportunity to make a commitment to technology development and its implementation and diffusion. They can expect a relaxation of their absolute emission reduction commitments in return. Of course, the verifiability of the technology commitment is crucial as not to create a loophole for being exempt from emission reactions.

We quantified the emission allowances for exemplary cases. Figure F shows the emission allowances under the Multistage agreement for the A1B scenario aiming at approximately 450 ppmv CO_2 concentration. Table C shows the likely date of entry into the different stages aiming

at 450 ppmv in the long term. Numbers represent the stage, averaged over six cases, one for each IPCC scenario. For regions, the population-weighted average is given.

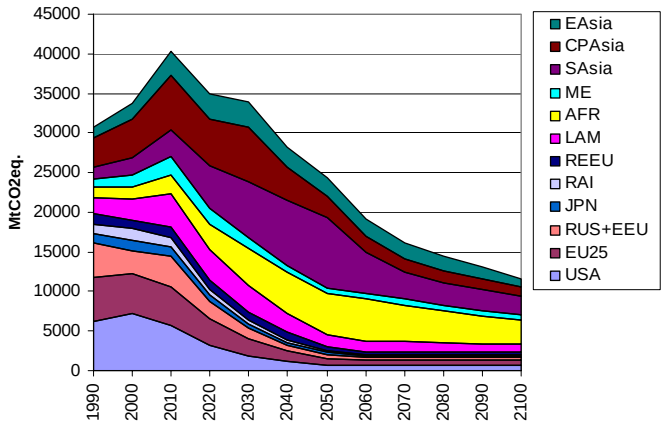


Figure F. Emission allowances under the Multistage approach for the A1B scenario aiming at approximately 450 ppmv CO_2 concentration

Table C. Likely date of entry into the different stages aiming at 450 ppmv in the long term. Numbers represent the stage, averaged over six cases, one for each IPCC scenario. For regions, the population-weighted average is given.

	2020	2030	2040	2050	2060	2070	2080	2090	2100
Annex I	4.0	4.0	4.0	4.0	4.1	4.9	5.0	5.0	5.0
Rest of Eastern Europe	2.6	3.2	3.4	3.4	3.6	4.1	4.2	4.3	4.3
Argentina	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
Brazil	3.0	3.0	3.8	4.0	4.2	5.0	5.0	5.0	5.0
Mexico	3.0	3.8	3.8	3.8	4.3	4.8	5.0	5.0	5.0
Venezuela	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
Rest of Latin America	2.4	2.7	2.8	3.2	3.2	3.5	3.8	3.9	4.0
Egypt	1.8	2.0	2.8	3.3	3.7	3.8	4.7	4.8	5.0
South Africa	3.0	4.0	4.0	4.0	4.7	5.0	5.0	5.0	5.0
Nigeria	1.0	1.0	1.7	2.0	2.5	3.3	3.7	4.3	4.7
Rest of North Africa	2.2	2.3	2.8	3.4	3.4	3.9	4.0	4.1	4.2
Rest of Africa	1.1	1.2	1.4	1.6	1.9	2.2	2.4	2.7	3.0
Saudi Arabia	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
United Arab Emirates	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
Rest of Middle East	2.8	3.4	3.4	3.6	3.9	4.4	4.5	4.5	4.5
China	3.0	3.0	3.2	3.7	3.7	4.2	4.7	5.0	5.0
India	1.0	1.5	2.0	2.3	3.2	3.3	3.8	4.0	4.3
Indonesia	1.0	1.7	2.0	2.3	2.3	2.5	2.7	3.0	3.7
South Korea	3.0	4.0	4.0	4.0	4.2	4.5	5.0	5.0	5.0
Malaysia	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
Philippines	1.0	1.0	1.5	1.7	1.8	1.8	1.8	2.3	2.8
Singapore	3.0	4.0	4.0	4.0	4.2	4.7	5.0	5.0	5.0
Thailand	3.0	3.2	3.7	3.8	4.2	4.8	5.0	5.0	5.0
Rest of Asia	1.2	1.3	1.5	1.7	1.7	1.8	1.9	2.1	2.3

Note: “Stage 5” denotes the state, where a country has reached a very low per capita emission level and does reduce emissions further.

The compromise proposal has several strengths:

- The proposal is designed as a compromise to accommodate many different viewpoints on specific issues and to satisfy multiple demands. Many countries or country groups can find elements of their concern in this proposal.
- The proposal allows for a gradual phase-in of countries in the mandatory emission reduction effort, which is in line with the UNFCCC spirit, and takes into account national circumstances (esp. if Triptych is chosen as the burden sharing concept for stage 4).
- The proposal allows flexibility to implement immediate emission reduction measures or to develop technologies that are able to reduce emissions in the future.
- The proposal allows for gradual decision making, which seems the most likely way of reaching an international agreement.
- The proposal builds trust, as industrialised countries take the lead in emission reduction efforts.

The proposal however has some weaknesses:

- The overall proposal describes a relative complex system that requires many decisions.
- The risk that countries enter too late in the emission reduction effort is high, so that some long-term stabilization options may be lost. Hence, incentives are needed for countries to participate in a certain stage, not just thresholds. The flexibility provided for countries in stage 3 and/or 4 to take a commitment in technology development while receiving a reduction of their commitment of absolute emissions in return adds additional uncertainty on the global emission levels.

Critical in this setting would be the participation of the USA. Their current point of view can be incorporated through the commitment for technology development. Here the USA would have to demonstrate serious actions for the development of new technologies. In return, the USA could receive a relatively moderate emission reduction target.

10. Comparison of Emission Allowances

A comparison of emission allowances under the various approaches addressed in previous chapters (Contraction and Convergence, Common but differentiated convergence, Multistage and Triptych) was developed. For the comparison we use the Evolution of Commitments Model (EVOC), which includes emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 for 192 individual countries.

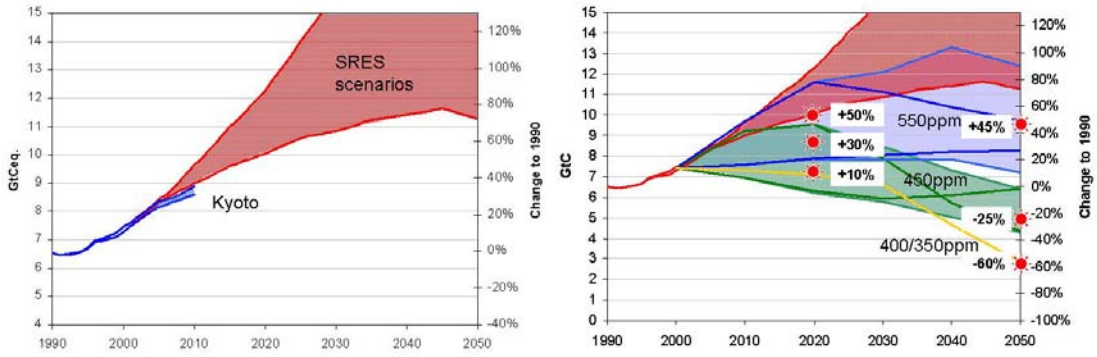


Figure G. Possible CO_2 emission pathways until 2050

We selected global emission levels in 2020 and 2050, which have to be met by all approaches for the following quantification of emission allowances for the various proposals. These are taken from Figure G to be in line with 550 ppmv CO_2 (roughly 650 ppmv CO_2eq.), 450 ppmv CO_2 (roughly ppmv 550 CO_2eq.) and towards 400 ppmv (roughly 450 ppmv CO_2eq).

Figure H provides the change in emissions from 1990 to 2020 and 2050 under the various approaches aiming at 450 ppmv CO_2 concentration. Error bars show the spread using different reference scenarios.

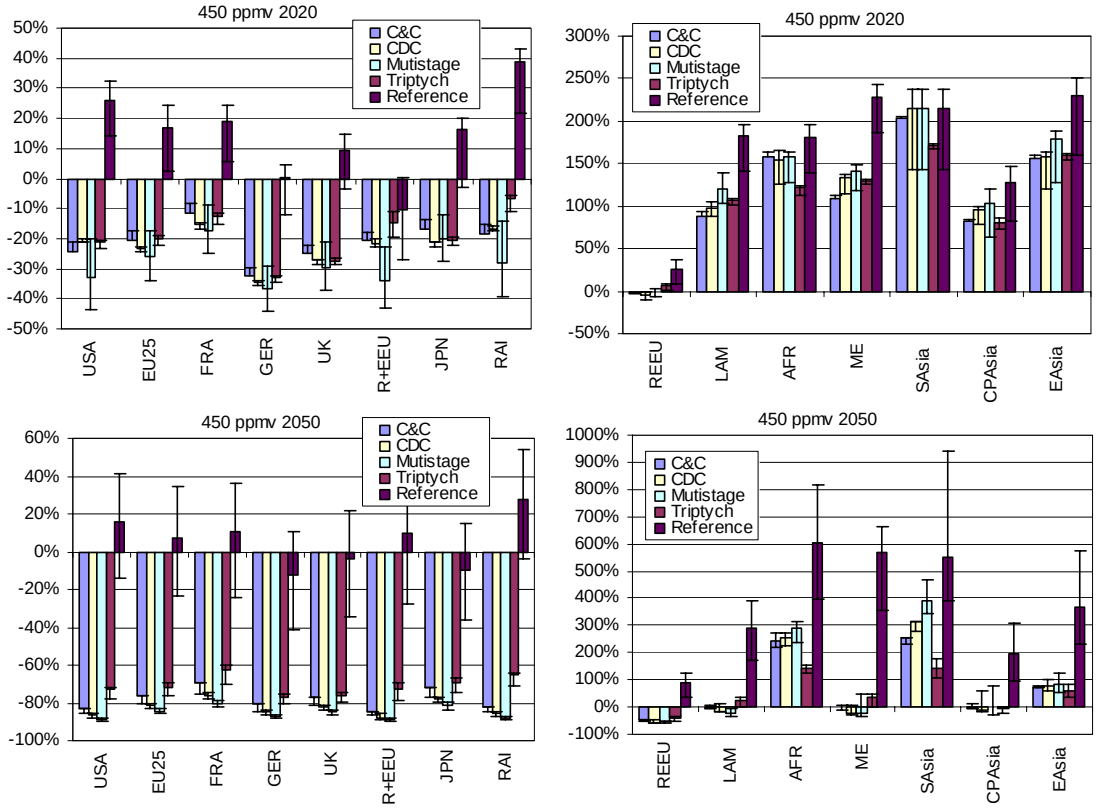


Figure H. Change in emissions from 1990 to 2020 and 2050 under various approaches aiming at 450 ppmv CO_2 concentration. Error bars show the spread using different reference scenarios

From the analysis we draw the following conclusions:

- To ensure that the EU target of a maximum increase of 2°C above pre-industrial levels is kept within reach, stabilization of CO_2 concentration below 450 ppmv has to be aimed for (according to current knowledge and medium climate sensitivity).
- If no efforts are made to reduce emissions and if the Kyoto Protocol is not implemented, there is a significant probability that the option of 450 ppmv CO_2 would be out of reach already as of 2020.
- To keep 450 ppmv CO_2 within reach, developed country emissions would need to be reduced substantially. For the exemplary global emission levels leading to stabilization and for the parameters of the approach chosen here, Annex I countries would need to reduce emissions in the order of -20% below 1990 levels in 2020 to aim at 450 ppmv CO_2. For 550 ppmv CO_2 it would be roughly -15%, and for 400 ppmv CO_2 roughly -35%. These values are significantly influenced by the ambition level set for Non-Annex I

countries. Almost all approaches leave room to alter this balance by varying some of the parameters.

- To keep 450 ppmv CO_2 within reach, the USA needs to be involved in the system most likely with stronger action than the national target of 18% intensity improvement. As this target can lead to US emissions 20% above 1990 levels in 2010, the ambitious reduction levels given above for the group of Annex I may be out of reach. For 550 ppmv, the US national target may be sufficient, if other Annex I countries would undertake more ambitious reductions.
- To keep 450 ppmv CO_2 within reach, developing country emissions need to deviate from the reference as soon as possible, for some countries even as of 2020 (Latin America, Middle East, East Asia). For 550 ppmv CO_2 it would be less, for 400 ppmv CO_2 more countries. Actions from Annex I countries, such as technology transfer or financial contributions would be needed to keep emissions in Non-Annex I countries below their reference.
- For most countries, the difference in reductions between stabilization targets (400, 450 and 550 ppmv) is larger than the difference between the various approaches aiming at one stabilization target. The choice of the long-term ambition is more significant than the choice of the approach.
- National long-term emission targets of individual countries of the EU are ambitious, but differ in which stabilization levels could be reached.

The reductions that are necessary to reach are summarized in Table D.

Table D. Difference between emissions in 1990 and emission allowances in 2020/2050 for various CO_2 concentration levels.

		2020	2050
400 ppmv CO_2	**Global***	+10%	-60%
	Annex I	-25% to -50%	-80% to -90%
	Non-Annex I	Substantial deviation from reference in Latin America, Middle East, East Asia and Centrally planned Asia	Substantial deviation from reference in all regions
450 ppmv CO_2	**Global***	+30%	-25%
	Annex I	-10% to -30%	-70% to –90%
	Non-Annex I	Deviation from reference in Latin America, Middle East, East Asia and Centrally Planned Asia	Substantial deviation from reference in all regions
550 ppmv CO_2	**Global***	+50%	+45%
	Annex I	-5% to -25%	-40% to –80%
	Non-Annex I	Deviation from reference in Latin America and Middle East, East Asia	Deviation from reference in most regions, specially in Latin America and Middle East

*: Global reduction values are chose to represent one possible path towards the given stabilization level. Other global emission levels in 2020 and 2050 would be possible to reach the same stabilization levels and their choice would influence the necessary reductions for the country groups.

11. Negotiation Strategy

Based on the results of the preceding analysis, elements and various aspects of a strategy to negotiating a future climate regime post 2012 were analysed from the viewpoint of the European Union.

To meet the EU's long-term goal that "global average temperatures should not exceed 2 degrees Celsius above pre-industrial levels", serious efforts are required on multiple levels. Negotiations within the UNFCCC have to be supplemented by agreements on renewable energy, technology in general and development cooperation. In addition, capacity building for developing countries and support for the scientific community is needed.

In this effort, EU leadership is crucial. Directional leadership (meeting the Kyoto targets, predominantly domestically), instrumental leadership (actively building coalitions) and structural leadership (making use of the general and economic weight of the EU) are needed.

The EU could be more aware of the weight it can have as a major trading or political block, and not hesitate to link the climate change issue to other issues, such as trade relations and foreign relations.

The USA needs to be in the focus of EU efforts. An expanding EU emission trading system can be complementary to the UNFCCC / Kyoto Protocol. This expanding system may include US States, providing a lever to future involvement of the US at a federal level after harmonisation.

Further, the dialogue with developing countries should be intensified. The EU should concentrate on those countries within the G77 and China that have shown first actions and would be eager to further extend actions provided the framework is acceptable. The goal must be to find ways to formulate targets that are acceptable for active developing countries to date. The EU could promote approaches that facilitate the participation of developing countries, such as a multistage setting with first targets for developing countries that avoid capping economic growth or the Triptych approach.

Within the UNFCCC process, the following sequence of decisions could be aimed at:

- Further definition of the long-term ambition level, as it is crucial for the stringency of short-term reductions and the timing of participation of further countries
- Agreement on types of commitments (e.g. binding emission targets or policies and measures), including an indication when they should be assumed and by whom
- Definition of the accounting or monitoring rules for these types of commitment
- Agreement on target values (reduction percentages or specific policies)

A key to break the deadlock could be to agree already in a mandate for the negotiations on future commitments at COP 11 in November 2005, which types of commitments will be taken by various groups of countries and when, e.g. binding emission limitation and reduction targets for all developed countries together with sustainable development oriented or non-binding targets for most developed countries for 2020 but binding targets in 2030. Giving it a long-term but defined perspective may increase the acceptability for all countries.

In addition, the efforts complementary to the UNFCCC, such as the coalition and the targets on renewable energy, should be further enhanced.

Finally, the EU should be instrumental in bringing scientists together on the future climate policy. An international scientific conference on the future climate policy would be an opportunity for the exchange of the divergent views on the most effective and efficient long-term climate policy. In addition, the elaboration and quantification of side benefits of emission reduction measures could be an important tool to reduce the reluctance against climate policies in the international negotiations.

Meeting the 2°C target is a major challenge. We would hope that the array of activities presented in this strategy will help the EU in meeting this challenge.

ZUSAMMENFASSUNG

1. Einleitung

Mit dem lange erwarteten In-Kraft-Treten des Kyoto-Protokolls am 16. Februar 2005 besteht Hoffnung, dass die Blockade der internationalen Klimaverhandlungen aufgehoben werden könnte. Die USA als weltweit größter Emittent lehnen jedoch weiterhin verbindliche Emissionsreduktionen ab. Entwicklungsländer werden nicht agieren, bevor Industriestaaten (inklusive der USA) nicht erhebliche Emissionsreduktionen nachgewiesen haben. Die Erreichung der Zielsetzung der Klimarahmenkonvention (UNFCCC), die Stabilisierung der Treibhausgaskonzentration in der Atmosphäre auf einem Niveau zu erreichen, welches eine gefährliche anthropogene Störung des Klimasystems vermeidet, ist nur möglich, wenn die Emissionsreduktionen weiter intensiviert und eine Beteiligung an Reduktionsmaßnahmen in größerer Breite erreicht wird.

Die Bearbeitung des Projekts: „Kyoto-Protokoll: Untersuchung von Optionen für die Weiterentwicklung der Verpflichtungen für die 2. Verpflichtungsperiode“ wurde vom deutschen Umweltbundesamt (UBA) an die ECOFYS GmbH im Juni 2003 vergeben. Die vorliegende Studie baut auf der ECOFYS Studie: „Weiterentwicklung der Verpflichtungen des UNFCCC: Einbeziehung von Schwellenländern und Entwicklungsländern“ auf und hat zum Ziel, Möglichkeiten der Ausgestaltung einer weiteren Verpflichtungsperiode Kyoto-Protokolls ab dem Jahr 2012 aufzuzeigen.

Der vorliegende Endbericht gibt einen Überblick über die Themen, die im Zusammenhang mit der Weiterentwicklung von bestehenden Ansätzen stehen. Außerdem zeigt der Bericht eine mögliche Strategie für die Verhandlung einer zweiten Verpflichtungsperiode nach 2012 auf. Die Ergebnisse dieses Berichtes sollen die laufenden Diskussionen um ein zukünftiges Klimaregime unterstützen.

Die im Rahmen dieses Projekts vorgenommenen Untersuchungen beinhalteten die folgenden Module:

- Aufbau eines internationalen Netzwerks von Experten, die aktiv zum Thema eines zukünftigen Klimaregimes arbeiten und an Post-2012 Diskussionen und Dialogprozessen teilnehmen,
- Durchsicht möglicher und derzeit diskutierter Optionen zur Ausgestaltung einer zweiten Verpflichtungsperiode,
- Weiterentwicklung ausgewählter Ansätze für eine zweite Verpflichtungsperiode,
- Quantifizierung und Einschätzung der Auswirkungen verschiedener Ansätze für ausgewählte Länder und Regionen und
- Entwicklung einer Verhandlungsstrategie für Deutschland und die EU.

Die Ergebnisse sind in diesem Endbericht in Kapitel 2 bis 11 detailliert dargestellt. Die wesentlichen Ergebnisse der einzelnen Kapitel sind im nachfolgenden kurz zusammen gefasst.

2. Netzwerk und Überblick über Vorschläge

Das Projektteam hat eine Webseite **„**Future international action on climate change“ (www.fiacc.net) entwickelt, die seit Dezember 2003 als Informationsplattform genutzt werden kann. Über die Webseite sind Informationen zu aktiv beteiligten Experten und Organisationen, die sich mit der Diskussion zur zukünftigen internationalen Weiterentwicklung des Klimaschutzes beschäftigen, bereitgestellt. Außerdem werden einzelne Ansätze erläutert und Unterstützungshilfen zur Quantifizierung weiterer Verpflichtungen und Handlungen angeboten. Eine Online-Diskussionsplattform wurde bereitgestellt und für die Diskussion verschiedener

Themen unter Experten genutzt. Alle Diskussionen waren öffentlich. Die Webseite hat seit dem Start im Dezember 2003 beachtliche Aufmerksamkeit unter Verhandlungsexperten und anderen Interessierten gefunden, insbesondere Personen, die sich über neue Entwicklungen zu diesem Thema informieren wollen bzw. nach Informationen suchen.

Diskussionen wurden zu den folgenden Themen durchgeführt: “Konvergierende Pro-Kopf Emissionen“, „die Rolle der USA und Möglichkeiten zur konstruktiven Wiedereinbeziehung in die Klimaverhandlungen“, „Interpretation von Artikel 2 der Klimarahmenkonvention hinsichtlich gefährlicher anthropogener Störungen des Klimasystems“ und „Vermeidungskosten und ihre Quantifizierung und Berechnung durch Integrierte Bewertungsmodelle“. Insgesamt registrierten sich 230 Personen im Zeitraum Dezember 2003 bis Mai 2004 und verfolgten die Diskussionen bzw. nahmen aktiv an ihnen teil.

Die Webseite wird auch nach Ende des Projekts weiter betrieben. Eine weitere Aktualisierung der Seite sowie weitere Diskussionen können Dank einer Weiterfinanzierung durch die Europäische Kommission gewährleistet werden.

3. Interessen einzelner Gruppen

In Kapitel 3 werden Erwartungen ausgewählter Länder bzw. Ländergruppen hinsichtlich eines zukünftigen internationalen Klimaregimes untersucht. Zunächst wurde eine detaillierte Kriterienliste entwickelt, an Hand derer verschiedene Ansätze geprüft werden können. Die Checkliste unterscheidet zwischen Umweltkriterien, ökonomischen Kriterien, technischen/ institutionellen Kriterien und politischen Kriterien.

Von diesen Kriterien ausgehend wurden anschließend ausgewählte Länderperspektiven (EU, USA, fortgeschrittene Entwicklungsländer, am wenigsten entwickelte Länder) zusammengefasst (siehe Tabelle A). Mögliche Konfliktbereiche zwischen den betrachteten Ländern bzw. Ländergruppen wurde herausgearbeitet und näher untersucht.

Tabelle A. Einschätzung der ausgewählten Länder bzw. Ländergruppen hinsichtlich der wahrgenommenen Gewichtung von Kriterien eines zukünftigen Klimaregimes

Kategorie des Kriteriums **Unterkriterium**	**EU 25**	**USA**	**Fortgeschrittene Entwicklungsländer**	**Am wenigsten entwickelte Länder**
Umweltkriterien				
(1) Betonung auf Umweltwirksamkeit	**YY**	**N**	0	Y[1]
(2) Beteiligung industrialisierter Länder	Y	0	**YY**	**YY**
(3) Unterstützung frühzeitigen Handelns (early action)	Y	Y	0	0
(4) Einbeziehung von Entwicklungsländern	Y	**YY**	N	N
(5) Vollständigkeit des Systems	Y	Y[2]	Y	Y
(6) Vermeidung der Erhöhung von Emissionen andernorts (leakage)	Y	Y	?	?
(7) Vermeidung unbeabsichtigter Überallokation von Emissionsrechten (hot air)	0	0	0	0
(8) Integration von ‚Anpassungsmaßnahmen an den Klimawandel’ und ‚nachhaltiger Entwicklung’	0	0	**YY**	**YY**
(9) Förderung von positiven Nebeneffekten	Y	0	Y	Y
Ökonomische Kriterien				

Kategorie des Kriteriums **Unterkriterium**	**EU 25**	**USA**	**Fortgeschrittene Entwicklungsländer**	**Am wenigsten entwickelte Länder**
(1) Minimierung negativer ökonomischer Auswirkungen	Y	**YY**	Y	Y
(2) Erzeugung positiver ökonomischer Nebeneffekte[3]	Y	Y	Y	Y
(3) Förderung von Wachstum in Entwicklungsländern	Y	0	**YY**	**YY**
(4) Förderung von Technologieinnovation und Schaffung von Anreizen zur Übertragung technologischer Fortschritte in andere Länder	Y	**YY**	Y	Y
(5) Berücksichtigung struktureller Unterschiede zwischen Ländern	Y	Y	Y	Y
(6) Kostensicherheit	Y	**YY**	Y	0
Technische und institutionelle Kriterien				
(1) System kann viele bereits vereinbarte Elemente des Kyoto-Protokolls nutzen bzw. auf diesen aufbauen	**YY**	**N**	0	0
(2) Moderate politische Anforderungen für den Verhandlungsprozess	Y	?	?	?
(3) Moderate technische Anforderungen	Y	Y	Y	Y
Politische Kriterien				
(1a) Erfüllt das Gerechtigkeits-prinzip "Bedürfnisse" (Needs)	Y	Y/0[4]	**YY**	**YY**
(1b) Erfüllt das Gerechtigkeits-prinzip "Leistungsfähigkeit" (Capability)	Y	0	**YY**	**YY**
(1c) Erfüllt das Gerechtigkeits-prinzip "Verantwortlichkeit" (Responsibility)	Y	0	**YY**	**YY**
(1d) Erfüllt das Gerechtigkeits-prinzip "Gleiche Rechte" (Equal rights)	0	**N**	Y	Y
(1e) Erfüllt das Gerechtigkeits-prinzip "Vergleichbare Anstrengungen" (Comparable efforts)	**YY**	Y	Y	Y
(1f) Erfüllt das Gerechtigkeits - prinzip "Souveränität" (Sovereignty)	?	**YY**	?	?

YY: "Erfüllung des Kriteriums ist sehr wichtig für Akteur"
Y: "Erfüllung des Kriteriums ist wichtig für Akteur"
0: "Akteur ist Kriterium gegenüber eher gleichgültig eingestellt"
N: "Erfüllung des Kriteriums ist vom Akteur nicht erwünscht"
?: "die Position des Akteurs ist nicht bekannt"

[1]: Am meisten vom Klimawandel betroffene Länder (z.B. kleine Inselstaaten) würden auf weitere Emissionsreduktionen drängen

[2]: USA war Hauptbefürworter der Einbeziehung aller 6 Kyoto Gase, wahrscheinlich eher um die Flexibilität als die Vollständigkeit des Systems zu erhöhen

[3]: Alle Länder würden es begrüßen, wenn das Regime positive ökonomische Nebeneffekte für sie bieten würde

[4]: "Y" für die "Bedürfnisse" der USA, "0" für die "Bedürfnisse" von Entwicklungsländern

Generelle Übereinstimmungen können beobachtet werden: Einzelne Kriterien scheinen für alle hier betrachteten Akteure gleichermaßen wichtig zu sein. Solche Kriterien sollten in jedem Fall von einem zukünftigen Regime erfüllt werden. Diese Kriterien rufen keinerlei Widerspruch bzw. Probleme hervor. Zu den unverfänglichen Umweltkriterien gehören: der Systemumfang sowie die eher weniger wichtigen Kriterien „Vermeidung der Erhöhung von Emissionen andernorts (leakage)“ und unbeabsichtigte Überallokation von Emissionsrechten. Viele Länder würden ebenfalls die meisten der hier genannten ökonomischen Kriterien befürworten, wie z.B. das Minimieren negativer ökonomischer Effekte, die Entstehung positiver ökonomischer Nebeneffekte, die Förderung von Technologieinnovation, Anreize zur Übertragung des technologischen Fortschritts auf andere Länder, die Beachtung struktureller Unterschiede von Ländern sowie Kostensicherheit. Die Gerechtigkeitsprinzipien „Leistungsfähigkeit“ und „vergleichbare Anstrengungen“ stellen ebenfalls allgemein akzeptierte Kriterien dar. Solange diese Kriterien derart allgemein formuliert werden, scheinen sie generell akzeptierbar. Es hängt jedoch wesentlich von den Details eines zukünftigen Regimes ab, ob einzelne Länder diese Kriterien als erfüllt oder als nicht erfüllt ansehen.

Konfliktpotenzial äußert sich eher in anderen Kriterien. Länder bzw. Ländergruppen haben unterschiedliche Erwartungen hinsichtlich eines zukünftigen Verpflichtungsregimes. Für einige Kriterien gibt es besonders unterschiedliche Wahrnehmungen. Eine „YY“ Wahrnehmung eines bestimmten Kriteriums wird von einem anderen Akteur als „N“ wahrgenommen (siehe Tabelle A). Innerhalb der identifizierten Kriterien haben wir insgesamt vier Konfliktbereiche herausgegriffen, die unbedingt und mit aller Sorgfalt in zukünftigen Klimaverhandlungen angegangen werden müssen (siehe Abbildung A).

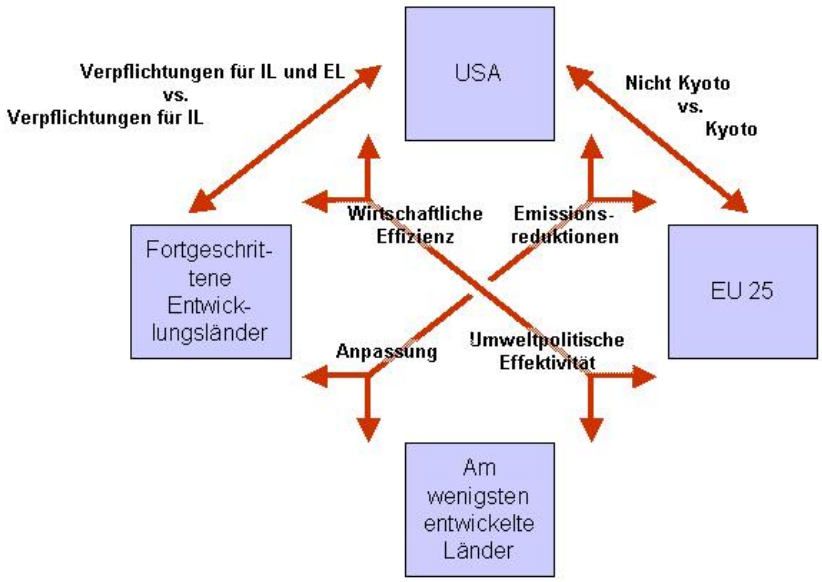


Abbildung A: Vereinfachte Darstellung der wesentlichsten Konfliktbereiche zwischen ausgewählten Ländern und Ländergruppen

Zukünftige Verhandlungen müssen auf die hier herausgearbeiteten Konfliktbereiche fokussiert werden. Die zukünftige Nutzung der Struktur des Kyoto-Protokolls sowie die Erreichung größtmöglicher Umweltwirksamkeit im Vergleich zur Sicherung wirtschaftlicher Effizienz sind Themen mit dem größten Konfliktpotenzial zwischen den Akteuren EU und USA. Die Integration von Entwicklungsländern in ein zukünftiges Klimaregime ruft nach einer Einigung besonders zwischen den USA und den fortgeschrittenen Entwicklungsländern. Es scheint angeraten, dass eine Verhandlungsstrategie diese wesentlichen Konflikte unter den betroffenen Akteuren als erstes behandelt.

Weiterhin nehmen bestimmte Länder innerhalb der Gruppe der Entwicklungsländer divergierende Positionen ein. Beispielsweise ist die Gruppe der Entwicklungsländer hinsichtlich der Erreichung größtmöglicher Umweltwirksamkeit und ökonomischer Effizienz des Systems stark gespalten. Die am wenigsten entwickelten Länder würden für stringente Anforderungen hinsichtlich globaler Emissionsreduktionen stimmen, während fortschrittliche Entwicklungsländer sich dem (und das tun sie bereits) widersetzten würden. Annahmen, wie die Gruppe der Entwicklungsländer agieren wird, sind ein wichtiges Element für die Entwicklung einer Verhandlungsstrategie.

4. Länderstudien

An die Kriterienanalyse schließt sich eine Untersuchung ausgewählter Länder hinsichtlich ihrer Position zu den diskutierten Kriterien an. Für die Länder Mexiko, Indien, China und die USA wurden bereits in Kraft getretene nationale Klimaschutzstrategien, ihre Emissionsprofile und zukünftige Emissionsentwicklungen untersucht, ihre Anfälligkeit gegenüber dem Klimawandel eingeschätzt und Anreize herausgearbeitet, unter welchen diese Länder in einem zukünftigen Klimaregime teilnehmen könnten. Hinsichtlich der Anreize zur Teilnahme an einem zukünftigen Klimaregime können folgende Beobachtungen gemacht werden.

Mexiko ist dem Thema ‘Bekämpfung des Klimawandels’ positiv eingestellt. Informellen Angaben zufolge hat die mexikanische Regierung zwei Bedingungen genannt, unter denen sie bereit wäre, weitere Anstrengungen gegen den Klimawandel zu unternehmen. Erstens würden solche weiterführenden Verpflichtungen seitens Mexiko nur dann übernommen, wenn sichtbare Emissionsminderungen von Industriestaaten erkennbar sind. Das könnte beispielsweise erreicht werden, indem man für Entwicklungsländer als Handlungsvoraussetzung vereinbart, dass die globalen, durchschnittlichen Pro-Kopf-Emissionen oder die Emissionsintensität sinken. Zweitens wäre eine Zusammenarbeit im Rahmen eines ausgeweiteten CDM denkbar, der auf bestimmte Sektoren und Politikbereiche angewendet werden könnte.

Außerhalb der Klimaverhandlungen gibt es zwei nicht zu unterschätzende Querbezüge hinsichtlich einer Teilnahme Mexikos an einer zukünftigen Klimaschutzkooperation: Einerseits wäre dies Mexikos weltweite Verpflichtung als Mitglied in der OECD und zum anderen weiterführende Verhandlungen mit der NAFTA und dem EU-Mexiko Vertrag.

Indien nimmt eine sehr klare Position ein und hat als Sprecher für die Gruppe G77/China eine sehr aktive Rolle seit Beginn der Verhandlungen gespielt. Indien hat frühzeitig klargestellt, dass die Emissionen im Land weiter steigen werden, da Indien sein wirtschaftliches Wachstum weiter verstärken will. Indien wird keine zukünftigen Verpflichtungen akzeptieren, bevor Industriestaaten nicht klar erkennen lassen, dass sie eine führende Rolle in der Bekämpfung des Klimawandels übernehmen.

Während der 8. Vertragsstaatenkonferenz (COP8) in New Delhi im Jahr 2002, äußerte sich der Premierminister Vajpayee, dass der Ruf nach Verpflichtungen für Entwicklungsländer unangebracht sei und erklärte, dass der einzig als gerecht erachtete, zukünftige Ansatz ein solcher sei, der auf Pro-Kopf-Emissionsrechten basiere. Ein Pro-Kopf-Ansatz, nach dem die länderspezifischen Pro-Kopf-Emissionen gegen einen vereinbarten Pro-Kopf-Emissionswert in der Zukunft konvergieren, wäre der bevorzugte Ansatz, da Indiens gegenwärtige Pro-Kopf-Emissionen nur bei rund einem Drittel des Weltdurchschnitts liegen. Wegen Indiens starker Positionierung hinsichtlich weiterer Verpflichtungen kann derzeit kaum davon ausgegangen werden, dass Indien in naher Zukunft absolute Emissionsminderungsziele akzeptieren wird. Ein Vorschlag, der Elemente eines Pro-Kopf-Ansatzes enthält, könnte Türöffner sein, um eine mögliche Zustimmung Indiens zu einem weiterführenden Klimaregime zu gewährleisten.

Aus der Erfahrung im Zusammenhang mit der indischen Position zu AIJ (Activities Implemented Jointly) und einer generellen Priorität für wirtschaftliches Wachstum, könnte sich diese Position jedoch auch ändern, wenn Indiens Verpflichtungen als ein Vehikel für wirtschaftliches Wachstum verstanden werden. Unter solchen Voraussetzungen wäre das Land bereit, seine Position zu überdenken und zu ändern.

China befindet sich derzeit in einem enormen wirtschaftlichen Wachstumsprozess (das Bruttoinlandsprodukt stieg um 9% im Jahr 2003). Ernstzunehmende Umweltprobleme und eine unvorteilhafte Ausstattung an Energieressourcen zwingen China, Maßnahmen zu ergreifen, die weiteren wirtschaftlichen Aufschwung ermöglichen. Dies umfasst z.B. vermehrte Anstrengungen hinsichtlich Energieeinsparungen, die Nutzung sauberer Energieformen sowie die Entwicklung effizienterer und erneuerbarer Energietechnologie.

Auch ohne äußere Einflusse in Form von politischem Druck oder durch äußere Unterstützung gibt es in China verschiedene Initiativen, die Energienutzungseffizienz zu erhöhen. Dies ist ein Nebeneffekt von Maßnahmen und Politiken, die auf Ziele wie Energiesicherheit und Gesundheitsschutz gerichtet sind.

China hat in der Gruppe G77/China eine wichtige Rolle während der Verhandlungen gespielt und nimmt hinsichtlich der weltweiten Anstrengungen für eine bekämpfung des Klimawandels allgemein eine proaktive Rolle ein. Allerdings wiederholte China als Entwicklungsland, dass es die wirtschaftliche Entwicklung und Armutsbekämpfung nicht den verbindlichen Emissionsreduktionen eines weltweiten Klimaregimes unterordnen werde.

Gemäß eines durch das Nationale Koordinationskomitee für Klimawandel vorgelegten Berichts (Juni 2001) sollten entwickelte Staaten weiterhin die Führung in der Bekämpfung des Klimawandels übernehmen. Diese Länder seien heute für einen Großteil der Emissionen verantwortlich und die Pro-Kopf-Emissionen weisen weiterhin ein großes Ungleichgewicht zwischen Industrie- und Entwicklungsländern auf. Entwicklungsländer wie China müssen in der Lage sein, ihre Emissionen zu erhöhen, um soziale und entwicklungspolitische Ziele zu erreichen. Der vorgelegte Bericht schließt mit der Bemerkung, „dass der Versuch, Entwicklungsländern Emissionsreduktionen oder Emissionsbegrenzungen aufzuerlegen weder fair noch realistisch ist und im Widerstreit mit den Grundprinzipien der Konvention liegt“.

China könnte von zukünftigen Aktionen nur überzeugt werden, wenn die Auflage so verstanden wird, dass sie wirtschaftliches Wachstum nicht beschränkt oder sogar ökonomisch von Vorteil für China wäre. Vermehrte Teilnahme im CDM könnte Einkünfte generieren. „Positiv bindende Ziele“ könnten angewendet werden, damit der Verkauf überschüssiger Emissionsrechte ermöglicht werden kann, sollten die Ziele übererfüllt werden. Solche Ziele sollten bei Nichterfüllung jedoch keine Strafen nach sich ziehen. Ziele wie z.B. pro erzeugte Menge Strom (CO_2 pro kWh) oder bezogen auf eine Tonne produzierten Stahls könnten ebenfalls akzeptiert werden und den Bedenken und Wahrnehmungen einer Begrenzung des wirtschaftlichen Wachstums entgegenwirken.

Die USA nehmen unter den hier diskutierten Ländern eine besondere Stellung bezüglich weiterer Klimaschutzmaßnahmen ein. Die amerikanische Klimaschutzpolitik ist wenig konsistent und stark vom jeweiligen Präsidenten abhängig.

Präsidentschaftskandidat John Kerry hatte kürzlich bemerkt, „dass auf Grund der Untätigkeit von Bush’s Administration, die im Kyoto-Protokoll festgeschriebenen Ziele nicht mehr erreichbar seinen.“ Er würde sich dagegen „sofort für den internationalen Prozess einsetzen, der zu strengen, effektiven und bedeutsamen internationalen Vereinbarungen führt“.

Dessen ungeachtet besteht eine attraktive Möglichkeit, die USA über einzelne Bundesstaaten für einen multilateralen Ansatz zur Treibhausgasreduktion zu gewinnen und einzubinden. Einige Staaten sind seit einiger Zeit aktiv und nehmen eine führende Rolle in der Verabschiedung und Umsetzung umweltpolitischer Vereinbarungen ein, z.B. über den regionalen „Clean Air Initiative Market“ für das südliche Kalifornien und den „US Clean Air Act“. Diese Themen können auf die US-Bundesebene gehoben werden. Einige Staaten haben auf die Bush-Regierung bereits Druck ausgeübt, die Emission von Treibhausgasen zu regulieren. Aktivitäten auf Ebene der Bundesstaaten haben eine Tendenz, sich auf andere Staaten auszudehnen und können somit zum Katalysator werden, den notwendigen politischen Willen zu erzeugen und darauf aufbauend eine verpflichtende nationale Klimagesetzgebung anzustoßen. Da der Liebermann-McCain Gesetzentwurf, der vorsieht, Treibhausgasemissionen in den USA zu beschränken, zunächst gescheitert ist, könnte ein „von unten nach oben“ Ansatz als Katalysator dienen, sich

zunächst die Akzeptanz der einzelnen Bundesstaaten hinsichtlich einer zunehmend aktiveren Rolle bei Emissionsreduktionen zu sichern.

5. Wichtige Themen

Um ein vollständiges und internationales Regime gegen den Klimawandel zu etablieren, müssen einige Themen besonders beachtet werden. Diese Themen werden in Kapitel 5 diskutiert und sind hier in Abbildung B zusammengefasst. Für jedes dieser Themen werden Möglichkeiten einer Ausgestaltung vorgeschlagen und diskutiert.

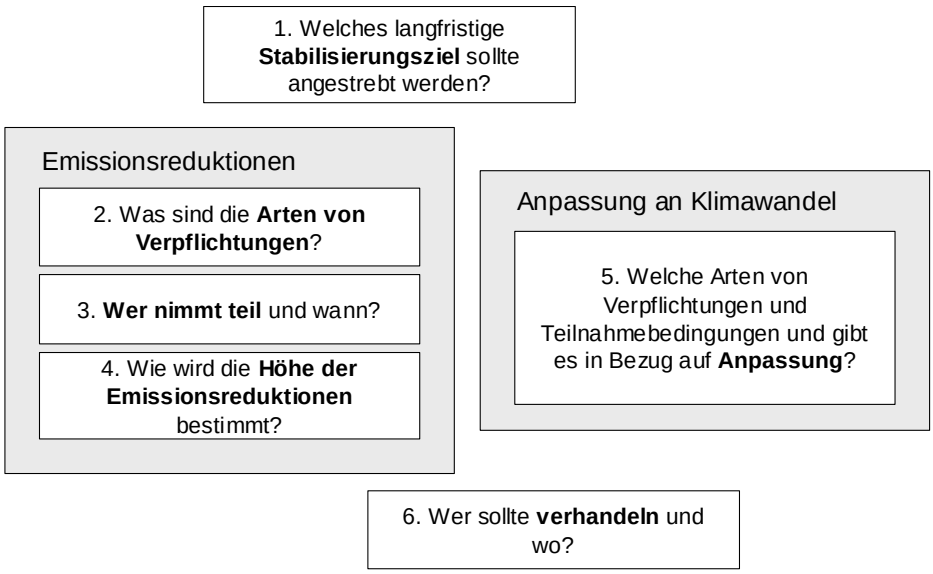


Abbildung B: Überblick über wesentliche Themen

Die Analyse zeigt, dass die Verhandlungen zukünftiger internationaler Klimaschutzaktivitäten sehr komplex sein werden und viele unterschiedliche Dimensionen annehmen. Darüber hinaus ist die Vielzahl der Themen miteinander verknüpft. Die Zahl in Frage kommender Optionen kann in die oben diskutierten Kategorien untergliedert werden. Die meisten Ansätze zur Ausgestaltung zukünftiger Aktionen gegen den Klimawandel integrieren verschiedene Elemente und sind aus diesem Grund schwer miteinander vergleichbar. Eine solche Teilung in Themen kann jedoch hilfreich sein, auch eher isolierte Optionen und Vorschläge einzuordnen und zu diskutieren.

6. Anpassung an den Klimawandel

Anpassung an den Klimawandel ist ein Schlüsselthema für Entwicklungsländer. Obwohl derzeit viele Maßnahmen in Richtung Emissionsminderung implementiert werden, um das Klimaproblem anzugehen, wurde dem Thema Anpassung an den Klimawandel bisher unzureichende Aufmerksamkeit gewidmet.

Trotz der verbreiteten Auffassung, dass Anpassung an den Klimawandel in gewissem Umfang unvermeidlich sein wird und dass die gegenwärtigen Verhandlungen ohne Fortschritte in dieser Hinsicht ausweglos scheinen, wurden bisher kaum konkrete Schritte vorgeschlagen, wie ‚Anpassung' in das internationale Klimaregime integriert werden könnte.

Wir haben folgende mögliche Aktivitäten identifiziert, durch die Diskussionen zum Thema ‚Anpassung' auf politischer Ebene angestossen werden könnten (Tabelle B).

Tabelle B: Zusammenfassung möglicher Optionen, die Anstrengungen zum Thema ‚Anpassung and den Klimawandel ' auszuweiten

Kategorie	Aktion	Verpflichteter Akteur	Verpflichtung	Forum
Vorausschauend erwarteter Veränderungen	Implementierung erster, in den NAPAs* und Nationalen Berichterstattungen identifizierter Anpassungsprojekte	Annex II Länder	Teilfinanzierung bereitstellen	UNFCCC
Schadenswiedergutmachung, Wiederaufbau, und Ausgleichsmaßnahmen	Entwicklung von Versicherungssystemen	Regierungen der entwickelten Länder	Sicherheiten bereitstellen	UNFCCC eventuell auch ISDR**
	Integration von Anpassung in internationale Schadensbekämpfung	Regierungen der entwickelten Länder	Teilfinanzierung bereitstellen	ISDR
Erhöhung der Anpassungskapazität	Integration von 'Anpassung' in Anstrengungen einer nachhaltigen Entwicklung	Regierungen der entwickelten Länder	Einen bestimmten Prozentsatz des Bruttoinlandsprodukts für klimabezogene Entwicklungshilfe bereitstellen	Offen, muss noch diskutiert werden
		Regierungen der Entwicklungsländer	Verpflichtung, 'Anpassung' in Entwicklungsstrategien zu integrieren	

*: National adaptation programmes of action, nationale Anpassungsaktionsprogramme
**: United Nations International Strategy for Disaster Reduction, Internationale Strategie zur Reduktion von Desastern der Vereinten Nationen

'Anpassung' beinhaltet eine große Bandbreite von Möglichkeiten: sofortige Maßnahmen gegen Klimaveränderungen durch Stärkung der Anpassungskapazität (z.B. Entwicklungszusammenarbeit) bis hin zu Schadenswiedergutmachung und anderen Kompensationsmechanismen.

Viele dieser Themen sind weiter gefasst, als es von der Klimarahmenkonvention abgedeckt werden könnte. Von den hier präsentierten vier Möglichkeiten scheint die zunehmende Integration von Anpassungsfragen in entwicklungspolitische Entscheidungen und Katastrophenschutz bzw. Katastrophenfürsorge die sinnvollste zu sein. Die Implementierung würde außerhalb des UNFCCC Regimes erfolgen. Ein separates ‚Protokoll zur Anpassung' unter der UNFCCC scheint nicht angebracht zu sein. Eine zu prominente Integration des Themas in die weiteren Beratungen unter der Klimarahmenkonvention könnte von der Minderung von Treibhausgasemissionen ablenken.

Andererseits ist das Thema Schadensbekämpfung und Wiederaufbau ein Thema, das eindeutig mit dem Klimawandel und damit der UNFCCC verknüpft ist. Innerhalb des UNFCCC Regimes könnten klar abgegrenzte Projekte zur Anpassung an den Klimawandel aus Anpassungsfonds implementiert werden. Zusätzlich sollten entwickelte Länder sich klar dazu bekennen, Anpassungsmaßnahmen auch außerhalb der UNFCCC zu unterstützen.

7. Gemeinsame, aber zeitlich unterschiedliche Konvergenz (CDC Ansatz)

Im Rahmen dieses Projekts haben wir einen neuen Ansatz ‚Gemeinsame, aber zeitlich unterschiedliche Konvergenz' (englisch: Common but differentiated convergence, CDC)

entwickelt. Mit dem CDC Ansatz wird ein weiterer Vorschlag für ein internationales Klimaregime unterbreitet. Einerseits könnte dieser Ansatz für einen weiten Kreis von Ländern akzeptabel sein, andererseits aber auch die Stabilisierung von Treibhausgaskonzentrationen gewährleisten. Der Ansatz basiert auf dem Prinzip, dass Pro-Kopf Emissionen der Annex I Staaten während der nächsten Jahrzehnte auf ein niedriges Niveau sinken müssen. Die Pro-Kopf-Emissionen der Nicht-Annex-I-Staaten konvergieren gegen diesen Wert innerhalb einer gleich langen Periode, beginnen ihre Reduktionen aber erst zu einem späteren Zeitpunkt. Der Beginn der Reduktion der Pro-Kopf Emissionen erfolgt erst dann, wenn diese einen bestimmten Prozentsatz des (sich im Zeitverlauf durch die Minderungen in Annex-I-Staaten verringernden) Weltdurchschnitts überschreiten. Bis zu diesem Zeitpunkt gelten für diese Länder freiwillige, ‚positiv bindende Ziele' vereinbaren.

Dieser Ansatz ist fast so einfach wie „Contraction & Convergence" (C&C) beseitigt aber zwei Nachteile, die oft im Zusammenhang mit C&C aufgeführt werden. Im CDC-Ansatz beginnen fortgeschrittene Entwicklungsländer mit ihren Emissionsrektionen zu einem späteren Zeitpunkt als Annex I Länder (siehe Abbildung C). Außerdem vermeidet der CDC-Ansatz politische Probleme, die mit dem Konzept der Ressourcenteilung und dem Kostentransfer verknüpft sind, denn der Ansatz bietet keine überschüssigen Emissionsberechtigungen wie das beim C&C-Ansatz der Fall ist. Aus diesen Gründen wäre ein solcher Ansatz im Vergleich zum C&C Ansatz akzeptabler für die größten Entwicklungsländer. Auch den USA kommt dieser Ansatz dadurch entgegen.

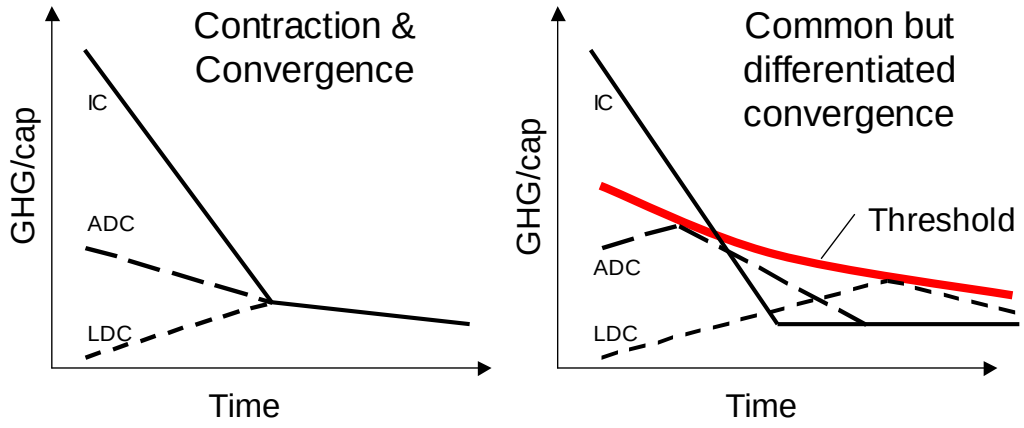


Abbildung C: Schematische Darstellung der Pro-Kopf-Treibhausgasemissionen für drei Länder (industrialisiertes Land (IC), fortschrittliches Entwicklungsland (ADC) und ein am wenigsten entwickeltes Land (LDC)) unter Contraction & Convergence (links) und unter Common but Differentiated Convergence (rechts)

Mit der Quantifizierung resultierender Emissionsberechtigungen zeigen wir, welche Konsequenzen für die jeweiligen Emissionsrechte mit dem CDC-Ansatz mit einer Stabilisierung auf dem Niveau 550 CO_2-Äquivalente und 650 ppm CO_2-Äquivalente im Jahr 2100 bzw. 2150 verbunden sind, wobei ein Schwellwert für eine Beteiligung zu etwa 0% und 50% über dem Weltdurchschnitt und eine Konvergenz auf etwa 3 und 4,5 t CO_2-Äquivalente/Kopf in 40 Jahren angenommen wird.

Unter dem CDC-Ansatz müssen zusätzliche Maßnahmen implementiert werden, die Anpassung besonders vom Klimawandel betroffener Entwicklungsländer betreffen.

Wir erwarten, dass die Weltgemeinsaft das Klimaregime auf Basis schrittweiser Entscheidungen weiterentwickeln wird. Die Regeln werden jetzt nicht für das nächste Jahrhundert fest vereinbart und verankert werden. Auch wenn demnach der CDC-Ansatz nicht in seiner Vollständigkeit

implementiert wird, so könnten die schrittweisen Entscheidungen wesentlich durch die dem CDC zugrunde liegenden Grundsätze geleitet werden: dass Pro-Kopf-Emissionen der entwickelten Länder konvergieren und dass Entwicklungsländer das gleiche tun, jedoch zeitverzögert und unter der Bedingung, dass entwickelte Länder zuerst handeln.

8. Triptych Ansatz – Version 6.0

Nach Durchsicht von früheren Versionen des Triptych-Ansatzes haben wir eine neue, überarbeitete Version des Ansatzes, Triptych Version 6.0, entwickelt.

Grundgedanke des Triptych-Ansatzes ist, die Emissionsberechtigungen innerhalb verschiedener Länder so aufzuteilen, dass nationale Unterschiede und Besonderheiten, die für Emissionen und Emissionsreduktionspotenziale relevant sind, in die Verteilung einfließen. Der Triptych-Ansatz als solcher definiert jedoch nicht, welche Länder an einem Klimaregime teilnehmen sollen und welche nicht. Der Ansatz wurde ursprünglich entwickelt, um das Emissionsbudget für die erste Verpflichtungsperiode unter den EU-Mitgliedsstaaten aufzuteilen.

Der ursprüngliche Triptych-Ansatz sah die Unterscheidung von drei Emissionskategorien vor: den Stromsektor, energieintensive Industriezweige und inländische Sektoren. Die Auswahl dieser drei Kategorien wurde während der Verhandlungen basierend auf einer Anzahl von Unterschieden einzelner Staaten getroffen: Unterschiede im Lebensstandard, Unterschiede in der Brennstoffzusammensetzung für die Stromgestehung, Unterschiede in der wirtschaftlichen Struktur sowie die Wettbewerbsfähigkeit global orientierter und agierender Unternehmen und Industriezweige. Unter Berücksichtigung und Anwendung definierter Regeln wurde für jede dieser Kategorien ein entsprechendes Emissionsbudget berechnet. Die sektorspezifischen Emissionsberechtigungen wurden je Land addiert und somit nationale Ziele definiert. Sektorale Ziele wurden nicht definiert, damit jedes Land flexibel in der Entwicklung kosteneffizienter Emissionsreduktionsstrategien sei.

Die wesentlichen Unterschiede des Triptych-Ansatzes der Version 6.0 im Vergleich zu früheren Versionen sind:

- Harmonisierung der Datensätze und klare Datenhierarchie basierend auf IPCC-SRES-Szenarien
- Berechnung auf Basis von 192 Staaten
- Schaffung einer Möglichkeit zur Integration aller 6 Kyoto-Gase einschließlich Senken
- Ausdehnung auf einen Simulationszeitrahmen bis 2050 (und darüber hinaus)
- Freie Wählbarkeit des Basisjahres zwischen 1990 und 2010
- Nutzung normativer, aber auf Szenarien basierender Wachstumsraten für den Strombedarf und die Industrieproduktion differenziert nach Bruttoinlandsprodukt pro Kopf

Die Emissionsberechtigungen unter dem Triptych-Ansatz für eine exemplarische Ausrichtung auf ein Stabilisierungsziel von 450 ppmv CO_2 sind in Abbildung D und F veranschaulicht.

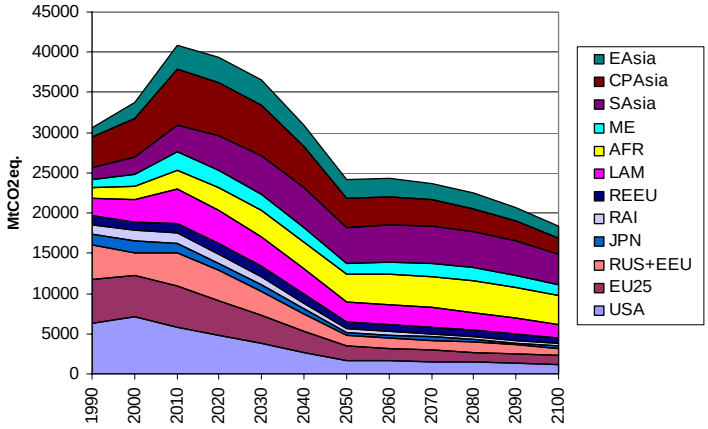


Abbildung D: Regionale Emissionen unter dem Triptych Ansatz für das SRES A1B Szenario für einen Stabilisierungsgrad von 450 ppmv CO_2

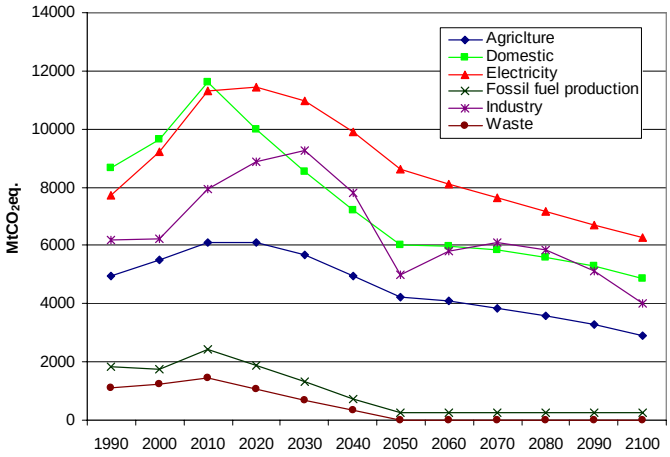


Abbildung E: Globale sektorspezifische Emissionen unter dem Triptych-Ansatz für das SRES A1B Szenario für eine Stabilisierungsgrad von 450 ppmv CO_2

Der Triptych-Ansatz in seiner hier präsentierten Version 6.0 ist der technisch ausgefeilteste Ansatz zur Aufteilung von Emissionsberechtigungen innerhalb verschiedener Länder, der auf sektorspezifischen Informationen beruht. Dieser Ansatz kann weltweit auf alle Länder angewendet werden, aber prinzipiell auch auf Ländergruppen. Eine frühere Version wurde bereits erfolgreich in der EU zur Aufteilung des Kyoto-Ziels der EU auf die einzelnen EU-Mitgliedsstaaten angewandt.

Der Ansatz kann dank der sektoralen Betrachtung viele verschiedene Umstände und Belange einzelner Ländern berücksichtigen. Länder, die heute beispielsweise auf Kohle angewiesen sind, werden weiter Kohle nutzen, müssen aber ihre Effizienz erhöhen. Länder, die stark vom Export energieintensiver Produkte abhängen, können diese weiter exportieren, würden aber die Effizienz steigern müssen. Der allgemeine Lebensstandard sowie der individuelle Konsum würden konvergieren.

Eine Stabilisierung auf einem Niveau von 450 ppmv CO_2 oder 550 ppmv CO_2 macht den Stopp eines weltweiten Emissionsanstiegs notwendig. Die Parameter des Triptych-Ansatzes müssen relativ streng gewählt werden, um weiteren Produktionszuwächsen noch Raum zu lassen. Mit

Hilfe dieses Ansatzes sind beträchtliche Reduktionen durch Industriestaaten erforderlich und erkennbar, besonders in Ländern mit kohlenstoffintensiver Industrie, wie dies in Mittel- und Osteuropa und in der russischen Föderation der Fall ist. Im Gegensatz dazu sind beträchtliche Emissionssteigerungen für die meisten Entwicklungsländer erlaubt, jedoch liegen diese in den meisten Fällen unterhalb des Referenzszenarios.

Der Triptych-Ansatz hat verschiedene Vorteile: Er kann unterschiedliche nationale Gegebenheiten berücksichtigen. Er erlaubt ausdrücklich die Integration von wirtschaftlichem Wachstum sowie die Verbesserung der Effizienz in Entwicklungsländern. Er wurde erfolgreich angewendet als Basis der Verhandlung einzelner Ziele der EU-Mitgliedsstaaten.

Auf der anderen Seite ist der Ansatz an sich eher komplex und erfordert viele verschiedene Entscheidungen und eine Vielzahl von sektorspezifischen Daten, weswegen er als wenig transparent wahrgenommen werden kann. Vorhersagen von Produktionswachstumsraten für die Schwerindustrie und den Stromsektor sind zudem notwendig, die oftmals nur grobe Schätzungen darstellen. Eine Einigung auf all die benötigten Daten und Parameter auf einem globalen Niveau könnte sehr schwierig sein.

Bei der Verteilung von Emissionsrechten ist ein grundlegender Zwiespalt sichtbar: Ansätze, die einfach sind, können keine nationalen Umstände und Besonderheiten berücksichtigen. Auf der anderen Seite können sehr ausgeklügelte Ansätze eben diese Unterschiede berücksichtigen. Der Triptych-Ansatz zählt zu den eher ausgefeilten Methoden. Die Anwendung in der EU hat aber gezeigt, das auch komplexe Vorschläge als Basis für politische Entscheidungen genutzt werden können. Trotz seiner Komplexität kann der Triptych-Ansatz weiterhin als Grundlage für die Aufteilung von Emissionsberechtigungen von Staaten oder Ländergruppen genutzt werden.

9. Ein Kompromiss Vorschlag

Im Rahmen dieses Projekts haben wir auch einen sogenannten „Kompromissvorschlag“ (Englisch: a compromise proposal) entwickelt. Dieser enthält und verbindet viele der vorangegangenen und diskutierten Vorschläge. Der Kompromissvorschlag zielt darauf ab, die meisten Bedürfnisse und Bedenken zu berücksichtigen, wobei jedoch das Umweltziel einer Treibhausgasstabilisierung weiterhin erreichbar sein soll. Wir glauben, dass dieses Konzept einen möglichen Weg aufzeigt, auf den sich weiterführende, multilaterale und internationale Klimapolitik gründen lässt.

Die Erreichung eines Stabilisierungsziels wie z.B. 2°C, ist nur möglich, wenn alle erdenklichen Anstrengungen unternommen werden, auf möglichst vielen Ebenen Emissionsreduktionen in Industriestaaten zu erreichen und Emissionen in Entwicklungsländern möglich niedrig zu halten. Der Kompromissvorschlag besteht aus vier Teilen:

1. Mehrstufenvereinbarung hinsichtlich Emissionsreduktionen
2. Neue Technologieentwicklung und Implementierung
3. Eine Vereinbarung zur Anpassung an den Klimawandel
4. Zusätzliche Anstrengungen hinsichtlich Emissionsreduktionen

Der Mehrstufenansatz würde insgesamt vier Stufen integrieren:

Stufe 1 – Keine Verpflichtungen: Länder mit besonders geringem Entwicklungsniveau haben keine Klimaverpflichtungen. Alle am wenigsten entwickelten Länder (englisch: least developed countries – LDCs) würden dazu zählen.

Stufe 2 – Vermehrte zukunftsfähige Entwicklung: In der nächsten Stufe verpflichten sich Länder, klare Schritte in Richtung einer zukunftsfähigen Entwicklung zu unternehmen. Umweltziele sind in Entwicklungsstrategien und –politiken eingebaut. Anforderungen für solch einen nachhaltigen Weg können definiert werden, z.B. das Auslaufen ineffizienter Technologie über einen bestimmten Zeitpunkt hinaus, ab dem definierte Standards eingehalten werden müssen, die neue Technologien zu erfüllen haben. Die Implementierung eines solchen

nachhaltigen Entwicklungspfads muss beobachtet und Ergebnisse verifiziert werden. Die dafür notwendigen Kosten können einerseits vom entsprechenden Land selber getragen werden oder aber durch Entwicklungshilfebudgets gedeckt werden, die durch zusätzliche klimabezogene Fonds ergänzt werden können.

Stufe 3 – Moderate, absolute Ziele: Länder verpflichten sich, absolute Ziele für Emissionsreduktionen anzunehmen. Das Emissionsniveau könnte steigen, sollte aber unter dem Referenzszenario liegen. Solch eine Zielvereinbarung könnte alternativ auch als ‚positiv bindende Ziele' gestaltet werden, womit gemeint ist, dass Berechtigungen verkauft werden können, sollte das Ziel übererfüllt sein. Sollte das Ziel nicht erreicht werden, müssen die Fehlbeträge an Emissionsberechtigungen allerdings nicht zugekauft werden. Ein wesentlicher Anreiz, ein solches Ziel zu akzeptieren besteht in der Möglichkeit zur Teilnahme am Emissionshandel bei Übererfüllung der Ziele.

Stufe 4 – Absolute Reduktionen: Länder in Stufe 4 müssen beträchtliche absolute Emissionsreduktionen erzielen bis ein niedriges Pro-Kopf-Emissionsniveau erreicht ist. Mit der Zeit würden immer mehr Länder in Stufe 4 eintreten und sich zu solchen absoluten Reduktionen verpflichten.

Länder bewegen sich durch diese Stufen gemäß definierter Schwellenwerte. Solche Schwellenwerte können z.B. Pro-Kopf-Emissionen sein. Da Minderungen für später in Verpflichtungen eintretende Länder tendenziell einfacher werden (sie können von technologischen Entwicklungen profitieren) wird sich der Schwellenwert von Stufe 3 zu Stufe 4 über die Zeit weiter vermindert.

Zusätzlich zu sofortigen Emissionsminderungen können sich Länder freiwillig dazu verpflichten, neue Technologien zu entwickeln und zu implementieren, die zu Treibhausgasreduktionen beitragen (ähnlich wie das bereits im Rahmen der Konvention und des Kyoto-Protokolls erfolgt ist, siehe Teil 2 des Kompromissvorschlags). Bei der Verhandlung absoluter Emissionsminderungsziele wird den Ländern Gelegenheit gegeben, solche Technologie-verpflichtungen einzugehen. Sollten diese Länder davon Gebrauch machen, werden im Gegenzug ihre absoluten Emissionsziele etwas entspannt, d.h. ihnen werden mehr Rechte zugeteilt. Die Verifizierung von Technologieverpflichtungen ist problematisch und müsste weiter konkretisiert werden, denn hier besteht Potential, das System zu untergraben.

Wir haben die Emissionsberechtigungen für einen Beispielfall berechnet. Abbildung F zeigt die Emissionsberechtigungen unter einem Mehrstufenansatz für das Szenario A1B mit einem Stabilisierungsniveau 450 ppmv CO_2 Konzentration. Tabelle C zeigt den möglichen Zeitpunkt, wann dieses Land in die verschiedene Stufen wechselt, wobei ein Langfriststabilisierungsniveau zu 450 ppmv angestrebt wird. Die Zahlenwerte in der Tabelle verdeutlichen die Stufe als Durchschnittswerte über 6 Fälle, ein Fall je IPCC Szenario. Für Regionen sind bevölkerungsgewichtete Durchschnitte angegeben.

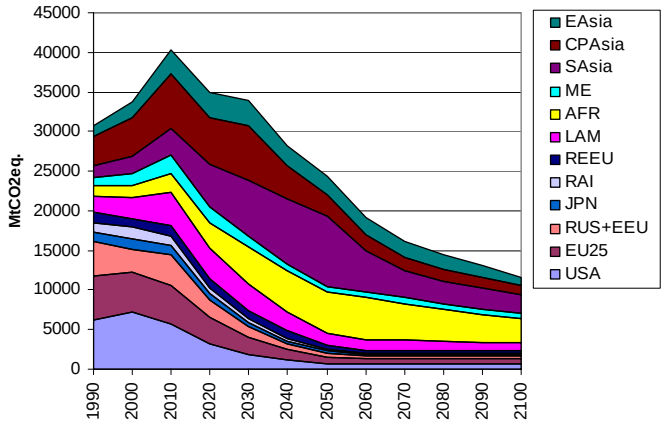


Abbildung F: Emissionsberechtigungen unter einem Mehrstufen Ansatz für das A1B Szenario mit dem Ziel einer Stabilisierung zum Niveau 450 ppmv CO_2 Konzentration

Tabelle C. Wahrscheinlicher Termin für den Übergang von Ländern in verschiedene Stufen unter Zielsetzung eines 450 ppmv Langzeitstabilisierungsniveaus. Die Zahlenwerte verdeutlichen die Stufe als Durchschnittswerte über 6 Fälle, ein Fall je IPCC Szenario. Für Regionen sind bevölkerungsgewichtete Durchschnitte angegeben.

	2020	2030	2040	2050	2060	2070	2080	2090	2100
Annex I	4.0	4.0	4.0	4.0	4.1	4.9	5.0	5.0	5.0
Rest of Eastern Europe	2.6	3.2	3.4	3.4	3.6	4.1	4.2	4.3	4.3
Argentina	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
Brazil	3.0	3.0	3.8	4.0	4.2	5.0	5.0	5.0	5.0
Mexico	3.0	3.8	3.8	3.8	4.3	4.8	5.0	5.0	5.0
Venezuela	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
Rest of Latin America	2.4	2.7	2.8	3.2	3.2	3.5	3.8	3.9	4.0
Egypt	1.8	2.0	2.8	3.3	3.7	3.8	4.7	4.8	5.0
South Africa	3.0	4.0	4.0	4.0	4.7	5.0	5.0	5.0	5.0
Nigeria	1.0	1.0	1.7	2.0	2.5	3.3	3.7	4.3	4.7
Rest of North Africa	2.2	2.3	2.8	3.4	3.4	3.9	4.0	4.1	4.2
Rest of Africa	1.1	1.2	1.4	1.6	1.9	2.2	2.4	2.7	3.0
Saudi Arabia	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
United Arab Emirates	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
Rest of Middle East	2.8	3.4	3.4	3.6	3.9	4.4	4.5	4.5	4.5
China	3.0	3.0	3.2	3.7	3.7	4.2	4.7	5.0	5.0
India	1.0	1.5	2.0	2.3	3.2	3.3	3.8	4.0	4.3
Indonesia	1.0	1.7	2.0	2.3	2.3	2.5	2.7	3.0	3.7
South Korea	3.0	4.0	4.0	4.0	4.2	4.5	5.0	5.0	5.0
Malaysia	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
Philippines	1.0	1.0	1.5	1.7	1.8	1.8	1.8	2.3	2.8
Singapore	3.0	4.0	4.0	4.0	4.2	4.7	5.0	5.0	5.0
Thailand	3.0	3.2	3.7	3.8	4.2	4.8	5.0	5.0	5.0
Rest of Asia	1.2	1.3	1.5	1.7	1.7	1.8	1.9	2.1	2.3

"Stufe 5" ist der Zustand, in dem ein Land in Stufe 4 pro Kopf Emissionen auf ein sehr niedriges Niveau gesenkt hat und nun keine weiteren Emissionsreduktionen durchführen muss.

Der Kompromiss Vorschlag hat mehrere Vorteile:

- Der Vorschlag ist als Kompromiss gestaltet, um viele verschiedene Ansichten zu unterschiedlichen Themen zu integrieren. Er kann somit verschiedene Anforderungen erfüllen. Viele Länder oder Ländergruppen können in diesem Ansatz ihre eigen Bedenken wieder- und letztlich berücksichtigt finden.
- Der Vorschlag ermöglicht eine Integration von Ländern in obligatorische Emissionsminderungsverpflichtungen. Dies ist im Sinne der UNFCCC. Der Vorschlag berücksichtigt damit nationale Umstände (insbesondere wenn Tryptich zur Lastenverteilung in Stufe 4 herangezogen wird).
- Der Vorschlag erlaubt Flexibilität hinsichtlich sofortiger Emissionsreduktionen und Technologieentwicklung, die zukünftige Emissionen reduzieren helfen.
- Der Vorschlag erlaubt eine schrittweise Entscheidungsfindung. Dies wird wohl der gangbare Weg sein, langfristige internationale Vereinbarungen zu erzielen.
- Der Vorschlag baut Vertrauen auf, denn industrialisierte Länder übernehmen zunächst massive Emissionsreduktionen.

Der Ansatz besitzt allerdings auch einige Schwächen:

- Der Gesamtansatz beschreibt ein relativ komplexes System, das viele Entscheidungen erfordert.
- Es besteht ein beträchtliches Risiko, dass Länder zu spät in die nächst höhere Stufe aufsteigen. Damit besteht die Möglichkeit, dass ambitionierte längerfristige Stabilisierungsniveaus außer Rechnweite gelangen könnten. Deshalb sind Anreize für Länder notwendig, in den einzelnen Stufen teilzunehmen. Schwellenwerte allein sind nicht ausreichend. Die für Stufe 3 und 4 vorgesehene Flexibilität hinsichtlich reduzierter Emissionsziele bei freiwilligen Technologievereinbarungen steigert zudem die Unsicherheiten der Erreichung globaler Emissionsziele.

Als besonders kritisch für die Praxistauglichkeit dieses Systems ist die Teilnahme der USA zu bewerten. Ihr gegenwärtiger Standpunkt kann jedoch in ein solches System durch die Technologieoption aufgenommen werden. Die USA müsste dann allerdings umfassende Anstrengungen zeigen, neue Technologie zu entwickeln. Im Gegenzug würden die USA ein eher moderates Emissionsminderungsziel erhalten.

10. Vergleich der Emissionsberechtigungen

Ein Vergleich von Emissionsberechtigungen unter den verschiedenen hier diskutierten Ansätzen wurde abschließend vorgenommen (Contraction & Convergence, CDC, Mehrstufenansatz und Triptych 6.0). Für den Vergleich nutzen wir das EVOC Modell (Evolution of Commitments Model), welches Emissionen der Gase CO_2, CH_4, N_2O, HFCs, PFCs und SF_6 für insgesamt 192 Länder enthält.

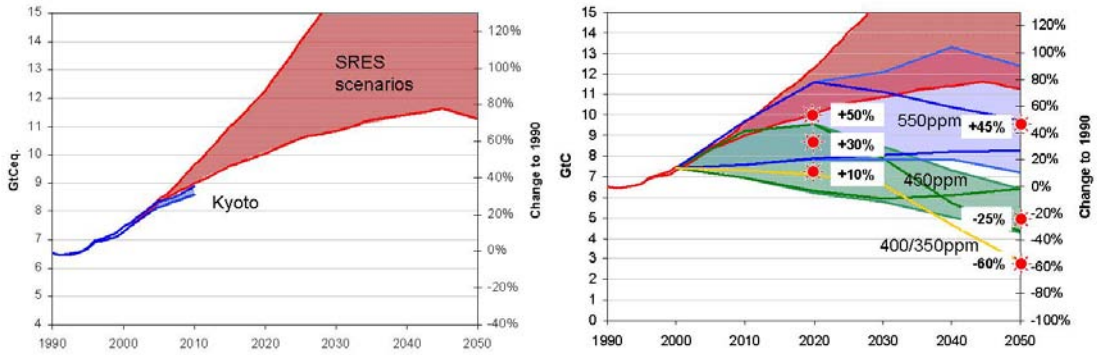


Abbildung G: Mögliche CO_2-Emissionspfade bis 2050

Wir haben globale Emissionsniveaus für 2020 und 2050 ausgewählt. Diese Niveaus müssen von allen Ansätzen für folgende Quantifizierungen der Emissionsberechtigungen eingehalten werden. Diese sind Abbildung G entnommen, um mit den Niveaus 550 ppmv CO_2 (etwa 650 ppmv CO_2-Äquivalent.), 450 ppmv CO_2 (etwa 550 ppmv CO_2- Äquivalent) und 400 ppmv (etwa 450 ppmv CO_2-Äquivalent) übereinzustimmen.

Abbildung H zeigt die Änderung der Emissionen von 1990 bis 2020 bzw. bis 2050 unter den verschiedenen Ansätzen, um das 450 ppmv CO_2-Konzentrationsniveau zu erreichen. Die Fehlerbalken zeigen die Bandbreite unter Nutzung der verschiedenen Referenzszenarien.

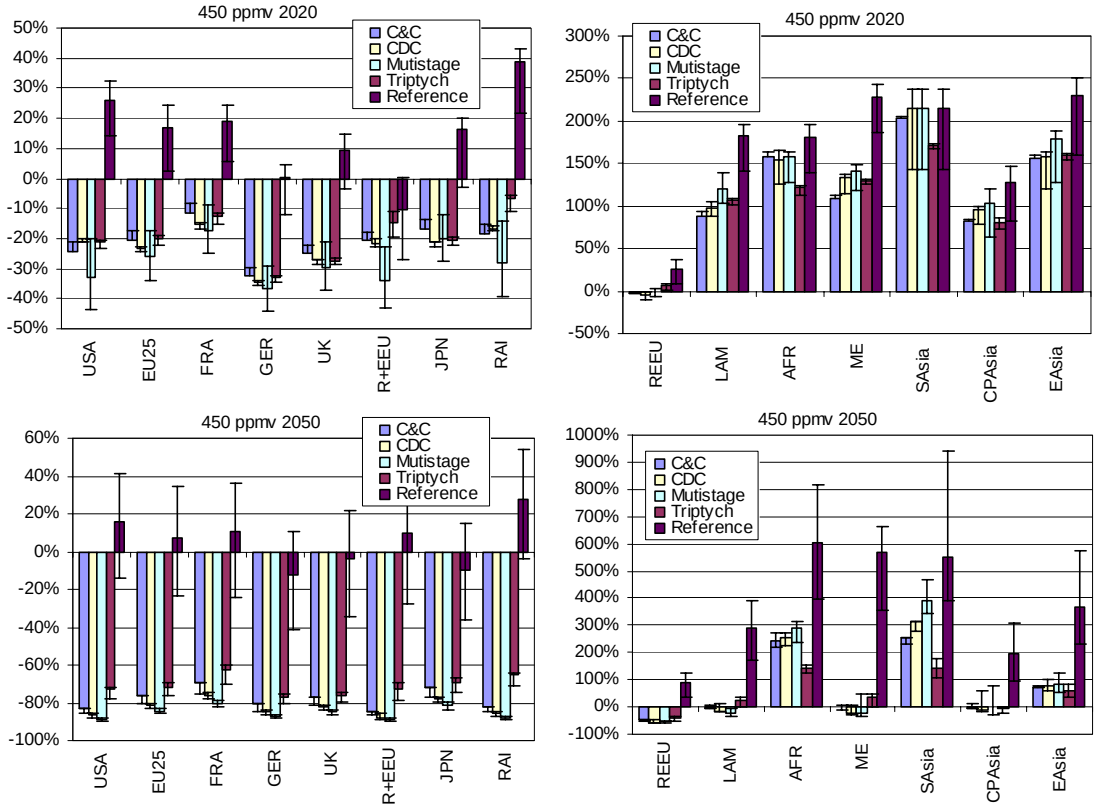


Abbildung H: Änderung der Emissionen von 1990 bis 2020 und 2050 unter verschiedenen Ansätze mit einem Stabilisierungsniveau von 450 ppmv CO_2-Konzentration. Die Fehlerbalken verdeutlichen die Spannbreite bei Nutzung verschiedener Referenzszenarien

Die Analyse zeigt folgende Ergebnisse:

- Um die Einhaltung des EU-Ziels, den Temperaturanstieg im Vergleich zum vorindustriellen Niveau auf höchstens 2°C zu begrenzen, müsste nach gegenwärtigem Stand des Wissens und unter Annahme einer mittleren Klimasensitivität eine Stabilisierung der CO_2-Konzentration deutlich unterhalb von 450 ppmv angestrebt werden.
- Im Falle, dass keine Anstrengungen unternommen werden, Emissionen weiter zu reduzieren, besteht eine hohe Wahrscheinlichkeit, dass die Option 450 ppmv CO_2 bereits zu Beginn des Jahres 2020 nicht mehr erreichbar sein wird.
- Um das 450 ppmv CO_2-Niveau zu erreichen, müssen die Emissionen der entwickelten Länder beträchtlich reduziert werden. Für das hier gewählte Beispiel hinsichtlich Stabilisierungsniveau und die für die betrachteten Ansätze gewählten Parameter müssten Annex-I-Länder ihre Emissionen in der Größenordung -20% unterhalb der Emissionen von 1990 bereits im Jahr 2020 senken. Für das 550 ppmv CO_2 Niveau würden die Reduktionen der Größenordung -15% und für das 400 ppmv CO_2 Niveau ungefähr –35% betragen. Diese Werte sind wesentlich von den Annahmen für Nicht-Annex-I-Länder beeinflusst. Fast alle Ansätze lassen Spielraum, durch Variation der gewählten Parameter diese Balance zu ändern.
- Um das 450 ppmv CO_2-Konzentrationsziel zu erreichen, müsste die USA in das System involviert werden und weitaus größere Anstrengungen unternehmen, als dies durch das nationale Ziel einer Verbesserung der Energieintensität um 18% der Fall wäre. Das von den USA vereinbarte nationale Ziel würde einen Anstieg der absoluten Emissionen um 20% zum Jahr 2010 im Vergleich zu 1990 erlauben. Mit diesem Ziel könnten die notwendigen Reduktionsziele für die Annex-I-Gruppe nicht erreicht werden. Für das 550 ppmv CO_2-Konzentrationsniveau könnte dieses nationale Ziel der USA ausreichend sein, wenn andere Annex-I-Staaten entsprechend ambitioniertere Reduktionen vornehmen.
- Um das 450 ppmv CO_2-Konzentrationsziel zu erreichen, müssen Entwicklungsländer so schnell wie möglich von ihrem Referenzszenario abweichen. Einige Länder müssen damit bereits ab 2020 beginnen, z.B. Lateinamerika, der Mittlere Osten, Ostasien. Für das 550 ppmv CO_2 Niveau wären von einer frühzeitigen Abweichung weniger Länder betroffen, bei strengeren Vorgaben, wie 400 ppmv CO_2 Konzentration, wären es dagegen entsprechend mehr Länder. Aktionen von Annex-I-Ländern in Form von Technologietransfer oder finanzieller Unterstützung wären notwendig, um die Emissionen der Nicht-Annex-I-Länder unterhalb ihres Referenzszenarios zu halten.
- Für die meisten Länder ist die Differenz der Reduktionen zwischen den Stabilisierungsniveaus (400, 450, 550 ppmv) größer als die Differenz zwischen den verschiedenen Ansätzen, die alle auf ein bestimmtes Stabilisierungsniveau hinzielen. Die Wahl eines bestimmten Langfriststabilisierungsziels ist somit signifikanter als die Wahl eines bestimmten Lastenteilungsansatzes.
- Nationale Langfristziele einzelner EU-Mitgliedsstaaten sind sehr anspruchsvoll, entsprechen aber unterschiedlichen Stabilisierungszielen.

Die notwendigen Reduktionen sind in Tabelle D zusammen gefasst.

Tabelle D: Änderungen zwischen Emissionen in 1990 und Emissionsrechten in 2020/2050 für verschiedene CO_2 Konzentrationsniveaus

		2020	2050
400 ppmv CO_2	**Global***	+10%	-60%
	Annex I	-25% to -50%	-80% to -90%
	Nicht-Annex I	Beachtliche Abweichungen vom Referenzszenario für Lateinamerika, den mittleren Osten, Zentral- und Ostasien	Starke Abweichungen vom Referenzszenario in allen Regionen
450 ppmv CO_2	**Global***	+30%	-25%
	Annex I	-10% to -30%	-70% to –90%
	Nicht-Annex I	Abweichungen vom Referenzszenario in Lateinamerika den Mittleren Osten, Zentral- und Ostasien	Beachtliche Abweichungen vom Referenzszenario in allen Regionen
550 ppmv CO_2	**Global***	+50%	+45%
	Annex I	-5% to -25%	-40% to –80%
	Nicht-Annex I	Abweichungen vom Referenzszenario in Lateinamerika den Mittleren Osten und Ostasien	Abweichungen vom Referenzszenario in den meisten Regionen, besonders in Lateinamerika und dem Mittleren Osten

*: Die ausgewählten Werte für weltweite Reduktionen stellen einen möglichen Emissionspfad in Bezug auf das angegebene Stabilisierungsniveau dar. Andere weltweite Emissionsniveaus für die Jahre 2020 und 2050 wären möglich, um die gleichen Stabilisierungsniveaus zu erreichen. Ihre Wahl würde die notwendigen Reduktionen für die Ländergruppen beeinflussen.

11. Verhandlungsstrategie

Abschließend wurde auf den vorangegangenen Ergebnissen aufbauend eine Verhandlungsstrategie für ein internationales Klimaregime nach 2012 aus Sicht der EU erarbeitet.

Um das ehrgeizige langfristige Ziel der EU zu erreichen, “dass der Anstieg der Weltmitteltemperatur 2°C über vorindustriellem Niveau nicht übersteigt“, sind erhebliche Anstrengungen auf verschiedenen Ebenen nötig. Die Verhandlungen im Rahmen der Klimarahmenkonvention müssen durch weitere Aktivitäten unterstützt werden, z.B. Einigungen zu erneuerbaren Energien, Technologieentwicklung und Entwicklungszusammenarbeit. Zusätzlich ist Wissensaufbau und –transfer sowie Unterstützung der Wissenschaft nötig.

Die EU muss in vielerlei Hinsicht eine führende Rolle übernehmen: Als richtungsweisendes Vorbild (durch die Umsetzung des Kyoto-Protokolls innerhalb der EU), als unterstützende Kraft (durch aktive Bildung von Koalitionen) und durch Einsatz ihres gesamten politischen und ökonomischen Gewichts.

Die EU könnte ihr Gewicht als Handels- und politischer Partner stärker einsetzen, um die internationalen Klimaverhandlungen an andere Themen zu knüpfen, wie zum Beispiel internationaler Handel und Auslandsbeziehungen.

Die USA sollten dabei im Zentrum der Bemühungen stehen. Eine Erweiterung des EU-Emissionshandelssystems könnte die Anstrengungen unter dem Kyoto-Protokoll ergänzen. Eine solche Erweiterung könnte einzelne US-Bundesstaaten miteinbeziehen und somit Druck zur nationalen Harmonisierung innerhalb der USA erzeugen und das Interesse der Wirtschaft wecken.

Zusätzlich sollte der Dialog mit Entwicklungsländern intensiviert werden. Dabei könnte der Fokus auf die Entwicklungsländer innerhalb der Gruppe der 77 fallen, die bereits

Anstrengungen zur Emissionsreduktion gezeigt haben und die zu weiteren Schritten innerhalb eines insgesamt akzeptablen Systems bereit wären. Die einzelnen Ziele müssen so formuliert werden, dass sie für diese Entwicklungsländer akzeptabel sind. Die EU könnte solche Ansätze unterstützen, die die Teilnahme von Entwicklungsländern begünstigt, wie z.B. ein Mehrstufenansatz mit einer ersten Stufe, die die wirtschaftliche Entwicklung der Länder nicht gefährdet, oder dem Triptych-Ansatz.

Innerhalb des Verhandlungsprozesses der Klimarahmenkonvention wäre der folgende Ablauf von Entscheidungen denkbar:

- Spezifikation der langfristigen Bestrebungen, da eine solche Entscheidung weitreichende Auswirkung auf kurzfristige Reduktionen und den Reduktionszeitplan hat
- Einigung über die Arten der Verpflichtungen (wie z.B. bindende Emissionsreduktionsziele oder Politiken und Maßnahmen), sowie Angabe, wann und von wem diese Ziele übernommen werden sollten
- Definition der Berechnungsgrundlage der Arten von Verpflichtungen (für Emissionsreduktionsverpflichtungen z.B. die Frage nach der Einbeziehung der Emissionen aus Landnutzungsänderungen, vom Flug- und Schiffsverkehr und von anderen klimawirksamen Gasen)
- Einigung über die exakten Ziele (Reduktionswerte oder bestimmte Maßnahmen)

Der Stillstand der Verhandlungen könnte mit einem Mandat zur Verhandlung der zweiten Verpflichtungsperiode bei COP 11 im November 2005 aufgehoben werden, in dem festgeschrieben ist, welche Arten von Verpflichtungen von welchen Ländergruppen übernommen werden sollten, z.B. bindende Emissionsverpflichtungen für alle Industrieländer, auf nachhaltige Entwicklung ausgerichtete oder positiv bindende Ziele für die meisten Entwicklungsländer in 2020, aber bindende Ziele in 2030. Eine solche langfristige aber definierte Perspektive könnte die Akzeptanz eines solchen Mandats für alle Länder erhöhen.

Auch Aktivitäten außerhalb der Klimaverhandlungen unter der Klimarahmenkonvention sollten verstärkt werden, wie z.B. die Koalition und Zielvereinbarungen zu erneuerbaren Energien.

Ebenso könnte die EU die Wissenschaft zum Thema langfristiger internationaler Klimapolitik unterstützen. Eine internationale wissenschaftliche Konferenz zur internationalen Klimapolitik würde die Möglichkeit schaffen, die unterschiedlichen Auffassungen zu einer effektiven und effizienten langfristigen Strategie zu diskutieren. Weitere Untersuchung der positiven Effekte und Nebeneffekte von Emissionsreduktionen könnte dazu beitragen, die Zurückhaltung gegenüber klimapolitische Maßnahmen zu senken und bereits unternommene Reduktionen in Entwicklungsländern mit in den Blick zu nehmen.

Das 2°C Ziel einzuhalten ist eine große Herausforderung. Wir hoffen, dass die in dieser Strategie beschrieben Aktivitäten der EU helfen, diese Herausforderung zu meistern.

12. Contents

ACKNOWLEDGEMENTS

This work was funded by the German Federal Environmental Agency as „Kyoto-Protokoll: Untersuchung von Optionen für die Weiterentwicklung der Verpflichtungen für die 2. Verpflichtungsperiode“/“Options for the second commitment period of the Kyoto Protocol”, FKZ 203 41 148/01.

The development of the “Future international action on climate change network” www.fiacc.net was co-financed by the European Commission, Directorate General Environment.

The development of the Triptych 6.0 approach was co-financed by the RIVM.

The authors thank Martin Weiß and Rolf Sartorius of the German Federal Environmental Agency, Michel den Elzen of RIVM and Xianli Zhu from the Chinese Academy of Social Science for their valuable contributions.

1. INTRODUCTION

The objective of this report is to provide an overview of the issues, to further develop approaches and to discuss a possible negotiation strategy related to the design the second commitment period of the Kyoto Protocol. It intends to facilitate any discussion on the future of the international climate change regime.

Under the Kyoto Protocol, OECD countries and economies in transition, the so-called Annex I countries, have accepted binding greenhouse gases (GHG) emission targets for period 2008-2012, the first commitment period. Developing countries (non-Annex I countries) have no such commitment, but may host emission reduction projects through the Clean Development Mechanism (CDM). But, reaching the ultimate objective of the UNFCCC, "to achieve … stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UNFCCC, 1992) is only possible, if emission reductions are intensified and participation in those reductions is broadened.

With the US' repudiation of its Kyoto commitments, the Protocol depended for a long time on ratification by the Russian Federation to enter into force. The EU intended to initiate a dialogue with developing countries on new mitigation commitments to prepare for formal discussions on future action in 2005, as called for under the Protocol. At COP8 in Delhi, India, 2002, and COP9 in Milan, Italy, 2003, it has become very clear that developing countries will not return to the table as long as the fate of the Kyoto Protocol is still uncertain and the USA is not seriously engaged. With the expected entry into force of the Kyoto Protocol on 16 February 205 it seems clear that any post-2012 regime architecture will have to bring both the USA and the major developing countries on board to be politically viable. The key question is how that could be reached in an acceptable way.

While the official negotiations are on hold, multiple activities and initiatives aim at identifying approaches for an international climate policy regime to follow the first commitment period after 2012. Much time and conceptual work was and continues to be dedicated to address the existing obstacles and examining alternative scenarios how such an approach would preferably result in full participation of Parties to the Convention.

This report is the final report of the research project „Kyoto-Protokoll: Untersuchung von Optionen für die Weiterentwicklung der Verpflichtungen für die 2. Verpflichtungsperiode"/"Options for the second commitment period of the Kyoto Protocol", FKZ 203 41 148/01, which was carried out by Ecofys on behalf of the German Federal Environmental Agency. The project was initiated in June 2003 and terminated in November 2004. The research project builds upon the preceding work of ECOFYS under the project "Evolution of commitments under the UNFCCC: Involving newly industrialized countries and developing countries" for the Germany Federal Environmental Agency (Höhne et al. 2003)

Within the project we focused our work around the following research questions:

- **Which proposals for future commitments or future actions are available and where are they discussed?** Chapter 2 includes a description of the activities and currently discussed proposals. A website was developed (www.fiacc.net), that provides detailed up to date information.
- **Which elements are important for individual countries or country groups?** Chapter 3 summarizes criteria for the evaluation of proposals. Chapter 4 considers in more detail individual interests of some countries.
- **Which overall concept can satisfy all demands?** As a first step, Chapter 5 lays out the key issues that need to be agreed upon when negotiating a future commitment scheme. Chapter 6 discusses in more detail the issue of adaptation to climate change. Chapters 7, 8 and 9 modify and further develop some of the existing approaches to better increase possible acceptance. Chapters 7 and 8 provide a new approach, the "Common but Differentiated Convergence Approach" and an update of

the Triptych approach. Based on these considerations, a compromise proposal is presented in Chapter 9. Chapter 10 provides a quantitative comparison of emission allowances of various approaches.

- **How should Germany and the EU act in the international negotiations**? Chapter 11 provides a strategy for Germany and the EU on how to act in the international negotiations.

2. NETWORK AND OVERVIEW OF PROPOSALS

This chapter describes the steps carried out to establish and maintain an information platform "Future international action on climate change network" (www.fiacc.net). It further provides an extract of the content of the website with an overview of discussion processes, active institutions and recently discussed proposals.

2.1 DEVELOPMENT OF THE NETWORK

Networks have different connotations and the term is used widespread in every day's life. Referring to people and their communication processes, a network represents a communication system consisting of a group of individuals sharing ideas and information of similar nature.

Future climate commitments after 2012 are widely discussed today. To date, discussion on this topic is not coordinated or streamlined nor is the issue officially negotiated at political level. Official negotiations on a second commitment period and a review of the Kyoto Protocol will start in 2005 at the earliest. Currently, individuals, research consortia and working groups at well established climate policy research organizations develop alternative concepts of a post-2012 regime and invite interested stakeholders to discussing these concepts within the framework of different dialog processes.

Some level of awareness on the various existing approaches, concepts and ideas has been raised by presenting those concepts at e.g. the Conferences of Parties and at SBSTA side events to a wider range of stakeholders. In addition, many workshops were initiated and hosted by researchers, project teams and other organizations in the past discussing specific issues on future commitments

The more concepts are being presented and discussed by the international climate change audience the more difficult it becomes to follow all activities and the less manageable it is to keep on track with the latest developments.

In mid 2003, there was clearly a need to address the ineffective information dissemination. Within this project, Ecofys developed the "future international action on climate change network (FIACC)". This web-based information network provides a single information pool on the "who is active", "what are the approaches" and "how do discussion and dialog processes work" for any stakeholder that is interested in the negotiations on a second commitment period after 2012.

The main activities undertaken to develop such a network include:

- *Collecting and updating information* by establishing contact to research institutions, delegates and individuals either hosting discussion processes on future commitments or developing approaches for a post-2012 commitments. A list of active players and processes was compiled in the initial phase of the project.
- *Increasing stakeholder participation* by awareness raising and information dissemination activities on the network during side events at COP9 and SBSTA 20. Contacts to developing country representatives active in research or negotiations on future action were strengthened in particular and awareness raising addressed throughout the entire project lifetime.
- *Setting up a website* in English language on "Future International Action on Climate Change" and public announcement. The website provides information on current processes, approaches and cross-cutting issues in an organised, transparent and open way and was launched in December 2003.
- *Supporting monthly discussions* that took place between December 2003 and May 2004 by inviting for opinion exchange on selected topics, providing input on various discussion papers to initiate discussions, circulating announcements, reminders and

providing the required web based logistics for posting information according different discussion streams.

A wide range of stakeholders such as research institutes, private businesses, NGOs, governments and delegates actively working in the area of future international climate change actions were reached with this networking initiative. The website became an internationally well-recognised information platform on future action on climate change.

To date, the FIACC website covers the following items:

- A home page welcoming the user and providing news such as announcements of recent meetings, upcoming meetings and recent literature;
- A meeting page where detailed information including results and presentations of recently held meetings can be accessed and upcoming meetings are announced;
- A compilation of ongoing and completed discussion processes and dialogs on future commitments and future actions distinguishing between dialog process for negotiators, dialog processes for generating new ideas and completed processes;
- A compilation of institutions involved in designing alternative approaches to the first commitment period and ordered by continents;
- A list and description of approaches under consideration and discussion on international action on climate change after 2012, special types of targets and additional and rather cross-cutting issues;
- A compilation of tools instructive when considering future international actions on climate change, and
- A forum interface for online discussions and information exchange.

2.2 OVERVIEW OF PROCESSES ON FUTURE ACTION

Informal discussion and dialog on future international actions on climate change currently take place at negotiator level and at policy research level.

At negotiator level, discussions are not yet formal but designed as informal and rather informative non-regular meetings and exchange of viewpoints. These discussions are mostly by invitation only and sometime include only certain countries or country groups.

At policy research level, the core activities include generating new ideas on future action and commitment schemes and discussing them with the international scientific and policy research community. These discussions are structured, linked to fixed term dialog processes and concrete outputs and are often supported by external funding agencies. These new insights and scientific outputs are meant to inform negotiators and assist them with preparing their negotiation strategy.

The following processes on future international action on climate change were identified in cooperation with Wuppertal Institute that kindly made information available that was compiled within the framework of the "South-North-Dialogue - Equity in the Greenhouse", one of the process listed below.

Dialog processes for negotiators

- Negotiations under the Climate Change Convention (UNFCCC)
- OECD Annex I Expert Group
- European Union Expert Group on Future Action (EGFA)
- Japanese Initiative
- CCAP dialogue on CDM and future international actions to address global Climate change
- International Network To Advise Climate Talks (INTACT), by SWP

Ongoing processes

- Beyond Kyoto: Advancing the International Effort against Climate Change, by the PEW Center
- CAN Equity Process
- Climate of Trust: the Kyoto Protocol and Beyond, by WRI
- Climate Policy for the 21st Century, by Centre for Transatlantic Relations
- Developing a post-2012 policy architecture, by Fridtjof Nansen Institute et al.
- Development and Climate, by UNEP Risoe, RIVM, IIED
- Equity and Justice Implications of Adaptation to Climate Change
- Helping to operationalise Article 2 (HOT), by RIVM, IVM
- Options for future international action on climate change, by ECOFYS
- Research project on the Next Step of Climate Change Regime, by NIES and IGES
- South-North-Dialogue: Equity in the greenhouse, by Wuppertal Institut and EDRC

Completed processes

- Climate Options for the Long Term (COOL), by RIVM
- Dangerous Climate Change, by Tyndall Centre
- Strategic Assessment of the Kyoto-Marrakech System, by RIIA et al.
- The transatlantic Dialogue on climate change: new ideas for a new era, by CEPS

Further information on those listed processes including their objectives and contact details can be found at the website www.fiacc.net.

2.3 OVERVIEW OF APPROACHES, TARGETS AND CROSS-CUTTING ISSUES

The website provides also an overview of approaches on how to design a post 2012 commitment scheme. Furthermore, different types of proposed targets are discussed and some additional issues addressed, representing rather crosscutting issues for a future political debate to consider.

The term “Approach” encompasses in principle the conceptual idea of how a post 2012 system can be designed. Currently, a number of such approaches are developed by different organisations. These approaches are briefly summarised in the following section and active researchers are identified. For more information readers should refer to www.fiacc.net.

Continuing Kyoto: (Research is done, e.g., by WRI and Ecofys). The Kyoto Protocol provides a very flexible structure, which could incorporate many of the approaches described below. For example, the converging per capita emissions or intensity targets could be included in a second commitment period of the Kyoto Protocol. Essentially, most other approaches could be called “Continuing Kyoto”.

When referring to “Continuing Kyoto” or “increasing participation”, often the key features of the Kyoto Protocol are meant, which include:

- Maintaining two groups of countries, Annex I and Non-Annex I, assuming that gradually countries move into Annex I
- Binding absolute emissions reduction targets for Annex I countries for a basket of greenhouse gases
- Flexibility through Kyoto Mechanisms, such as emissions trading (ET), Joint Implementation (JI) and the Clean Development mechanism (CDM)

Some also refer to a "Kyoto Plus" approach, where the main features are kept and only minor additional changes are made. Intensity targets instead of absolute targets or other minor adjustments such as "price caps" or only "positively binding targets" can be introduced as an interim measure for some or all developing countries. The critical issue of this approach is to

ensure that Annex I countries commit to sufficiently stringent targets and that some further countries move into Annex I.

Multistage Approach: (Research is done, e.g., by RIVM, HWWA, Ecofys). The "multistage approach" assumes that countries gradually move through several stages in between Annex I and Non-Annex I countries with respect to increasing stringency, as opposed to the current system of two stages (Annex I and Non-Annex I). This approach would reflect that countries today have different levels of economic development and therefore have different obligations under a future climate treaty.

The starting point for grouping countries is to assess their characteristics and to define, to what stage they best correspond. Usually a country "graduates" into the next stage, when it exceeds a certain threshold expressed in, e.g., emissions per capita or GDP per capita.

Such multistage approaches are developed by a number of organizations. One option would be to define four such stages e.g.:

1. No Commitments Stage, where countries have no binding emission obligations (as the current Non-Annex I)
2. Decarbonisation Stage, where countries will have GHG intensity targets expressed as emissions per GDP
3. Stabilization Stage, where countries stabilize their absolute emissions
4. Reduction Stage, where countries need to reduce their absolute emissions

The critical issue about this approach is to ensure that a sufficient number of countries move to higher stages. Regular review of each country's situation and assessment whether it graduates into the next stage would be necessary.

Contraction and Convergence: (Research is done, e.g., by GCI (The Global Commons Institute), RIVM, ECOFYS). With the "Contraction and Convergence" approach, all countries would agree on a global target of, e.g., 450 ppmv stable concentration of carbon dioxide in the atmosphere. They would also agree on a path of yearly global emissions that lead to that concentration level (contraction). In a second step, the global emission limit for each year would be shared among all countries, including developing countries, so that per-capita emissions converge by a specific date, e.g. 2050 (convergence). The defined targets for each country can be reviewed and revised when new scientific findings require it.

This approach allows for full emissions trading. As all countries participate, those countries with less allowances than needed (e.g. industrialized countries) can buy allowances from other countries that receive excess allowances (e.g. least developed countries). If stringent stabilization levels such as 450 ppmv CO_2 are to be reached, convergence to a per capita emission level below current Non-Annex I average is needed. Consequently, benefits from transfer of resources will be limited to the least developed countries and to the first decades of operation of the system.

This approach has very simple rules. Two major issues need to be negotiated and agreed upon: the target atmospheric concentration of CO_2 and the date, at which the entitlements would converge at equal per capita allocations.

Multi-Sector Convergence: (Research is done, e.g., by ECN, CICERO). The "multi-sector convergence" approach applies the principle of converging per-capita emissions to emissions of individual sectors and not on the national level (as the contraction and convergence approach). The convergence level for each sector and the date when convergence should be achieved are defined beforehand based on technical potential. They are also open to political negotiations. This approach can in principle be applied on a global scale. It can include all greenhouse emissions gases currently covered under the Kyoto Protocol.

The multi-sector convergence approach takes into consideration the different emissions structures of the countries. It can take into account that emissions from some sectors, e.g. transport, are difficult to reduce (resulting in a high sector per-capita convergence level), while

emissions in other sectors, e.g. from landfills, are relatively easy to reduce (resulting in low sector per-capita convergence levels). Under the multi-sector convergence approach, a country with high landfill emissions has to reduce emissions more than a country with high transport emissions.

Brazilian Proposal: (Research is done, e.g., by IVIG and RIVM). In the negotiations of the Kyoto Protocol, the Brazilian government suggested a method to share emission reductions amongst countries. It was proposed to attribute responsibilities to countries according to the impact of their historical emissions on the surface temperature change and to share emission reduction efforts proportional to their historical contribution.

The approach requires a complex analysis to identify historic emissions and attribute country's contributions to temperature change, which is subject to further research (see MATCH, www.match-info.net). In general, countries with a longer process of industrialization and thus a longer record of greenhouse gas emissions will have a greater share of responsibility for emission reductions than countries where industrialization started later.

The proposal was originally designed for covering Annex I countries. However, it could theoretically be applied to other countries as well.

Triptych Approach: (Research is done, e.g., by Utrecht University, ECOFYS, RIVM). The Triptych approach is a method to share emission allowances among a group of countries, based on sectoral considerations. The approach can theoretically be applied to any group of countries.

The Triptych approach originally distinguished three broad emission sectors: the power sector, the sector of energy-intensive industries and the 'domestic' sectors (e.g. residential and transport emissions). The selection of these sectors was based on a number of differences in national circumstances raised in the negotiations that are relevant to emissions and emission reduction potentials: differences in standard of living, in fuel mix for the generation of electricity, in economic structure and the competitiveness of internationally-oriented industries. The approach was later extended to include also include deforestation and emissions of methane and nitrous oxide.

The emissions of the sectors are treated differently: For electricity production and industrial production, a growth in the physical production is assumed together with an improvement in production efficiency. This takes into account the need for economic development. For the ‘domestic’ sectors, convergence of per-capita emissions is assumed. This takes into account the converging living standard of the countries.

The allowances of the sectors are added up to a fixed national allowance for each country. Only one national target per country is proposed, no sectoral targets, to allow countries the flexibility to pursue any cost-effective emission reduction strategy.

The Triptych approach was originally developed at the University of Utrecht to share the emission allowances of the first commitment period under the Kyoto Protocol within the European Union.

Commitment to Human Development with Low Emissions: (Research done by Research Centre for Sustainable Development, Chinese Academy of Social Sciences (CASS), China). The “commitment to human development with low emissions” approach draws a line between basic and luxury goods of human beings and associated emissions. Having a decent living standard and meeting human being basic needs would not result in taking on commitments to reduce greenhouse gases. The problem with anthropogenic greenhouse gas emissions lies within the consumption of luxury goods that go beyond the basic needs and thus generate GHG emissions that are not necessary.

Unresolved in this approach is the line between basic and luxury consumption and thus basic and luxury GHG emissions. In addition, those products and services need to be identified, that would be acceptable under a decent living standard and which would not.

Some other issues are listed on the website under “Approaches” that refer to broader topics of discussion such as different types of targets, the structure of future negotiations, treaties, the equity issue and vulnerability and adaptation.

In the following, different proposed types of targets are discussed (for details see section 5.2).

- Absolute binding emission reduction targets
- Flexible emission targets (dynamic targets, non-binding targets, positively binding targets, dual targets, price caps, sector targets)
- Coordinated policies and measures
- Enhanced coordinated technology RD&D efforts
- Extended CDM
- Sustainable Development First

In addition to different concept designs and types of targets, information is provided on the web site on the following crosscutting issues (for details see Chapter 5):

- Stabilization of greenhouse gas concentrations
- Vulnerability and adaptation
- Equity
- Structure of negotiations

2.4 OVERVIEW OF INSTITUTIONS

The project team compiled a list of institutions to allow stakeholders to contact active institutions in either guiding processes or developing approaches. The list is accessible on the website as a means to facilitate network operation. The page is updated periodically when new information becomes available:

Africa

- Energy and Development Research Centre (EDRC), South Africa
- Environement et Dévelopment du Tiers-Monde (ENDA), Senegal

Asia

- Bangladesh Centre for Advanced Studies (BCAS)
- Central Research Institute of Electric Power Industry (CRIEPI), Japan
- Centre for Science and Environment (CSE), India
- Chinese Academy of Social Sciences (CASS), PR China
- Institute for Global Environmental Studies (IGES), Japan
- Government of Japan
- Korea Environment Institute, Korea
- Munasinghe Institute for Development (MIND), Sri Lanka
- National Institute for Environmental Studies (NIES), Japan
- Pelangi, Indonesia
- The Energy and Resource Institute (TERI), India

Europe

- Centre for Environmental System Research, University of Kassel, Germany
- Centre for European Economic Research (ZEW), Germany
- Centre for European Policy Studies (CEPS), Brussels
- Centre for International Climate and Environmental Research Oslo, (CICERO), Norway
- Chalmers University of Technology, Department of Physical Resource Theory, Sweden
- Energy Research Centre of the Netherlands (ECN)
- ECOFYS
- Fondazione Eni Enrico Mattei (FEEM), Italy

- Foundation for Environmental Law & Development (FIELD), United Kingdom Free University of Amsterdam, Institute for Environmental Studies (IVM)
- Fridtjof Nansen Institute, Norway
- German Advisory Council on Global Change (WBGU)
- German Federal Environmental Agency (Umweltbundesamt), Germany
- German Institute for International and Security Affairs (SWP)
- Global Commons Institute (GCI), United Kingdom
- Hamburg Institute if International Economics (HWWA), Germany
- International Energy Agency (IEA), France
- International Institute for Environment and Development (IIED), United Kingdom
- National Environmental Research Institute (NERI), Denmark
- National Institute for Public Health and the Environment (RIVM), The Netherlands
- New Economies Foundation (NEF), United Kingdom
- Oxford Institute for Energy Studies, United Kingdom
- Royal Institute of International Affairs (RIIA), United Kingdom
- Swedish Environmental Protection Agency, Sweden
- UNEP Risoe Centre (URC), Denmark
- University of Utrecht, The Netherlands
- Wuppertal Institute, Germany

Latin America

- IVIG (COPPE / Federal University of Rio de Janeiro), Brazil
- El Colegio de Mexico (Programa Agua, Medio Ambiente y Sociedad)

North America

- Centre for Clean Air Policy, USA
- Center for Transatlantic Relations, USA
- EcoEquity, USA
- International Institute for Sustainable Development (IISD), Canada
- Lawrence Berkeley National Laboratory, USA
- McDonough School of Business, Georgetown University Washington, D.C.
- MIT Joint Program on the Science and Policy of Global Change, USA
- PEW Center for Global Climate Change (PEW), USA
- Tellus Institute/ Stockholm Environment Institute, USA
- World Resources Institute (WRI), USA

International

- Climate Action Network (CAN)
- International Energy Agency
- Organization for Economic Co-operation and Development (OECD)

2.5 INTERACTIVE FORUM

The web site includes an interactive internet-based discussion forum with the following purposes:

a) Allow stakeholders to share their viewpoints and opinions on specific discussion topics that were initiated on a regular basis. The preparation of discussion papers was initiated by the German Federal Environmental Agency, supported by Ecofys or other co-authors.

b) To provide individuals not directly involved in future actions on climate change an opportunity to post questions on future actions on climate change such as to approaches or discussion processes.

Online forum discussions were organised at www.fiacc.net and discussed the following themes (Kick-off papers can be found in Appendix A to Appendix D):

- Discussion January 2004: "Converging per capita emissions". Discussions focused on two areas: First, the trade off between simplicity and adequacy was addressed. It was noted that some differentiation in addition to per capita emissions would be necessary in particular related to historical responsibility. Second, the issue of inclusiveness versus practicability was addressed. Converging per capita emissions is often seen as including all countries, but also an approach including only the largest emitters could still aim for convergence in per capita emissions.
- Discussion February 2004: "The role of the USA and its re-engagement in climate policy debates". Discussion concluded that engaging private businesses constructively with proactive players will be key for a re-engagement of the USA. It was mentioned that many US states have implemented or are planning to implement binding absolute targets. The question whether federal actions could be triggered by such state action was controversially discussed, although general consensus was there, that state-level action is key to US-reengagement.
- Discussion March 2004: "Interpreting Article 2 of the Convention, dangerous anthropogenic interference with the climate system". Discussion concluded that any target is strategic, since it implies damages/risks to some which cannot be justified on ethical grounds. The *perception* of risks seems to be the key to a decision on Article 2. Accordingly, it is not science only that matters, but public and administrative awareness as well.
- Discussion May 2004: "Costs of mitigation and its calculation by utilising Integrated Assessment Models". Online discussion was intended to provide some preliminary thoughts that could be used to further discuss at a workshop organised on this topic and hosted by the Federal Environmental Agency at Berlin on 9 to 11 June 2004. Possibly because of the proximity to the workshop, unfortunately no contributions to this discussion topic were received.

2.6 LESSONS LEARNT AND OUTLOOK

At project end, the functioning of the interactive forum discussion platform was assessed. The results can be summarised as follows.

- Users reported personal registration to participate in forum discussions to be not user friendly and would prefer an alternative means for participation. However, apart from minor problems with registration handling, 230 individuals registered and followed discussion but only a few contributed to discussion. The team concludes that some adjustments should be provided to facilitate discussion participation thus attracting more people to participate.
- High-quality kick-off papers were prepared to initiate monthly discussions. Although very useful to use as a document to start a debate on, some of the papers may have been too long to attract readers to share their viewpoints with others. A rather long discussion paper might be a major reason for no participation in the May discussion on mitigation costs and Integrated Assessment Models.
- Participation takes place on a voluntary basis and required participants to free up some of their time. Since time is the most critical issue for many professionals in climate change, moderate participation in discussion is likely due to individual time constraints.

The website will remain active and discussions will continue on further topics also after project termination in November 2004, then funded by the European Commission. Ecofys will

improve user-friendliness of global opinion exchange and discussion. Future discussion themes tentatively scheduled until the end of 2004 could for instance include:

- The future role of adaptation and its inter-linkages with mitigation in a future climate regime
- Differentiations between developing countries with regard to their position of a future climate regime.

3. INTERESTS OF COUNTRIES

This chapter further elaborates on the countries' different expectations for a future international climate regime. It first elaborates a detailed list of criteria against which various approaches can be checked. Second, country perspectives are summarized and possible areas of conflict between different groups of countries are identified. In a third step, positions of major countries are outlined with respect to the criteria and key conflicts. Finally, a few example countries are discussed in greater detail, outlining their national situation in terms of greenhouse gas emissions, climate change strategies and key interests.

3.1 CATALOGUE OF CRITERIA

Different criteria can be used to assess a future international climate regime. A distinction can be made into general or factual criteria, such as environmental criteria, economic criteria and, technical/institutional criteria, and more political criteria. Table 1 provides an overview of the general criteria. Starting from the criteria in Höhne at al. (2003), the catalogue of criteria was extended, taking into account recent literature (e.g. Berk & den Elzen, 2003).

Table 1: Overview of general criteria to assess future climate regimes

Category of criteria **Sub-criteria**	**Key question**
Environmental criteria	***Can the approach safeguard the fulfilment of the ultimate objective of the Convention (Article 2)?***
(1) Putting emphasis on environmental effectiveness	Does the approach put environmental effectiveness (e.g. greenhouse gas emission reductions) as the core of a future regime
(2) Participation of industrialized countries	Does the approach consider substantial emission reductions by key emitters in industrialized countries?
(3) Encouraging early action	Are countries that do not yet have binding commitments encouraged to keep emissions as low as possible by e.g. considering technology leapfrogging? If early actions are encouraged, are they rewarded later?
(4) Involvement of developing countries	Are developing countries with substantial GHG emissions (gradually) involved in the reduction efforts?
(5) Comprehensiveness of system	Is the regime a comprehensive system that includes the most important GHG gases responsible for climate change?
(6) Avoiding leakage effects	Does the regime minimize that emission reduction efforts in one country/sector are compensated by increasing emissions in another country or sector? If such leakage is not prevented, is it adequately accounted for?
(7) Avoiding unintentional "hot air"	Does the regime prevent that a country receives more emission rights than it would need under a business-as-usual scenario?[1]
(8) Integrating adaptation and sustainable development	Does the regime consider specifically adaptation and does it create synergies with sustainable development?
(9) Promoting ancillary benefits	Does the approach promote other environmental benefits such as improved air quality?
Economic criteria	***Can the approach ensure that global emission reduction efforts can be achieved in a cost-effective way and lead to positive economic side effects?***
(1) Minimizing negative economic effects	Does the approach allow distribution of commitments so that the aggregate global costs are minimized and give countries sufficient flexibility to reach their commitments?

[1] A regime may intentionally include "hot air", as under the convergence approach, as a compensation mechanism.

Category of criteria **Sub-criteria**	**Key question**
(2) Generating positive economic side effects	Does the regime generate positive economic side effects as result of a climate friendly development?
(3) Promoting growth of developing countries	Does the regime promote / not hinder (economic) growth of developing countries thus setting positive economic growth impulses?
(4) Stimulating technological change and providing incentives for technology spill-over	Can the approach stimulate the technological change necessary for the transition to a low greenhouse gas emission energy system in an efficient manner? Will these technologies be deployed also in developing countries?
(5) Accounting for structural differences between countries	Are different national circumstances of countries taken into account in the approach?
(6) Certainty about costs	Does the regime allow predicting the level of costs and related economic impacts on countries to avoid the risk of unexpected high costs and/or unintended unevenly distributed burden?
Technical and institutional criteria	***Is the approach designed in an efficient way?***
(1) Can build upon and use many agreed elements of the existing Kyoto system	Can the regime be built upon or use key elements of the Kyoto system such as a) basket of gases, b) Kyoto mechanisms, c) emission monitoring systems, and d) negotiation structure?
(2) Moderate political requirements for the negotiation process	Is the approach simple and requires a low number of separate decisions by international bodies? Do the decisions cover a clear and manageable future timeframe?
(3) Moderate technical implementation requirements	Are all necessary data and tools available and easily verifiable and is the regime built in a way that it avoids or limits fraud and corruption?
(4) Inherent stability of the regime	Is the regime flexible enough to ensure countries' continued participating also in the case of unexpected events? Can countries easily "walk away" from the agreement?

In addition to the criteria listed above, "political criteria" can be used to assess the acceptability of the approaches for countries and regions. An assessment of the acceptability of approaches is largely determined by the countries' assessment for the general criteria listed in Table 1. Countries give different weight to these criteria and may have a different perception of the regime.

When evaluating a regime or proposal, one would have to assess, whether it could be acceptable to the major players. We selected here four: a) the EU, b) the USA, c) advanced developing countries[2] and d) least developed countries.

In addition, a successful future regime could satisfy certain equity criteria, including "need", "capability", "responsibility", "equal rights", "comparable efforts", and "sovereignty". Table 2 lists these sub-criteria.

[2] For this analysis we understand "advanced developing country" as a Non-Annex I country that could be considered, if additional developing countries were to take on commitments. Such countries would have for example high per capita emissions, high absolute emissions or high per capita income. Examples could be Argentina, Brazil, China, Malaysia, Mexico, South Africa and South Korea.

Table 2: Overview of political criteria to be used to assess equity elements of approaches and country perspectives

Category of criteria Sub-criteria	Key question
Political criteria	
(1a) Meeting equity principle "Needs"	Is the opportunity given to all countries to satisfy their basic development needs?
(1b) Meeting equity principle "Capability"	Are the countries required to act those that have the capability to do so?
(1c) Meeting equity principle "Responsibility"	Are the countries required to act those that are responsible for the problem?
(1d) Meeting equity principle "Equal rights"	Does the regime take equal rights of all people to use the atmosphere into account?
(1e) Meeting equity principle "Comparable efforts"	Does the regime anticipate comparable efforts from similar countries to mitigate climate change?
(1f) Meeting equity principle "Sovereignty"	Does the approach take into account that states are sovereign? Does the approach use nations' current emission as the basis for a future climate policy?
(2a) In agreement with fundamental positions of the EU	Could the approach be acceptable for the EU given their current position?
(2b) In agreement with fundamental positions of the USA	Could the approach be acceptable for the USA given their current position?
(2c) In agreement with fundamental positions of advanced developing countries	Could the approach be acceptable for large developing countries given their current position?
(2d) In agreement with fundamental positions of LDCs	Could the approach be acceptable for LDCs (Least Developed Countries) given their current position?

The catalogue of criteria is quite comprehensive and may prove too long to serve as an assessment framework for different future climate policy regimes. However, it may be instructive to keep this full list in mind when further developing selected approaches.

3.2 COUNTRY PERSPECTIVES AND POSSIBLE CONFLICTS

This chapter discusses, which of the criteria outlined in Table 1 and Table 2 are particularly important for major players, such as the EU 25, the USA, advanced developing countries and least developed countries to filter out the most important criteria and major conflicts. We recognize that the views of the 189 parties of the UNFCCC are more diverse than the four shown here, but we also view that these four are the crucial ones for the future negotiations.

As a first step, we assessed the emphasis given to the different criteria by the major players according to our own assessment. As most positions are not known publicly, the assessment is subjective. Table 3 shows our perception of whether the different players think the fulfilment of the criterion is important (Y) or very important (YY), whether they are indifferent towards the criterion (0), whether the fulfilment of the criterion is undesirable (N) or whether the position of the player could not be determined (?).

Table 3: Assessment of countries' perceived emphasis on criteria for future climate regimes

Category of criteria Sub-criteria	EU 25	USA	Advanced developing countries (ADCs)	Least developed countries (LDCs)
Environmental criteria				
(1) Putting emphasis on environmental effectiveness	**YY**	**N**	0	Y[1]
(2) Participation of industrialized countries	Y	0	**YY**	**YY**
(3) Encouraging Early Action	Y	Y	0	0
(4) Involvement of developing countries	Y	**YY**	**N**	**N**
(5) Comprehensiveness of system	Y	Y[2]	Y	Y
(6) Avoiding leakage effects	Y	Y	?	?
(7) Avoiding unintentional "hot air"	0	0	0	0
(8) Integrating adaptation and sustainable development	0	0	**YY**	**YY**
(9) Promoting ancillary benefits	Y	0	Y	Y
Economic criteria				
(1) Minimizing negative economic effects	Y	**YY**	Y	Y
(2) Generating positive economic side effects[3]	Y	Y	Y	Y
(3) Promoting growth of developing countries	Y	0	**YY**	**YY**
(4) Stimulating technological change and providing incentives for technology spill-over	Y	**YY**	Y	Y
(5) Accounting for structural differences between countries	Y	Y	Y	Y
(6) Certainty about costs	Y	**YY**	Y	0
Technical and institutional criteria				
(1) Can build upon and use many agreed elements of the existing Kyoto system	**YY**	**N**	0	0
(2) Moderate political requirements for the negotiation process	Y	?	?	?
(3) Moderate technical requirements	Y	Y	Y	Y
Political criteria				
(1a) Meeting equity principle "Needs"	Y	Y/0[4]	**YY**	**YY**
(1b) Meeting equity principle "Capability"	Y	0	**YY**	**YY**
(1c) Meeting equity principle "Responsibility"	Y	0	**YY**	**YY**
(1d) Meeting equity principle "Equal rights"	0	**N**	Y	Y
(1e) Meeting equity principle "Comparable efforts"	**YY**	Y	Y	Y
(1f) Meeting equity principle "Sovereignty"	?	**YY**	?	?

YY: "Fulfilment of the criterion is very important for the player"
Y: "Fulfilment of the criterion is important for the player"
0: "Player is indifferent towards this criterion"
N: "Fulfilment of the criterion is not desired by the player"
?: "Position of the player is not known"
[1]: most vulnerable countries (e.g. small island states) would urge emission reductions
[2]: USA was a main proponent of 6-gas basket, probably rather to increase flexibility than to be inclusive
[3]: all countries would welcome if the regime had positive economic side effects for them.
[4]: "Y" for needs of the USA, "0" for developing countries' needs

General points of agreement can be observed in the assessment presented in Table 3. Several criteria seem to be important for all major players considered here. Such criteria should be fulfilled by any future regime; they are uncontroversial. The uncontroversial

environmental criteria include the comprehensiveness of the systems, and the less important avoiding leakage effects and unintentional "hot air". Many countries would also subscribe to most of the economic criteria such as minimizing negative economic effects, generating positive economic side effects, stimulating technological change and providing incentives for technology spill-over, accounting for structural differences of countries and certainty about costs. The equity principles "capability" and "comparable efforts" are also generally accepted. As long as these criteria are formulated in such general way, they are generally acceptable. But it depends on the details of the future regime, whether countries will view these criteria as fulfilled or not.

Potential conflicts lie in other criteria. Countries or country groups have different potential expectations of a future commitments regime and for some criteria views strongly oppose, a "YY" usually is opposed by a "N" in Table 3. From the assessment presented, we extracted four major conflicts that need to be addressed with care in future climate negotiations. These conflicts are listed in Table 4. Figure 1 shows the interrelation between the players regarding these conflicts. Although the conflicts are shown here as independent it is recognized that they are interrelated.

Table 4: Possible conflicts between expectations

Position A	Versus	Position B
Ensuring economic efficiency (low cost and certainty about emission reduction costs)	vs.	Ensuring environmental effectiveness (low emissions and certainty on low global emission levels)
Further commitments for Industrialized Countries (ICs) and Developing Countries (DCs)	vs.	Further commitments only for Industrialized Countries (ICs)
Focusing on mitigation measures	vs.	Considering adaptation measures
Building upon the Kyoto Protocol	vs.	Restart negotiations on a new protocol or new agreement

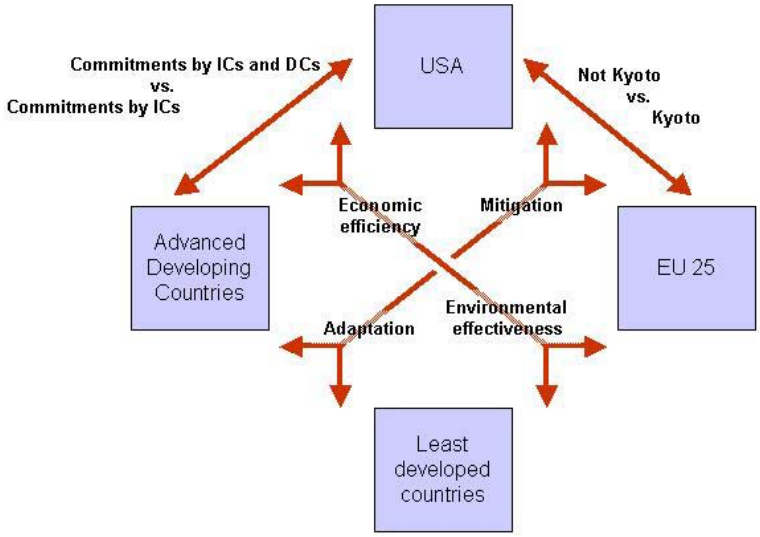


Figure 1: Simplified conflict areas between selected countries / groups

Conflict area 1: Economic efficiency vs. environmental effectiveness:

The most prominent conflict lies within the fundamental approach to the problem of climate change: Some players, most prominently the USA, approach it as an economic problem. To keep the costs for reducing GHG emissions at a minimum bearable level has highest priority. Emphasis is given to short-term economic considerations rather than to long-term

environmental objectives. Hence, emission reductions are not treated with urgency, one is preparing to act later through, e.g. technology development. Some other players, in particular the EU and LDCs, put instead high priority to the environmental aspect of the problem and stress the urgency to act. For these groups of countries, keeping global emissions low has the highest priority. Those countries could probably not agree to a regime where the costs are minimized, but where it is unclear whether the long-term objective of the Convention can be met. Those countries would prefer to work towards defining a joint long-term goal. This fundamental conflict is illustrated in Figure 1 between the USA and advanced developing countries on the one side and the EU and least developed countries on the other side.

Conflict area 2: Further commitments for ICs & DCs or only ICs:

The UNFCCC states that Parties should protect the climate system "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." With the Kyoto Protocol, such a first step for Annex I countries was negotiated. Since the Kyoto Protocol still has not entered into force, two fundamentally different positions still exist: On the one hand, the group of developing countries is of the view that industrialized countries have not yet "taken the lead" and should commit to further reductions due to the fact that they started emitting greenhouse gases many decades ago and therefore carry most historic responsibility. Developing countries will only commit to act, once proven progress has been made by Annex I countries to reduce emissions. On the other hand some countries point to the fact that some developing countries considerably contribute to global GHG emissions today and that even dramatic emission reductions in industrialized countries alone cannot ensure that stabilization of greenhouse gas concentrations. In addition, limits on greenhouse gas emissions only on some countries would distort the market and provide a competitive advantage. Some developing countries should also commit to reductions depending on their current stage of development. On this conflicting issue, which is essentially between the USA (and to a lesser extent the EU) and advanced developing countries (Figure 1), a compromise has to be found.

Conflict area 3: Mitigation vs. adaptation:

Another conflict area is the relation between mitigation and adaptation. Some countries are more vulnerable than others to climate change, e.g. countries with low lying coastal areas. In most cases, these countries do not have the financial resources to cope with the effects of climate change themselves such as sea level rise, accelerated soil erosion and increased risks of storm flooding. They therefore need considerable financial assistance today or in the very near future. These most vulnerable and affected countries therefore call for early and effective adaptation measures as part of their sustainable development and argue a future climate change regime should support their sustainable development in general. For another group of countries, mitigation, the reduction of greenhouse gas emissions, is of priority rather than adaptation. They argue that mitigation measures are the best means to adapt to climate change, thus a future regime should focus on further reducing emissions. Those countries are not completely against adaptation measures but the immediate need for adaptation with its immediate effects needs to be balanced with mitigation efforts, which show an effect only with some time delay. Attention on adaptation should not distract from the need to reduce emissions. This fundamental conflict is illustrated in Figure 1 between the USA and the EU on the one side and the developing countries on the other.

Conflict area 4: Building upon Kyoto Protocol or negotiating a new Protocol:

Some countries, lead by the EU, clearly stated that a second commitment period of the Kyoto Protocol is the only way forward in international climate policy. Building upon the existing elements and the institutional structure would avoid time-consuming and costly future negotiations on a completely new institutional setup. One should make use of as many elements (technical and institutional structures) of the Kyoto Protocol as possible when strengthening the overall mitigation efforts. Some other countries, lead by the USA, have taken a very different position, arguing that the Kyoto Protocol includes too many flaws and does not provide a good basis for a continued discussion on future actions to mitigate climate

change. Abandoning the Kyoto Protocol, setting up some other mechanism is therefore favoured by those countries. Strong, almost emotional sentiments are brought forward in favour or against the Kyoto Protocol. Yet it is unclear, exactly which elements are to be rejected and which could possibly be kept. Again, a compromise must incorporate the divergent views of mainly the USA and EU (Figure 1).

3.3 SUMMARY

Several criteria are perceived important by all major countries or country groups. These uncontroversial criteria should always be satisfied when designing a future international climate regime. The system should be comprehensive, should minimise negative economic effects and should be shaped according to the principle of capability and comparable effort. All countries could agree to these general requirements. These areas would need careful consideration when designing the future regime, but it will depend on the detailed elaboration of these concepts, whether countries will view the requirements as fulfilled or not.

Future consultations and negotiations must focus on the major conflict areas identified here. We observe that several fundamental conflicts involve only a limited group of countries. E.g. the question of using the structure of the Kyoto Protocol and to a large extent the divergence on the issue of economic efficiency versus environmental effectiveness are essentially disputes between the EU and the USA. Involvement of developing countries in a future climate regime needs agreement between the USA and advanced developing countries. This may point towards a strategy that these major conflicts are addressed first between the players most concerned.

Another observation is that individual countries within the group of developing countries have very diverse and often conflicting positions. For example, the group of developing countries is split on the issue of economic efficiency and environmental effectiveness. Least developed countries would opt for stringent global emission reduction efforts, while advanced developing countries would (and currently do) resist this. The way the group of developing countries operates would be an important element to consider for the negotiation strategy (see chapter 11).

4. COUNTRY CASE STUDIES

This Chapter presents four case studies on individual countries, outlining their implemented climate policies, emission profiles and projections, vulnerability and key incentives to participate in a climate regime. The cases include Mexico, India, China and the USA.

4.1 CASE STUDY: MEXICO

4.1.1 National climate policy

In 1993, Mexico ratified the Framework Convention on Climate Change. Following ratification, the government of Mexico appointed the Secretariat for Environment and Natural Resources (Semarnat) as the legal entity responsible for planning, coordinating, supervising and evaluating climate change policies in the country. In April 1997, the Inter-Ministerial Committee on Climate Change was formed to coordinate climate change issues. In 2000, Mexico ratified the Kyoto Protocol as the first large oil-exporting developing country.

Mexico has implemented several specific measures and policies to reduce GHG emissions, particularly from the energy sector and through forestry projects. Table 5 outlines some specific examples for each of these measures implemented in Mexico during the last decade.

Table 5: Examples of GHG mitigation measures implemented in Mexico

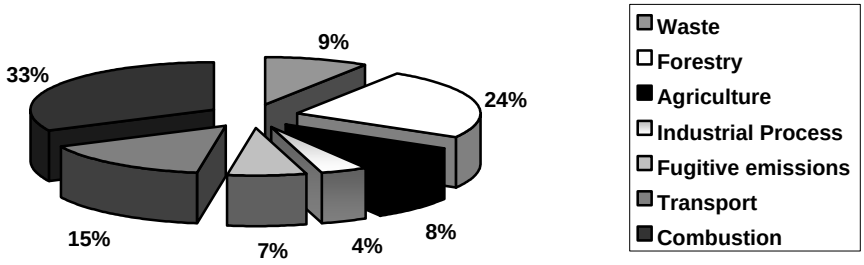
Measures	Examples
Energy conservation and energy efficiency	Creation of the National Commission for Energy Saving (CoNAE), to promote energy savings at national level and the use of renewable energy; Creation of a fund aimed at saving electric energy to assist in the implementation of a utility based program for savings
Use of new and advanced technologies	Introduction of electric power plants using combined cycle in the electric system; Several demonstration projects which have increased the industrial capacity for solar technologies
Fuel substitution and improvements of fuel quality	Fuel switch from oil to natural gas; Reduction of carbon contents in major fossil fuels
Fuel price changes	Reduction of specific energy subsidies; Increasing gasoline taxes
Policy change in forest conservation	Implementing forest fire control

Source: Second National Communication and “Climate change mitigation in developing countries” and PEW Center (2002)

Implementation of these measures has considerably contributed to avoiding additional emission growth. The success of future energy-related emission reductions will depend on the evolution of the energy sector and the possibilities of private investment into cleaner energy fuels. The Mexican constitution is the principal bottleneck to allow increasing investments into renewable energy in Mexico since it currently limits participation of the private sector in the production and distribution of energy. The Congress has not yet approved the President’s efforts pushing free market reforms in the energy sector. The National Energy Plan for the period 2001 to 2006 presented by the Fox Administration proposed a greater share of the involvement of the private sector in Mexico in producing and distributing energy. In May 2002 a historical step was taken into the direction of energy sector privatization when shares of two of the main state-owned energy companies were sold through funds to be invested in infrastructure.

4.1.2 Emission profile: current and future emissions

Current and Past Emissions: In 1990 Mexican GHG emissions reached 188 MtCeq. and grew about 16 percent until 1996 reaching 217 MtCeq. (Second National Communication of Mexico). The predominant gas was carbon dioxide (79%), followed by methane (20%) and nitrous oxide (1%). Figure 2 shows how GHG emissions are distributed among the sectors.



Source: Second National Communication by Mexico

Figure 2: Greenhouse gas emissions in CO_2 eq. according to sectors

Table 6 illustrates the development of energy-related GHG emissions during the period 1990 to1998 from Mexico's second national communication of 2001. Energy related CO_2 emissions have increased by 30% from 1990 to 1998.

Mexico is the 12th largest GHG emitting country. Mexico's per capita emissions are slightly below global average (sources: Höhne et al. 2003, WRI climate analysis indicator tool).

Table 6: Energy-related CO_2 Emissions per sector ($MtCO_2$)

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998
Industrial	55.769	55.345	55.757	56.149	59,926	61,070	62,083	60,935	62,408
Utilities	37,872	38,380	35,586	35,980	37,059	32,201	38,976	41,606	47,301
Residential	18,784	19,490	20,114	20,676	21,608	21,985	22,361	22,471	22,580
Commercial	3,725	4,690	5,370	5,306	5,878	5,377	5,828	6,043	6,418
Agriculture	4,984	5,138	5,169	5,204	4,927	5,072	5,421	5,797	5,738
Electricity	66,992	69,237	67,761	70,350	84,200	77,958	82,868	92,146	101,343
Total Without Biomass	188,126	192,280	192,757	193,665	213,598	203,663	217,537	228,998	245,788

Source: Second National Communication of Mexico under the United Nations Convention on Climate Change, 2001

Future Emissions: Table 7 illustrates the projection of carbon dioxide emissions for the energy sector and forestry until 2010. These projections were calculated assuming an average growth of the GDP of 4.5 percent and an average population growth rate of 1.2% for the decade 2000-2010[3]. According to this source, emissions from energy are expected to almost double (+80%) from 2000 to 2010. Emissions from forestry are expected to decrease by 20%.

[3] For more information on the methodology used read the Second National Communication of Mexico under the UNFCCC

Table 7: Projected CO_2 emissions ($MtCO_2$)

Sector	1990	1995	2000	2005	2010
Energy[4]	292,1	333,4	397,9	546,3	726,0
Forestry	228,9	206,7	186,6	168,9	152,9
Total	521,0	540,1	584,5	715,2	878,9

Source: see 2nd NC Mexico: Sheinbaum C. y O. Masera 2000. Mitigating carbon emissions while advancing national development priorities; the case of Mexico climatic change

4.1.3 Vulnerability

Changes in climate can already be observed in Mexico. In northwestern Mexico, there is a tendency for more winter precipitation, which has resulted in positive trends in river water levels. However, inter-annual climate variability has also increased. On the other hand some parts of southern Mexico and Central America exhibit positive or negative rainfall trends, depending on the orientation of the catchment.

Future climate scenarios of Global Climate Models predict an increase in mean temperature changes for the next century between 0,2-2% for large parts of Latin America. Downscaled global climate model experiments for Mexico suggest that the climate in Mexico in general will be drier and warmer. Several hydrological regions in Mexico are highly vulnerable to decreased precipitation and higher temperature having a substantial impact on agriculture and land use. Along the central American coastline that includes parts of Mexico, sea level rise will affect infrastructure, agriculture and natural resources, as well a potentially exacerbate coastal erosion and salinization of aquifers and increased flood risks and the impacts of severe storms (IPCC, Impacts, Adaptation, and Vulnerability, 2001).

In 1998 a Vulnerability Study of Mexico City was carried out, in order to analyze a scenario of the bioclimatic conditions of this city in the case of doubling of CO_2 concentrations in the atmosphere. With one of the models a possible increase of 2.1°C in the annual temperature was obtained for a specific part of this urban area.

The 1982-1983 droughts and forest fires registered in Mexico and Central America caused damages estimated at more than US$600 million. The extended drought over the past decade in Mexico seems to be the result of general climate changes. The “El Nino” events have been occurring more frequently and more intensively since the eighties, as compared with previous periods (Magana 1999)

4.1.4 Domestic interest groups supporting climate change activities

Amongst the major interest groups in Mexico are the Petroleos Mexicanos (PEMEX) a state-owned oil and gas company and the Comision Federal de Electricidad (CFE), the national electricity utility. PEMEX (in contrary to CFE) has a rather proactive position towards climate protection. It has implemented internal energy saving programs, and is at the moment developing plans to deal with climate change issues. In addition, the firm has developed a voluntary company-based emission trading system to early gain knowledge and hands on experience with such a new mechanism.

4.1.5 Incentive for Mexico to engage in further action on climate change

Mexico has demonstrated a positive position towards combating climate change. At COP6, Mexico confirmed supporting the Kyoto Protocol and announced political willingness to continue with implementing additional GHG regulations in the country.

Two conditions were informally mentioned by Mexico’s government under which the country would be willing to support further actions on climate change. First, future actions on climate

[4] The energy sector includes; industrial, self-consumption, residential, commercial, electricity and transport sector.

change would need to be explicitly linked to visible progress by industrialized countries to reduce emissions. This could be achieved by making a "condition for action by developing countries" that the global average per capita emissions or global average emission intensity decreases. Second, further action is taken through a broadened CDM, which could be applied to sectors and policies.

In spite of its active national climate policy, Mexico is one of the two OECD countries that are not included in the Annex I to the UNFCCC (together with South Korea). The main reason for this was that the Framework Convention on Climate Change was adopted before Mexico became a member of the OECD, of which it is now a member for almost 10 years.

Becoming member of the OECD was part of the international trade policy implemented in the beginning of the 80's. As part of this process Mexico also joined the GATT (General Agreement on Tariffs and Trade) and the WTO (World Trade Organisation) and signed several bilateral and multilateral international trade agreements. Within the most relevant ones are the EU-Mexico and the North American Free Trade Agreement (NAFTA) with Canada and the United States. As only Canada and the EU are committed to emission targets, Mexico may be left with a competitive advantage. Canada has already expressed its concern about this matter.

Consequently, there are two mayor forces outside the climate regime that could influence Mexico's participation on future action on climate change. One is its global commitment as an OECD country. And the other one is the future negotiation to continue with NAFTA and the EU-Mexico treaty.

4.2 CASE STUDY: INDIA

4.2.1 National climate policy

In 1985, India founded the Ministry of Environment and Forests, MoEF that has since then initiated many activities in the area of environmental protection. In 1993, India ratified the United Nation Framework Convention on Climate Change and appointed responsibility for national climate change issues to the MoEF. In August 2002, India ratified the Kyoto Protocol.

One of the key challenges for GHG emissions reductions is the substantial development need that India faces today. In order to increase economic growth India has developed an open and market based economy and developed a highly sophisticated science and technology sector. This market reform has, among others measures, improved India's fuel quality, technological standards, infrastructure and operating practices in the power and coal sector. Another important change was implemented with price reforms, which brought the coal price in India to world coal price levels.

Despite technology improvements local environmental protection initiatives are a second important factor that have contributed to GHG emissions reductions. Pressure from citizens to reduce air pollution has pushed the court to enforce existing laws to improve air quality. Table 8 below provides some examples of the GHG mitigation measures implemented in India.

Table 8: Examples of GHG mitigation measures implemented in India

Measures	Examples
Clean Power from Fossil Fuel	More efficient use of coal is being encouraged through legislative, financial, managerial and technical interventions; In 1994, the Centre for Power Efficiency and Environmental Protection was established to assist utilities in reducing CO_2 emissions.
Energy Conservation and Efficiency Improvements	Under the Energy Act 2001, the Bureau of Energy Efficiency was established to facilitate and enforce efficient use of energy; Energy conservation measures such as increasing recovery of heat and use of natural gas were implemented the Indian refining industry.
Harnessing Renewable	The foundation of the Ministry of Non-Conventional Energy Sources in

Energy	1992 pushed renewable energy; Development of different programmes to increase sustainable energy in rural areas
Enhancing Scientific Understanding	Monitoring weather and climate data by the Indian Meteorological Department; Creation of a network of institutes for the preparation of sectoral GHG inventories
Strengthening Adaptive Capacity	Adaptation strategies in agriculture, such as promotion of integrated pest management; Training programmes, workshops and projects related to climate change with an aim to strengthen indigenous capabilities of institutions for suitable long-term planning and assessment.

Source: "Asia Least-cost Greenhouse Gas Abatement Strategy", Asia Development Bank, 1998 and "Climate change mitigation in developing countries", PEW Center 2002

India has an ancient tradition of protecting forest and conserving biodiversity and thus has initiated forestry-related GHG mitigation measures. India's forestry legal framework dates from 1927 when it produced the Indian Forestry Act. There is a National Forest Policy, which aims at increasing forestry in the country and conserving the existing ones. Programmes such as the National Forestry Research Programme and the National Forestry Action Programme support this policy, National institutes, such as the Indian Council of Forestry Research and Education (ICFRE), the Forest Survey of India, the Wildlife Institute of India, and the Indian Institute of Forest Management are involved in activities related to climate change.

4.2.2 Emission profile: current and future

Current and past emissions: India has not yet submitted a national communication, so emission data have to be taken from other sources. The following chart and table illustrate India's GHG emission profile from the Asia Least-cost Greenhouse Gas Abatement Strategy project (ALGAS). Figure 3 illustrates India's energy–related CO_2 emissions and Table 9 summarizes India's national GHG inventory for 1990.

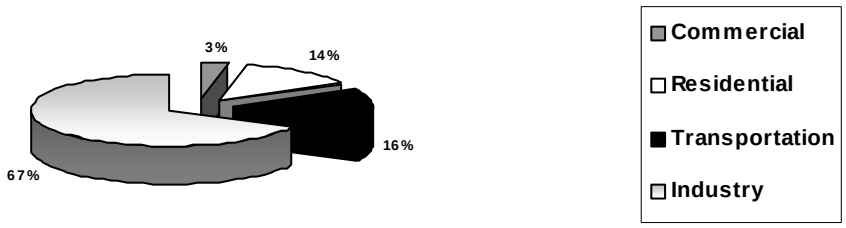


Figure 3: Energy- related CO_2 Emissions

Table 9: India's National GHG Inventory for 1990

Greenhouse gas sources and sinks	CO_2 emissions kt	CO_2 removals kt	CH_4 kt	N_2O kt	NO_x kt	CO kt	Total (CO_2 +CH_4 +NO_x) ktCO_2 eq.
Energy sector Fuel combustion + fugitive	508,600		2,535	11	3,084	14,965	565,245
Industrial process	24,200			1			24,510
Agriculture			12,654	243	109	3,038	341,064
Land use change and forestry	52,385	-50,900					1,485
Waste			3,288				69,048
Total national emissions and removals	585,185	-50,900	18,477	255	3,193	18,003	1,001,352

Source: Asia Development Bank, Global Environment Facility, United Nation Development Programme: Asia Least-cost Greenhouse Gas Abatement Strategy

The IEA also provides CO_2 emissions from fuel combustion for India, which are provided in Table 10.

Table 10: India's emissions from fossil fuel combustion ($MtCO_2$)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Public Electricity and Heat Production	237	263	286	316	331	375	406	418	437	470	478
Unallocated Autoproducers	14	15	17	19	19	22	24	25	27	29	30
Other Energy Industries	18	17	18	18	18	19	19	19	19	22	27
Manufacturing Industries and Construction	152	162	169	163	187	182	184	189	197	181	188
Transport	76	86	89	90	94	100	110	116	118	125	125
Other Sectors	88	89	88	88	90	90	90	91	86	90	90
Total	583	632	667	693	738	788	832	858	882	917	937

Source: IEA, CO_2 emissions from fuel combustion, 2002 version

India is ranked the 5th contributor to global GHG emissions. Absolute energy related CO_2 emissions increased from 1990 to 2000 by around 70%, on a per capita level by around 40% (sources: Höhne et al. 2003, WRI climate analysis indicator tool). Nevertheless, India's carbon emissions per capita are only a third of the global average (accounting all Kyoto sectors and gases).

Future Emissions: Table 11 shows the projected GHG emissions for the energy sector taken from the ALGAS study. The ALGAS scenario is driven by a continuation of economic, demographic and energy trends and current policy. Under this scenario, energy related emissions will threefold between 2000 and 2020.

Table 11: Energy Sector: Projections of CO_2 emissions ($MtCO_2$)

Sectors	Year 1990 Historic data	Year 2000 projection	Year 2010 projection	Year 2020 projection
Coal	328.4	628.0	1,125.0	2,040.0
Petroleum	162.7	270.0	439.8	715.0
Natural gas	17.5	50.1	81.6	133.0
Total	508.6	948.1	1,646.4	2,862.0

Source: ALGAS

4.2.3 Vulnerability

In India, chronically drought-affected areas cover the western parts of Rajastahan and Kutch region of Gujarat. Drought conditions have also been reported in Bihar and Orissa States in India. Drought disasters are expected to increase and happen more frequently in the areas mentioned during the following decades thus intensifying stress on ecosystems and population. Densely settled and intensively used low-lying coastal plains, islands and deltas, including the Indian coastline, are extremely vulnerable to coastal erosion and land-loss, inundation, sea flooding and upstream water fronts as a result of seal-level rise. Due to the high population and still increasing number of population India, is likely to suffer from adverse impacts on agriculture, significant differences in seasonal runoff and increased risks of severe tropical weather disturbances, including storms and other stresses (IPCC, 2001).

4.2.4 Domestic interest groups supporting climate change activities

Climate change issues in the past have been only dealt with within the Indian government. Neither industry nor the Confederation of Indian Industry has participated or were involved in the policy making process with regard to climate change. However, the private sector is active to announce their individual positions on climate change and climate policies. For example, the Indian coal-fired power sector generally objects to international agreements on climate change policies and measures. The main concern lies within the argument that an emission target allocated to the coal-producing sector would restrict the growth of the sector thus affecting Indian economic growth.

The power sector is also an important group that can influence climate change issues to some extent. Nevertheless, its position is only slightly different than the position of the coal sector, since the increasing energy demand could be met from alternative energy sources.

The Indian industry sector such as the steel, cement, aluminium, fertilizer and chemical industry is another group influencing climate change issues. These industries are to large extent publicly owned and benefit from an administered price system thus facing little market competition. They are therefore in a position to hampering efforts to improve their energy efficiency. Investment expanding the growing demand for industrial products is more attractive than investment to reduce costs by improving energy efficiency (Akiyama, 1995).

Two other significant players in the Indian climate change policymaking process should be mentioned: TATA Energy Research Institute (TERI) and the Centre for Science and Environment (CSE). These research organizations gain a more important standing to advise government in climate policy issues. Research, lobbying and other efforts by TERI resulted in governmental approval to accept an AIJ pilot phase. Since then, TERI has established itself as one of the major advisers to the federal administration on energy matters.

4.2.5 Incentive for India to engage in future actions on climate change

Right at the beginning of the negotiation process India had a very clear and strong position and has played a very active role by being as spokesperson for the G77/China. Although India's economy is highly vulnerable to climate change, economic growth and meeting the needs of large parts of the Indian population are priority issues. As a matter of fact, India has stated that emissions will grow as the country seeks to expand its economic growth.

India, as part of the G77, has the position that no further commitments are accepted by India until developed countries have demonstrated to take the lead in combating climate change. At COP8 in New Delhi 2002, Prime Minister Vajpayee described the call for developing country commitments "misplaced" and said that the only equitable form for the future would be one based on equal per capita rights.

One of India's major concern after adoption of the Convention has been securing the implementation of convention-specific commitments by industrialized countries, both with respect to their commitments to stabilize national GHG-emissions at the 1990 level by the

year 2000 and with respect to promised technological and financial transfer to developing counties.

With regard to AIJ, India has been quite sceptical. The AIJ phase was seen by developing countries as an attempt to distract from Annex I country obligations. India has changed its position after realizing that AIJ and subsequently the CDM is an instrument that assists in achieving the overall goal.

For India, a per-capita approach, where emission levels from different countries converge at a common per capita level, is the preferred approach, since India's per-capita emissions are only one third of the world's average. Due to India's current firm position on future commitments, it is difficult to believe that it will accept any absolute emission target in the near term. Choosing an approach that clearly incorporates the element of per-capita emissions could open the door for possible acceptance by India.

Nevertheless, based on how AIJ issues developed in India and its priority for economic growth, the position may change. If India perceives that taking a commitment could contribute to economic growth, it would be open to change its position.

4.3 CASE STUDY: CHINA

4.3.1 National climate policy

China was regarded as one of the world's poorest countries over much of the 20th century. The transition toward market economy and opening to outside world since 1978 has put the country on the track of rapid development. With an average annual GDP growth rate of over 9%, China had more than quadrupled its GDP during the years between 1978 and 2000. The country has set the ambitious target of further quadrupling its GDP on the 2000 level by 2020, which means an annual GDP growth of 7.18%. The annual GDP growth rate of the country in 2003 is 9% and the Chinese economy continues showing strong vitality.

In recent years, the restrictions of energy resources on development are increasingly felt in China. In 2003, the electricity demand grew 15% from the year before. Despite an 8% increase in supply, in summer 2004, 19 out of the 32 Chinese provinces, autonomous regions and municipalities were forced to implement electricity consumption restrictions and electricity supply to enterprises was provided in shifts.

According to the State Electricity Regulatory Commission of China, China's installed generating capacity has exceeded 400 GW by May 2004. Under the background of nationwide electricity shortage, the Chinese electricity-generating sector has entered in a period of fast development and China becomes the only country in the world that sees some new generating units of 20 million or above kW put into operation each year. It is expected by in the next 15 years, the electricity generating capacity of China has to increase 500 GW to satisfy its targets of comprehensively building a well-off society.

In a country with a large population and limited energy resources, reducing growth in energy demand was deemed synonymous with raising the sustainability of its ongoing rapid economic development. China has a history of implementing renewable energy and sustainable development programs stretching back to the 1980s under its Five-Year Social and Economic Development plans. Environmental goals were officially included in the Ninth Five-Year Plan (1996-2000).

The Chinese government took the lead in publishing its Agenda 21 in 1994, only one year after the United Nations issued the Agenda 21. China ratified the UNFCCC in January of 1993 and the Kyoto Protocol in August of 2002.

China is drafting a Renewable Energy Development and Utilisation Promoting Law, which is expected to be approved by the National People's Congress (NPC) Standing Committee, China's legislature, in 2005.

Table 12 below details the different measures introduced that have led to a reduction of GHG emissions.

Table 12: Examples of GHG mitigation measures implemented in China

Measures	Examples
Energy conservation and energy efficiency	• National energy conservation plans have been expounded in each of Five-Year Plans since the early 1980s • Law on the Prevention and Control of Atmospheric Pollution (1987) • Set up "China Energy Conservation Corporation" to promote the use and development of energy conservation products • Environment Protection Law (1989) • China Green Lights Program (1996) enacted in the 9th Five-Year Plan to increase the amount of high-efficiency lighting in use. • Energy Conservation Promotion Project (1996), a 10-year project designed to reduce emissions by 200 million tonnes • Energy Conservation Law enacted (1997) • Projects in various Priorities of Agenda 21 (China's White Paper on Population, Environment and Development in the 21st century) • Establishment of hundreds of energy conservation technology service centres throughout China working with the end-user • 10th Five-year Plan on Energy Conservation and Comprehensive Resource Utilisation (establishing the target of lowering the energy consumption of each dollar of GDP at the speed of 4.5% each year during 2001-2005 (2001) • Clean Production Promotion Law (2002) • "Administration Procedures on China Energy Label" issued, demanding products of wide use and large energy-saving potential to bear specify their energy efficiency and the energy standards they follow (2004)
Use of new and advanced technologies	• Various projects in Agenda 21's Priority 3: Cleaner Production and Environmental Protection Industry
Clean Power from Fossil Fuel	• Projects in Agenda 21's Priority 4: Clean Energy and Transportation, developing the advanced coal-fired integrated gasification combined cycle (IGCC) power generation technology and achieving greater efficiency through coal use • Begin to implementing the EU II emission standards on automobiles on July 1st, 2004
Harnessing Renewable Energy	• China announced formulating a renewable energy act (or law) and a national renewable energy development strategy. The expected result is an installed capacity for power generated by renewable energy accounting for about 12% of China's total installed power generation capacity and an annual use of renewable energy up to a 17% share in China's projected energy consumption in 2020 (International Action Programme of the renewables conference in Bonn 2004). • Projects for developing the wind, PV, solar thermal and biomass industries under Agenda 21's Priority 4: Clean Energy and Transportation • 10th Five-year Plan on the Development of New Energy and Renewable Energy Industry, aimed at increasing the annual supply of new energy and renewable energy to 13 million tonnes of coal equivalent by 2005 (2001)
Enhancing Scientific Understanding	• Establishing the National Climate Centre for China under Agenda 21's Priority 9: Global Change and Biodiversity Protection
Strengthening Adaptive Capacity	• Training programmes, workshops and projects related to climate change with an aim to strengthen indigenous capabilities of institutions for suitable long-term planning and assessment.
Fuel substitution and improvements of fuel quality	• Fuel switch from coal to natural gas • The West-East Natural Gas Transmission Project
Fuel price changes	• Oil, gasoline and diesel prices in line with world market as of 2001 • Deregulation of coal prices in 2002

Policy change in forest conservation	• China Forest Law (1984) • Forestry action plan from Agenda 21's Priority 9: Global Change and Biodiversity Protection and various reforestation initiatives • The forest coverage rate of China increased by 1.43 percentage points to 16.55% in 2004, and according to the forest development plan of China, it will further raise its forest coverage to 18.2% by 2005, 19.4% by 2010, and to over 24% by 2030 (2004)

Source: updated from "Climate change mitigation in developing countries", PEW Centre 2002

Although not designed specifically with GHG mitigation in mind, the above measures have reduced GHG emissions considerably.

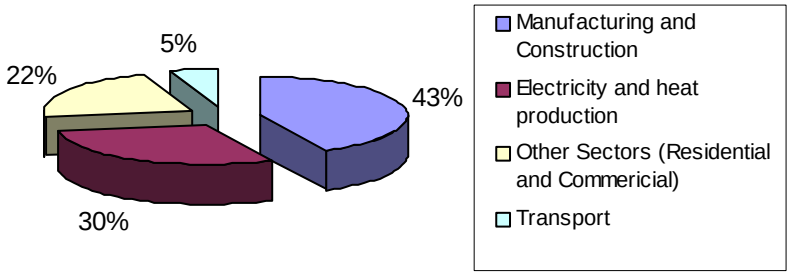
In 1990, the Chinese government established the National Group of Coordination on Climate Change. Under this group, four sub-groups were created and together deal with such climate change issues as its scientific assessment, impact assessment and response strategies, economic implications, and matters relating to the Convention itself.

4.3.2 Emission profile: current and future

Current and past emissions: Primarily due to fossil fuel combustion – coal accounted for approximately 62% of the country's primary energy use – China ranks as the world's second largest GHG emitter after the USA. Per capita emissions though are far below that of the USA. In fact, China's per capita emissions are about half the global average and about one twelfth the level in the USA.

Energy consumption within China has also greatly increased during its recent economic rise, but proportionally, the increase in GHG has been half the increase in economic growth – an indication as to the success of China's energy conservation and efficiency programs, its switch in fuel sources as well as population stabilization strategies.

Given that China has not yet submitted a national communication, presented emission data is taken from other sources. Figure 4 illustrates China's energy–related CO_2 emissions and Table 13 summarizes China's national GHG inventory for 1990.



(Source: IEA CO_2 Emissions from fuel combustion, 2002 version)

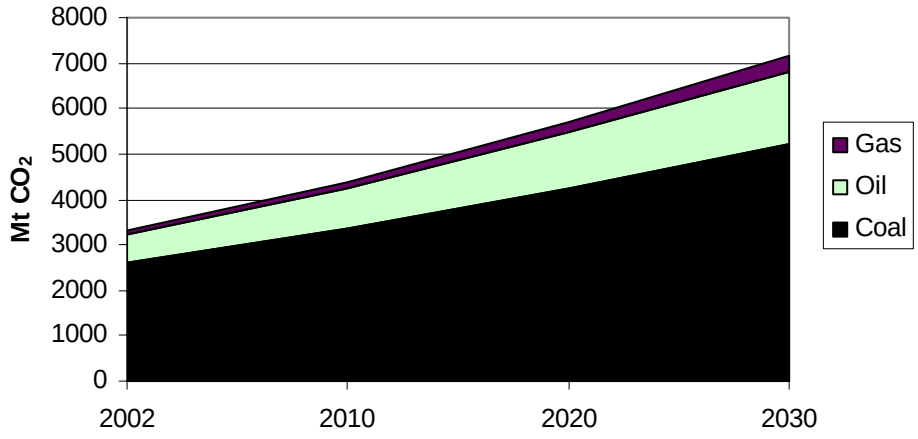
Figure 4: Energy- related CO_2 Emissions

Table 13: China's GHG emissions and sinks (Mt CO_2 eq.)

Greenhouse gas sources and sinks	1990	1995	2000
CO_2 energy	2493.9	3261.1	3473.6
CO_2 (land use change)	223.9	113.9	-47.3
CH_4	679.9	780.4	802.9
N_2O	520.9	626.4	644.7
HFCs	3.6	5.7	36.9
PFCs	3.0	2.8	5.3
SF_6	3.0	3.5	3.4
Total	**3928.2**	**4793.8**	**4919.5**

Source: WRI Climate Analysis Indicator Tool (CAIT), 2003

Future Emissions: Figure 5 shows the projected CO_2 emissions from energy taken from the IEA World Energy outlook. Under IEA's scenario, carbon emissions are expected to increase by about 3% annually driven by continued economic growth and increased coal use. The country's total carbon emissions are expected to double by around 2025.



Source: IEA (2004)

Figure 5: Energy Sector: Projection of carbon emissions by fuel source

Among the proven energy resource reserve in China, 96% is coal, and petroleum and natural gas resources only accounted for around 4%. The per-capital possession of economically explorable oil is only 9.4 tons, only equivalent to about one fifth of the world average.

Major factors influencing the GHG emission of China included population growth, urbanization, industrial restructuring, and energy mix changes.

1) Population

China began to implement a birth control policy since early 1970s, its population growth rate had fallen to less than one per cent. However, due to its large population base and consistency in population changes, the Chinese population continues to see a net increase of over ten million year. By the end of 2003 China's population had reached 1.29 billion and it is expected that the figure will increase to 1.48 billion by 2020 and further to a peak of about 1.6 billion by middle of the 21 century before it witnesses slow declines. A larger population, smaller families, and a higher proportion of old people means increases in the household consumption of energy and GHG emission.

2) Urbanization

China is also in a transition from a rural and agricultural society to an industrial and urban one. By the end of 2003, 40.5% of the Chinese population are living in towns and cities and it

is expected the rate will further increase to 44% by 2010 and further to 55% by 2020 (Zhou et al. 2003). Although population aggregation means higher efficiency of economic resources, it also means the massive construction of infrastructure facilities and houses. Higher urbanization rate means further expansion of existing cities and towns and the building of new cities and towns. This will cause rises in energy consumption and GHG emission.

Besides, at higher living standards, people also use more household electric appliances, automobiles, and public infrastructure facilities. The per capita energy consumption of a Chinese resident is over 3 times that of a rural resident. Moreover, people's energy consumption will also shift from non-commercial biomass to commercial energy.

3) Industrial Restructuring

China is still in the process of industrialization. During the 20 years from 1980 to 2003, the shares of primary sector, secondary sector and tertiary sector in China's annual GDP had changed from 30:49:21 to 15:53:32 (China Statistics Bureau), indicating that the industrial sector is the pillar to China's rapid economic growth. Among the total energy consumption in China, around 70% goes to the industrial sector. Industrial sector not only contributes to more than half of China's GDP, it is also the sector sees the fast growth. Because of its low labour costs and huge markets in China, China is one of the biggest uses of foreign-direct investment and many multinational enterprises are moving their production centre into China. The technology, managerial, and human resource capability gap between China and western countries is there. So it is unlikely that China's role in the worldwide labour division as a manufacturing centre could be changed in the next 15 years.

4) Energy Mix

The potential of developing large-scale hydropower in China is limited. Besides, most of China's energy resources, including coal, natural gas, petroleum and rivers on which hydropower plants can be built are located in west China while its economic activities and growth are concentrated in the coastal East China. This means long distance of energy resource transport or power transmission. Although the Chinese government gives strong support to the development of renewable energy, because of their higher costs and the small scale developments, renewable energy's share in China's energy mix is unlikely see major increase. In China's Sustainable Energy Scenarios in 2020, it is estimated even if 70% of the explorable hydropower development potential is put into use and nuclear, wind, solar energy as well as other energy sees rapid development, 90% of China's energy consumption still relies on such fossil fuel as coal, natural gas, and petroleum. So in the foreseeable future, the Chinese energy mix will still be dominated by fossil fuel and higher energy consumption and supply will lead to more emission.

4.3.3 Vulnerability

China is suffering severely of weather-related disasters. Higher temperatures have bring about numerous problems in ecology, resources and environment, which include frequent dry spells, tropical cyclones, a rapid rise in the number of rainstorms and severe droughts, landslide, hailstones, frost, and hurricanes at increasing severity. Each year, weather-related disasters inflict direct economic losses accounting for 3 percent to 6 percent of its GDP, far exceeding the average of less than 2 per of developed countries (Dahe 2003). In ordinary years, the area of crops hit by natural disasters is between 40 and 47 million hectares and around 200 million Chinese people are struck by natural disasters.

China is vulnerable to climate change due to a number of circumstances. To begin with, because of its vast territory and complicated physiographic conditions, the extreme uneven spatial and temporal distribution of rainfalls, climate-related disasters are frequent in China. Over 10% of the Chinese territory is under the threat of floods. Mountainous region, tableland, and hills cover two thirds of China's total land area.

The country's share of GDP assumed by agriculture is about 14.86% (2003). Although the past few decades this figure has been steadily decreasing, China's share remains considerably higher than in other developed countries – about 8 times greater than the shares

agriculture plays in the GDPs of USA or Japan. Climatic changes affecting agriculture would not only affect the country economically, but impact the country's ability to meet its population's food requirement.

Water shortage costs China around RMB 200 billion (24 bn US$) of industrial output losses and RMB 150 billion (18 bn US$) of agricultural losses each year. Among the 660 Chinese cities, two thirds are facing water shortage and around 110 are harassed by severe water shortage. In the IPCC's *The Regional Impacts of Climate Change: An Assessment of Vulnerability (1998)* considerable negative impacts were expected on rice production and the following agricultural areas were highlighted to be most affected by climate change due to a greater risk of drought and increased soil erosion:

- Areas around the Great Wall southeast of the transition belt between agriculture and animal husbandry
- Huang-Hai plains
- Area north of Huaihe River
- Middle and lower banks of the Yangtze river
- Loess Plateau.

Further negative impact, depending on the scenario, is possible in other crops, such as wheat and corn. Forests would also be affected, particularly the distribution of many tree species. A study performed in 1995[5] predicted that a doubled carbon dioxide concentration scenario would reduce tree species such as the important Chinese Red Pine by an additional 9.4%.

Climate change would also affect China's water resources. In a country as densely populated as China, this poses special risks especially given the high level of hydro and water sequestration projects in some regions. Depending on scenario used, changes in run-off vary significantly but they are likely to create adverse flood or drought situations.

4.3.4 Domestic interest groups supporting climate change activities

Given China's socialist structure and strong centralist policies, domestic activities are primarily driven by the Chinese Communist Party. Formal decision-making power rests with the Political Bureau and its Standing Committee, Chinese leaders have historically also played a significant role in personally driving Chinese policy. Climate change policies are officially formulated through the National Coordination Committee for Climate Change.

Industry and business associations have also been more active internationally, for example the All-China Federation of Industry and Commerce (ACFIC) association. For the most part though, government influence remains strong. For instance, the ACFIC was established in 1953 and to this day remains under the direct leadership of the Chinese Communist Party.

Numerous other associations whose industry members would be affected by climate change policies also retain strong ties to the Chinese Communist Party. These include the China Iron & Steel Association (CCISA) and the China Coal Industry Association (CCIA). Notwithstanding, CDM projects can be congruent with a particular association's goal. For instance, the CCIA has since its inception in 1999 been active in extending foreign cooperation and drafting technological and qualitative standards in line with international practices to help address environmental and health concerns.

Environmental groups are a relatively recent addition to the Chinese scene, such as the China Biodiversity Network (1995) in addition to many student environmental organizations, but to date they have little influence in adopting climate change activities. The WWF does have a presence in China (since 1980) and has promoted climate change mitigation through various workshops and programs.

[5] A study on the impacts of climate change on distribution of Pinus tabulaeformis in China, Guo Q. 1995

4.3.5 Incentive for China to engage in future actions on climate change

In 2003, the GDP growth of China is as high as 9%. Among the 1.3 billion of Chinese people, more and more families possess their own cars. The wide-sweeping electricity shortage is forcing many factories to buy their own petroleum-fired electricity generators. China became a net oil importer in 1993 and in 2003, it overtook Japan and became the 2nd biggest oil importer in the world, second only to the United States. As a result, reliable oil import at stable prices is widely discussed in China as a key aspect of national security.

The utilization rate of water resources is at 60% for the Huaihe River, 65% for the Liaohe River, 62% for the Yellow River and as high as 90% for the Haihe River, all surpassing the internationally accepted warning line of 30-40 percent (Dahe, 2003). As a result, the natural process of water purification in the rivers is barely functioning, and the ecological environment along the rivers will be damaged.

Still in the short and medium-term, China takes economic development as its top priority. The severe environmental problems and unfavourable energy resource endowment are forcing China to take some measures to maintain its economic growth, including encouraging energy saving, the use of clean energy and supporting the development of energy efficiency and renewable energy.

The 16th Session of the National Congress of the Communist Party of China (CPC) Nov. 2002 for the first time defined sustainable development as one of the four aspects of its objectives to building a well-off society in an all-around way in the first 20 years of the 21st century. “The capability of sustainable development will be steadily enhanced. The ecological environment will be improved. The efficiency of using resources will be increased significantly. We will enhance harmony between man and nature to push the whole society onto a path to civilized development featuring the growth of production, an affluent life and a sound ecosystem.” [6]

So even without external pressure and support, China has some initiative to improve its energy utilization efficiency, a side effect of its various related measures and policies.

China has played an important role in G77/China and takes a proactive attitude towards the global efforts for climate change control. However, it reiterates that as a developing country, its should focus on economic development and reducing the number of people living in poverty and not be subject to binding emission reduction obligations under world climate change framework.

As expressed in the National Coordination Committee for Climate Change’s paper on global climate change (June 2001), China’s position remains one where developed countries should take the lead in combating climate change. These countries have been responsible for the bulk of emissions to date and a large disparity in per capita emissions continues to this day. Developing countries, like China, must be able to increase their emissions to meet their social and developmental needs. As the paper concludes, “*the attempt to impose emission reduction or limitation obligations on developing countries is neither fair nor realistic and is in breach of the basic principles of the Convention.*”

China’s overall energy efficiency is expected to improve from internal reforms, restructuring measures, but will remain dependent on outside countries to meet its modernisation objectives. As Bill Nitze, the assistant administrator for international activities at the US Environmental Protection Agency, stressed, China is the most important country with which to form a green energy partnership with. Substantial GHG mitigation potentials at low incremental costs are possible provided barriers to technology transfers are removed and development capital is secured.

China may only be convinced to take further action, if the obligation is perceived as not capping economic growth or being economically beneficial for China. Increased participation

[6] Full Text of Jiang Zemin's Report at 16th Party Congress, http://english.people.com.cn/200211/18/eng20021118_106984.shtml

in the CDM could generate revenues. “Positively binding” or “no lose targets” could be applied that allow the sale of excess emission credits, if the target is overachieved but that imply no penalty if not achieved. Or rate based targets (e.g. as a function of kWh or tonne of steel produced) could take away the fear of capping economic growth.

4.4 CASE STUDY: USA

4.4.1 National climate policy

In November 2001, President Bush announced that he rejects the Kyoto Protocol and that the country will withdraw from the Protocol. The general argument was that there were fundamental flaws in the treaty. In February 2002, the President announced an alternative approach for the USA. The approach is based on a climate policy that does as little harm as possible to the economic sector. This idea emphasises regulatory flexibility, voluntary actions by industry, the development of cleaner technologies and emission allowance trading. The administration proposed first pass to stabilization of emissions before carrying out a reduction plan. The overall goal is to reduce the greenhouse gas intensity (emissions per GDP) by 18% between the years 2002 and 2012.

The overall goal to reduce the greenhouse gas intensity by 18% in ten years would translate into stable absolute greenhouse gas emissions (assuming a 2% annual GDP growth rate) or into a 10% increase in absolute emissions (assuming a 3% annual GDP growth rate) in the next ten years. Since the US emissions from 1990 to 2000 have increased by 12%, the absolute emissions would be allowed to increase by 23% (assuming a 3% annual GDP growth rate) from 1990 to 2010. Under the Kyoto Protocol, the US emissions would have to decrease by 7% from 1990 to 2010, but the USA could use mechanisms such as emissions trading to reach this target. For comparison, the greenhouse gas intensity (i.e. emissions per GDP) over the last 10 years has decreased by 14% in the USA, by 21% in the EU and by at least a third in China.

Not all governmental bodies in the USA support this position towards climate change. Some members of the U.S. congress do believe in the need for a long-term mandatory programme and a supportive international agreement. In May 2003, the Senate Foreign Relations Committee passed a provision calling for U.S. engagement in the development of a binding international climate change treaty. In January 2003 Senator Joseph I. Lieberman (D-CT) and John McCain (R-AZ) introduced a bill, which set out a national cap on greenhouse gas emissions and allowed companies to buy and sell emissions. All have introduced packaged legislation to cover CO_2 in multi-pollutant bills, especially focused on power generation.

There are no mandatory federal efforts dealing with climate change. Efforts to reduce GHG emissions have been limited almost exclusively to voluntary activities at federal, state, local and corporate level.

There has been significant investment in federal programmes to encourage voluntary reductions, such as the Climate Wise from the U.S. EPA programs and the U.S. DOE’s Climate Challenge Programme for electric utilities. Recently the U.S. has signed an agreement with thirteen other countries in order to found the Carbon Sequestration Leadership Forum in which the U.S. will invest 30 million Euros.

Companies and other organisations have also contributed voluntarily to the reduction and sequestration of GHG emissions. In spring 2003 a group of American and multinational companies founded the first voluntary GHG emission-trading programme in North America. Some of the companies involved were American Electric Power, Ford Motor Company, Motorola and Dupont.

The most relevant GHG mitigation policies and measures are state initiated. As of April 2003, 25 states have launched their State Action Plan for GHG mitigation and have already implemented several programmes and measures to reduce GHG gasses. Table 1 identifies some programmes, measures or policies implemented in the respective state.

Table 14: Selection of state action in the USA

State	Programme
California	Renewable Energy Program: The Renewable Energy Program has jumpstarted California's renewable energy resource development. The quantity of California's electrical generation produced from overall renewable resources is estimated to increase from 12 percent in 2000 to 17 percent in 2007. Through June 2001, the program resulted in 60,830,142 kilowatt-hours of electricity generated from renewable energy, displacing fossil fuel generation. The resulting reduction in CO_2 is at least 25,000 tons per year. This CO_2 reduction benefit will grow as the program expands.
Iowa	Building energy management program: Iowa currently saves more than $23 million per year on its energy bills in the public and non-profit sectors. The fossil energy saved to date has resulted in a reduction of over 796,000 tons of carbon and 360 tons of NOx per year. Chariton valley biomass project, the full demonstration project at 35 megawatts of switch grass will reduce CO_2 emissions by approximately 114,000 tons per year.
Maine	Greenhouse Gas Reduction Target: On June 26, 2003, Maine became the first state in the country to pass a law that sets a state-wide target for reducing greenhouse gas emissions. The law, called An Act to Provide Leadership in Addressing the Threat of Climate Change, requires the state to develop a climate action plan to reduce greenhouse gas emissions to 1990 levels by 2010 and to 10 ten percent below 1990 levels by 2020. As for the long term, the legislation states that the goal is a “reduction sufficient to eliminate any dangerous threat to the climate,” and notes that this may eventually require reductions of 75 to 80 percent below 2003 levels. By October 15, 2004, the Maine Department of Environmental Protection (DEP) must adopt a state climate action plan to meet the reduction goals.
Massachusetts	Reduction of CO_2 emissions from power plants: The Department of Environmental Protection expects a reduction of two to four million tons of CO_2 per year through direct reductions at the facilities or through emissions trading, depending on variations in output.
New Hampshire	Multiple Pollutant Reduction Program: The Clean Power Act requires CO_2 emissions to be reduced to 1990 levels by the end of 2006. Corresponding to that reduction, a cap of 5,425,866 tons of CO_2 annually will apply through December 31, 2010.
New Jersey	Greenhouse gas reduction target: New Jersey has established a goal to reduce its greenhouse gas emissions by 3.5 percent from 1990 levels by 2005. The state draws upon voluntary agreements with public- and private-sector organizations as well as regulatory initiatives in order to reduce emissions.
Nevada	Renewable portfolio standard: Over 10 years the Nevada RPS will increase renewable energy production by 1200 to 1500 MW. Assuming the renewable capacity would have an effective utilization of forty percent, if the renewable capacity displaced the current Nevada fuel mixture, 3,405,000 tons of CO_2 would be saved annually, which is thirteen percent of Nevada’s current emissions. If the renewable capacity displaced coal, 4,672,000 tons of CO_2 would be saved a year, or eighteen percent of current emissions. Displacing natural gas would save 2,353,000 tons, or nine percent of current emissions.
Oregon	Power plant CO_2 offset program: The five projects under the program's initial phase will reduce CO_2 at an average cost of about $1.50 per metric ton. These projects will offset about 844,000 metric tons of CO_2 over the next 10 to 100 years.
Texas	Loan star program: The program has saved Texas state agencies, local governments, schools, universities, and colleges more than $95 million to date. By January 2001, the program also reduced emissions of NOx by over 3,400 tons, CO_2 by over 980,000 tons, and SO_2 by over 2,200 tons. Energy and pollution savings will multiply as current projects continue and more projects are developed.
West Virginia	Promoting wind energy production through the tax code: If this were to displace an equivalent amount of West Virginia’s current energy mix, which is almost entirely coal, it would prevent approximately 690,000 tons of CO_2 emissions a year.

Source: PEW Center, http://www.pewclimate.org/states.cfm

4.4.2 Emission profile: current and future

Current and past emissions: The following Figure 6 and Table 15 illustrate the United States GHG emission profile. Figure 6 specifies the sources of GHG emissions for 1998 whereas Table 15 shows the recent trends in U.S. GHG emissions and sinks during the last decade. Emissions have risen by 12% over the last decade.

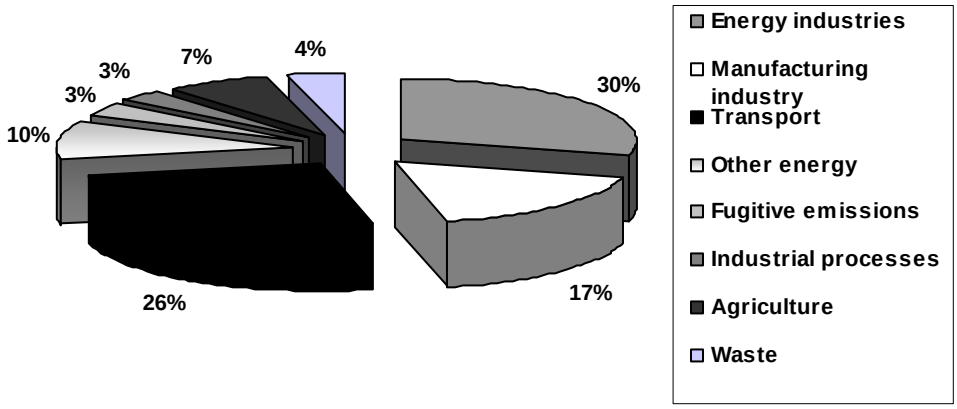


Figure 6: Sources of total GHG emissions in CO_2 equivalent in the United States by Sector, 1998

Table 15: Greenhouse Gas Emissions and Sinks (Mt CO_2 Eq.)

	1990	1995	1996	1997	1998	1999	2000	2001	2002
Net CO_2 emissions/removals	4,044	4,364	4,443	4,757	4,897	5,001	5,169	5,042	5,092
CO_2 emissions (without LUCF)	5,002	5,312	5,499	5,578	5,602	5,676	5,859	5,732	5,782
CH_4	643	650	637	629	620	613	614	605	598
N_2O	393	427	437	436	432	428	426	417	416
HFCs	35	52	66	77	97	97	105	103	112
PFCs	20	16	17	16	14	14	14	8	9
SF_6	35	28	32	29	24	24	20	19	18
Total (with net CO_2 emissions/removals)	5,171	5,537	5,632	5,943	6,085	6,177	6,348	6,194	6,244
Total (without CO_2 from LUCF)	6,129	6,485	6,687	6,764	6,790	6,853	7,038	6,884	6,935

Source: US 2004 inventory submission to the UNFCCC from www.unfccc.int

The USA is the world's largest single emitter of greenhouse gases, accounting for 24% (energy CO_2 only) or 20% (all Kyoto gases) of global emissions. The USA has nearly the highest per capita emissions superseded by only some oil producing countries. Per capita emissions of the USA are 5 times (energy CO_2 only) or 4 times (all gases) above world average and still 70% above Annex I average (sources: Höhne et al. 2003, WRI climate analysis indicator tool).

Future Emissions: Total net U.S. greenhouse gas emissions are projected to rise by 42.7 percent, from 5,777 $MtCO_2eq.$ as the actual level for 2000, to 8,237 $MtCO_2eq.$ projected for 2020. Table 16 shows projected U.S. GHG emissions from all sources for the period 2000-2020. Emissions are expected to rise by around 40% from 2000 to 2020.

Table 16 Projected U.S. Greenhouse Gas Emissions from All Sources: 2000-2020 (Mt CO_2eq.) [7]

Greenhouse gas	2000	2005	2010	2015	2020
Energy related CO_2	5,726	6,210	6,727	7,206	7,655
Non-Energy CO_2	132	138	145	153	161
CH_4	623	633	630	625	611
N_2O	433	447	464	483	504
HFCs, PCFs, and SF_6	124	170	208	290	410
Sequestration Removal	-1,205	-1,175	-1,144	-1,096	-1,053
Adjustments	-59	-58	-59	-57	-51
Total	5,773	6,366	6,972	7,604	8,237

Source: Third National Communication of the United States of America Under the United Nations Framework Convention on Climate Change

4.4.3 Vulnerability

Changes in precipitation, temperature and other variables have been observed during the last decades in the United States. Climate model predictions on precipitation of North America are highly uncertain. Preliminary results from modelling of the United States suggest that projected changes in climate will cause substantial changes to the distribution and productivity of ecosystems and the disturbance regimes such as fire and drought probabilities. Subtropical conditions will extend further north into the United States with accompanying changes in vegetation, hydrology and the potential for diseases thus requiring population and ecosystems to adapt.

Coastal regions are particularly vulnerable to rising sea level. Climate models show that the pace will accelerate in the next decade. Increased acceleration would increase the difficulty to adaptation of human settlements and natural systems. The greatest vulnerability is expected in areas that recently have become much more developed such as Florida and much of the U.S. Gulf and Atlantic coasts. Rising sea level can also cause increased erosion to shores and habitat and may contaminate freshwater bodies with salt. Climate extremes such as hurricanes, can add to adverse effects. Climate related consequences for water, health, food, energy, insurance governments and human settlements thus are likely to require substantial infrastructural and institutional changes in some cases in the Unites States (IPCC 2001).

4.4.4 Domestic interest groups supporting climate change activities

Strong and influential groups in the USA are either in favour or against climate change policies. The key players on both sides can be summarize as follow:

Pro actions to mitigate climate change: In the political arena a key supporter is the Democratic Party. Especially some state governments are in favour of climate change policies and some have adopted comprehensive programmes. On the NGO side, there are some strong players that push debates forward namely the Pew Foundation and NRDC as well as the WWF, Sierra Club and Friends of the Earth. Several NGOs founded a new organization, the National Commission on Energy Policy, to develop a long-term U.S. energy strategy that promotes national security, economic prosperity, and environmental safety and health. There are also several additional programmes that are supportive of balanced climate change policies, such as the Center for Clean Air Policy and the MIT Joint Program on Science and Policy of Global Change. Finally, several industry groups have come forward to support action on climate change.

Against actions to mitigate climate change: The main political opposition against an active climate policy is the Republican Party together with those states that are mostly dependant on

[7] Notes: These total U.S. CO_2 equivalent emissions correspond to carbon weights of 1,574 Mt for year 2000; 1,901 Mt for 2010; and 2,226 Mt for 2020. Totals may not add up due to independent rounding.

fossil fuels. On the governmental side a non-supporter is the White House Council on Environmental Quality. Several organizations lobby against climate change actions such as Competitive Enterprise Institute and the Cato Institute. Some oil companies, such as ExxonMobil, coal companies and power companies, such as Southern Co. lobby against action on climate change. Also the railroads are not in favour, since bringing coal from Wyoming to the Midwest and East is a major revenue source.

4.4.5 Incentive for the USA to engage in future actions on climate change

Unlike some of the other countries discussed above, the USA take a unique position with respect to engagement on future climate change actions. In the case of China and India, for example, there remains a "consistent" view towards adopting a binding greenhouse gas emissions target – i.e. responsibility must start with the most industrialised countries as their per capita emissions are much less than the majority of Annex I countries and these countries' comparatively low GDPs bring their own set of deflections from climate change. American policy on climate change is less consistent and is greatly influenced by the flavour of the ruling administration.

Presidential candidate John Kerry recently commented that "because of the Bush Administration's inaction, the binding targets set in the Kyoto Protocol are no longer achievable;" he would therefore "immediately reengage the international process [that would lead to] a strong, effective, and meaningful international agreement."

Notwithstanding this issue, there remains an interesting option in engaging the US in a more multilateral approach to greenhouse gas mitigation through the involvement of individual states. There is a history of states taking the lead in environmental policies (such as the Regional Clean Air Incentives Market operating in Southern California and the US Clean Air Act), which in turn become matters of federal concern. Individual states have also been pressing the Bush Administration to regulate emissions of greenhouse gases.

State action has a tendency to replicate itself across other states and could form the catalyst to building sufficient political will in establishing a mandatory national greenhouse gas policy. Given the recent defeat of the Lieberman-McCain bill to cap greenhouse gas emissions within the USA by a narrow margin of 55 to 43, a "bottom-up" approach could well serve as the catalyst to ensure federal acceptance of a more active international role in greenhouse gas mitigation efforts.

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5. ISSUES TO BE CONSIDERED

This section provides an overview and literature review of the issues that need to be considered to describe a full future climate regime. The discussion provides a first insight in addressing the question and point to the major conflicts when designing a full concept that can best satisfy all different demands and a strategy (chapters 9 and 11).

The discussions on future climate regimes cover a broad range of topics, represent a wide range of opinions and include authors from many different backgrounds. Several studies have summarized the issues, such as WRI (2002), Storey (2002), OECD (2003), Höhne et al. (2003), Bodansky (2003), Helm et al. (2003) and Torvanger et al. (2004). This overview outlines the issues and options in the light of recent developments.

In the following sections, most prominent issues are discussed as outlined in Figure 7. First Article 2 of the Convention, the stabilization of greenhouse gas concentrations is considered (5.1). Furthermore, two different types of actions can be distinguished: actions related to mitigation and actions related to adaptation (5.5). Within the area of mitigation, three separate issues are discussed:

- The types of future commitments (5.2)
- Which countries participate and when (5.3) and
- The stringency of emission reductions (5.4)

Finally, issues around the negotiation process have to be considered (5.6).

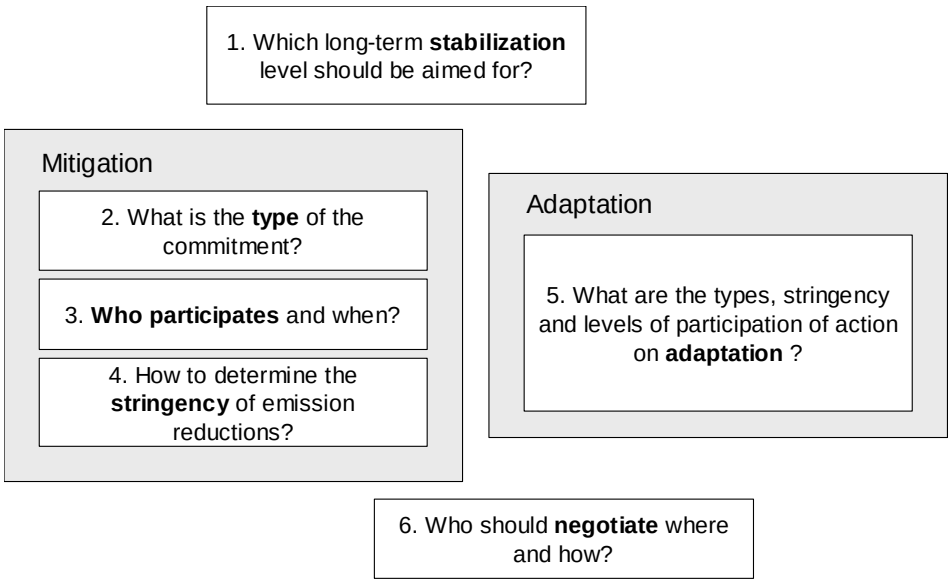

Figure 7. Overview of issues to be addressed

5.1 STABILIZATION OF GREENHOUSE GAS CONCENTRATIONS

Which long-term stabilization level should international climate policy aim for?

The ultimate objective of the Convention in its Article 2 calls for stabilization of greenhouse gas concentrations that prevent dangerous anthropogenic interference with the climate system. In order to aim for this objective, the international community needs to define the level of climate change that would constitute such “dangerous” interference. Several

obstacles prevented the international community from taking such a decision or even from officially discussing such levels in the past (see also Corfee-Morlot & Höhne, 2003):

- *Long time scale:* A stable level of concentration will be reached only in one to several centuries and temperature will continue to rise for a century even when concentrations have stabilized. Sea level rise will even continue to rise for millennia. It is difficult to take decisions on such enormous time scales.
- *Inherent uncertainty:* Due to the current scientific uncertainties of the carbon cycle and the effect of elevated CO_2 concentrations on temperature, the range of possible changes in the global-mean surface temperature associated with certain greenhouse gas concentration stabilization levels is large. E.g. stabilization of CO_2 concentrations at 450 ppmv and similar levels for other greenhouse gases can lead to a global-mean surface temperature change of between 1.2°C to 2.3°C from 1990 to 2100 and between 1.5°C to 4°C from 1990 to equilibrium (IPCC 2001a).
- *Value judgement of "dangerous":* A "dangerous" level cannot be defined objectively. It always involves a value judgement on priorities, e.g. which ecosystems need to be secured and which may be lost without constituting a danger.
- *Unacceptability of any level:* Some countries may not be able to agree to any level of stabilisation other than that prior to industrialization. E.g. some small island states fear already at the current concentration level that large parts of their national territory will be flooded in the future. Those countries may not be able to agree to any level that is higher than that prior to the industrial revolution.

Given these difficulties, the Council of Ministers of the European Union made a political judgment on what constitutes "dangerous" interference in 1996: It agreed that "global average temperatures should not exceed 2 degrees Celsius above pre-industrial levels and that therefore concentration levels lower than 550 ppmv CO_2 should guide global limitation and reduction efforts" (EC 1996). Climate models, which take into account greenhouse gases other than CO_2 and use average climate sensitivity, usually predict a temperature increase higher than 2°C for a stabilization of CO_2 concentrations at 550 ppmv in 2100 (1.5° to 3° in 2100 and 2° to 5 ° at equilibrium, see also Figure 28 in Chapter 10). Keeping global mean temperature below 2°C above pre-industrial level is therefore likely to require even more stringent reductions aiming at stabilization of CO_2-concentration below 450ppmv. Substantial emission reductions (in the order of globally 25% below 1990 levels in 2050 and 80% below for industrialized countries) are necessary to reach the stabilization level of 450ppmv CO_2 concentrations (see also Chapter 10).

Three options for considering long-term stabilization levels in the international climate negotiations are outlined below:

1. A first option would be to **agree on a long-term stabilization level**. A discussion on the level of greenhouse gas concentrations that are "dangerous" and that are not "dangerous" helps to understand the magnitude and scope of the problems ahead and is urgently needed. The EU has already agreed that global average temperature should not rise with more than 2°C above the pre-industrial level. But due to the reasons mentioned above, a broader international agreement on this seems unlikely.
2. A second option would be to adopt a **"hedging strategy"** (IPCC 2001b, chapter 10), defined as a shorter-term goal, from which it is still possible to reach a range of desirable long-term goals. Once the short-term goal is reached, decisions on next steps can be made in light of new knowledge and decreased levels of uncertainty. To implement this option, the international community could agree on a maximum amount of greenhouse gases that the global community should emit in, e.g., 2020 (see Corfee-Morlot & Höhne, 2003).
3. A third option would be to **formulate reductions step by step**, based on the willingness of countries to act, without explicitly considering a long-term perspective. As under the Kyoto Protocol negotiations, countries would propose reduction percentages, which are later modified by negotiations. This approach has the risk that the individual reductions

do not add up to the level required for certain stabilization levels. Some stabilization options may be out of reach in the near future.

5.2 TYPES OF FUTURE COMMITMENTS

What are the types of mitigation commitments and other future actions that could be applied?

Mitigation commitments of countries under an international climate regime could take several forms. Annex I countries under the Kyoto Protocol have legally binding emission limitation or reduction commitments. Non-Annex I countries have more general commitments but no quantified emission targets. Table 17 provides an overview of eight types of commitments countries could adopt in the future. These types of commitments could be (and are today) applied in parallel, not exclusively. A comprehensive package of commitments has to be formulated, choosing from these options.

Table 17. Summary of possible future *types* of commitments

Quantified emission commitments	1.	Binding absolute emission reduction targets
	2.	Flexible emission targets (non binding, positively binding, dual targets, price caps, intensity targets)
Action oriented commitments	3.	Enhanced coordinated technology RD&D efforts
	4.	Coordinated policies and measures (technology standards, taxes, menu of P&Ms)
Actions by industrialized countries aimed at avoiding future developing country emissions	5.	Mandatory financial contributions to funds, technology transfer
	6.	Greening of investment flows (e.g. export credit agencies)
Actions taken by developing countries	7.	Sustainable development policies and measures
	8.	Enhanced participation in an extended CDM

1. The most prominent type of commitment is the **binding absolute emission reduction targets** as included in the Kyoto Protocol for Annex I countries. Such targets provide certainty about future emission levels of the participating countries (assuming targets will be met). The target can be reached in a flexible manner across greenhouse gases and sectors as well as across borders through emission trading and/or project based mechanisms (Joint Implementation and the clean development mechanism). These targets could be applied for Annex I as well as Non-Annex I countries in the future. However, several Non-Annex I countries, as well as the USA, have expressed their concerns about the absolute targets being too rigid and capping economic growth.
2. Alternatively, countries could take on **flexible emission targets**, including the following options:
   - *Non-binding emission targets*, meaning that not reaching them has no consequences. Here emission trading could not be applied.
   - *"Positively binding" emission targets*, meaning that additional emission rights can be sold, if the target is reached, but no additional emission rights have to be bought, if no rights have been sold and the target is still not met.
   - *"Dual" targets*, meaning that two targets are defined, a "selling target", below which emission rights can be sold, and a "buying target", above which emission rights have to be bought (WRI 2002).
   - *"Price cap"*, meaning that an unlimited number of additional emission rights is provided at a given maximum price (IEA 2002).
   - *Dynamic targets*, meaning that targets are expressed as dynamic variables as a function of the GDP ("intensity targets") or variables of physical production (e.g. emissions per tonne of steel produced).

All of these options aim at providing more flexibility to the countries, to avoid extremely high costs, if the economic development and therefore emission development is different than expected at the time of setting the target. However, providing this flexibility reduces the certainty that a given emission level is really reached. The increased certainty in costs is traded against an increased uncertainty in the total resulting emissions.

3. Another option would be to **enhance and coordinate technology research**, **development and deployment** efforts. Such activities would influence the development of new technology that will be needed to reduce emissions in the long-term. But such activities would have less measurable effects on short-term emission levels. The formal commitment to promote and cooperate in the development, application and diffusion of such technology is already included in the UNFCCC (Article 4.1(c)), but specific measures to enhance such development are not defined.
4. As another alternative, countries could agree on **coordinated policies and measures** such as technology standards or taxes on the emission of greenhouse gases. In the negotiations toward Kyoto, policies and measures were rejected by many countries, because they were seen as prescriptive and leaving less flexibility to the countries compared to emission reduction targets. To overcome this barrier, a menu of the best practice policies and measures could be provided, of which countries have to choose those that best fit their national circumstances. In such a system, it would be difficult to compare the stringency of the measures between countries. A system solely based on policies and measures would also not allow using the flexibility mechanisms such as emissions trading.
5. Two options for commitments for developed countries aim at limiting emissions in developing countries. One would be **mandatory contributions to funds and technology transfer**. Such funds would finance emissions reduction projects or adaptation activities. The current system of the UNFCCC and the Kyoto Protocol already includes some funds and project activities, but contributions to and participation in those are mostly voluntary. It also includes provisions for technology transfer, but volumes of financial flows are not defined.
6. A second option for commitments for developed countries that aim at limiting emissions in developing countries would be the "**greening of investment flows**" (CCAP 2004). These are those flows of resources that are currently transferred from developed to developing countries through development banks and export credit agencies. These amount to much larger volume of funds than the total volume estimated to be involved in the CDM (Müller 2003). Formulating conditions directing these resource flows towards low greenhouse gas emitting technology would be a substantial opportunity to limit future emission growth in Non-Annex I countries.
7. An option particularly for developing countries, would be the commitment to adopt **sustainable development policies and measures** (Winkler et al. in WRI 2002). In this approach, development objectives are formulated first. In a second step, it is considered how climate policies can support these development goals. This approach is very attractive to developing countries as it focuses on their main concern of (sustainable) development. The major difficulty lies in the assessment of whether these activities are additional to what would have happened otherwise, whether the country is showing action. This approach is seen as a possible first step for Non-Annex I countries into more comprehensive action.
8. Another option for developing countries could be to participate in an **enhanced CDM**, which would allow sectoral government programmes to be eligible CDM projects. Comprehensive climate change action would be rewarded (in part) as emission reduction credits that can be sold on the market. It remains to be seen how such an enlarged CDM can be monitored and how the baselines would be set.

A consecutive set of options to influence emission development of developing countries is shown in Figure 8 in order of increasing comprehensiveness. First, emission development of

developing countries is influenced by the development of new technologies in developed countries. These technologies automatically "spill over" to other countries. As a next step, developing countries emissions are influenced by more direct action and financing of developed countries, e.g. through CDM projects, technology transfers and funded projects as well as through greening investment flows. As a more active step, the country could commit to sustainable development policies and measures. Then possibly to assuming flexible quantitative targets and finally to assuming absolute emission targets.

Figure 8. Options for influencing developing countries' emissions

There are some similarities between extended CDM, positively binding targets and price caps. All concepts provide that the developing country's participation is only for its benefit.

In the CDM, the projects are financed externally. The advantage of the CDM is that the activities are confined to particular projects. But implementation problems may occur with setting the baseline, showing additionality and monitoring of the emissions.

Positively binding targets would be equivalent to a nation wide CDM project with the positively binding target as the baseline. If a country is confident that it will comply with the target, it can provide allowances to its industry to enable them to participate in international emission trading. An advantage would be that, once this target is set, monitoring would occur through the national greenhouse gas inventory. The option to participate with positively binding targets would be an incentive for developing countries to provide high quality national communications, as these will be the basis for setting the target. A disadvantage would be that it is unclear, who would be liable in the case the country does not comply but has provided allowances to its industry.

A price cap would act very similar: Countries would be allowed to issue additional allowances at a given price. If it were set at a very low price or even zero, the non-compliance with the target would have no consequences. However, with international emission trading it may be difficult to implement a price cap for only a limited number of trading countries. It would require a gateway mechanism to prevent that additional allowances are issued in the country with the low price cap and sold on the international market at a higher price.

Of these three options we would therefore recommend the positively binding targets as those to further consider, since they are simpler to implement on the international level.

5.3 PARTICIPATION

Should there be two, one or many groups of countries in the future?

Four options are outlined below on how a future system could differentiate groups of countries:

1. A future system could continue to split countries in **two groups**, where the one group, Annex I, has a certain type of commitment and other countries, Non-Annex I, have other commitments. In such a system, Annex I could be extended gradually through the procedures that are provided in the UNFCCC and the Kyoto Protocol. Originally, the countries that were members of the Organization for Economic Co-operation and Development (OECD) in 1992 and countries with "economies in transition" (EITs), that is, the Russian Federation and several other Central and Eastern European countries, were included in the list. The Kyoto Protocol updated Annex I by adding those countries that applied to be included and changing the names of those, whose geographical borders changed (new states formed out of Yugoslavia and Czechoslovakia), as well as deleting those that had not ratified the Convention at the time of adoption of the Kyoto Protocol. Any further changes in the past to move into Annex I (Kazakhstan) or out of Annex I (Turkey) received large opposition of many countries, which has lead to a rigid divide between the two groups. Figure 9 provides an overview over the existing groupings under the UNFCCC and Kyoto Protocol.
2. Another approach to defining participation requirements would be to design a system of **several stages**, where countries graduate from one stage to another. Different types of commitments are applied at different stages. E.g. the Multistage approach by RIVM (den Elzen et al., 2003) proposes a first stage with an intensity target, a second stage with constant emission levels and a third stage with absolute emission reductions. ECOFYS (Höhne et al. 2003) proposed a first “soft” stage (sustainable development policies and measures), followed by moderate emission limits and, finally, emission reductions. Crucial in such a set up is to define when a country is moving to a next stage and to ensure that sufficiently strict targets are taken on at all stages, so that the desired stabilisation levels can be reached.
3. Another alternative participation regime would be to provide a **menu of different types of commitments**, and to allow countries to choose the type of commitment that best suits its conditions (e.g. Kameyama 2003). Incentives need to be built into such a system, so that countries take on commitments that are sufficient to reach the desired stabilization level. More flexible targets could be made slightly more stringent as to compensate for the additional uncertainty. Further, countries need to have the capability to judge the stringency of the other countries’ commitments, which will be more difficult when comparing two different types of commitments, e.g. an absolute emission target with an intensity target or a commitment to implement polices.
4. Lastly, the problem of defining country groups could be overcome by applying **one type of commitment for all countries**. E.g. the contraction and convergence approach (Meyer, 2000) applies one type of commitments, absolute binding emission targets, to all countries so that per-capita emissions converge. Such a system would be simple, but could not take into account the structural differences between countries, which limits its acceptability.

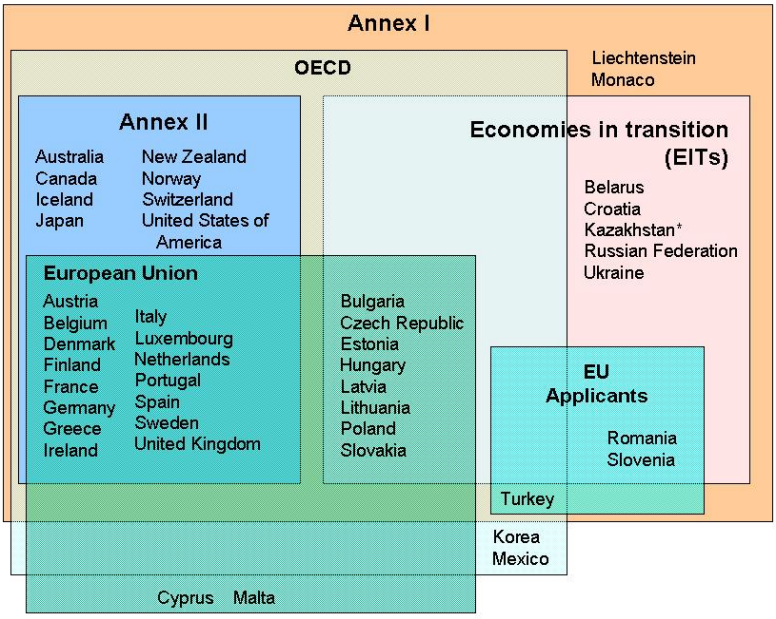

Figure 9. Current country groupings under the UNFCCC

If there are several country groups with different commitments, which country should be in which group and when should it enter?

It is generally accepted that dangerous climate change could only be prevented, if industrialized countries' emissions decline and developing countries emissions do not rise as much as currently expected. Therefore industrialized countries need to reduce emissions substantially and an increasing number of countries would need to gradually take on more stringent commitments.

In the UNFCCC system, two groups of countries are defined, those that are included on the list of Annex I, and those that are not included. The criterion for being included in the list was being a member of the OECD at that time and being an Eastern European country. A generic rule, such as for example an emissions-per-capita or GDP-per-capita threshold was not applied. In contrast, the Montreal Protocol uses a dynamic rule, i.e. a threshold of the consumption of ozone depleting substances per capita, to distinguish two groups of countries with different commitments. For the UNFCCC, the condition could have been formulated as "being member of the OECD". Now Mexico and South Korea have joined the OECD after 1992, but they are not automatically members of Annex I.

Three options for selecting countries for groups are outlined below:

1. For a future system with several stages or with a menu of different types of targets, **indicator thresholds** for the participation could be set that define when a country has to participate with a particular type of target. Such threshold could be calculated using the following indicators or a combination of them:

    - Absolute emissions
    - Emissions per capita
    - Emissions per GDP
    - GDP per capita
    - Cumulative emissions
    - Contribution to temperature increase
    - Other measures of development, such as the human development index

However, the choice of such indicator would be very controversial, as countries will have different views on which is the most appropriate indicator. It seems unlikely that any single indicator or any combination of indicators would be generally acceptable to all countries.

A threshold defined as per-capita emissions would provide an incentive to keep emissions low as to not move to the more stringent next step. It would however include countries with high emissions but relatively low development, such as South Africa and oil exporting countries, and exclude countries with high development and income, but low emissions. Therefore Criqui et al. (2003) proposed a composite index using the sum of per-capita emissions and per-capita GDP.

2. A second option would be that countries themselves decide which group to join (**self-identification**). In such a system, incentives have to be provided to motivate countries to move into certain groups, e.g. publicly available and comparable data on the indicators and political pressure. The withdrawal of the USA from the Kyoto Protocol and hesitance of the Russian Federation to ratify shows that the placement of countries in groups and incentives for participation is not only an issue for Non-Annex I countries but also for Annex I countries.

   One the one hand, pull incentives ("carrots") help countries to participate, if they see a benefit in it. Russia would have an economic benefit when participating in the Kyoto Protocol due to the amount of excess emissions that could be sold. CDM or positively binding targets would be incentives for developing countries to participate, because they can only benefit from participating. For companies in the USA it would be the access to the EU emission trading market that could be an incentive to participate. The choice of the topic of the discussion may also be an incentive to participate, e.g. the USA may be more willing to participate, if the focus of the action is on technology development and innovation. Developing countries would be interested, if the focus of the activities is on their economic development.

   On the other hand, push incentives ("sticks") may have to be applied as well. In the absence of a supra-national authority, only countries exercise incentives against other countries. One option is to link the climate to other issues such as trade. Trade sanctions may too strict, however, the application of border tax adjustments as well as engaging into preferred trade relations in the case of climate change action to could be viable options (see also chapter 11.2.3).

   In addition, disincentives should be eliminated. For example, it would be a clear disincentive for developing countries to participate, if they have to fear that their economic development is capped.

3. Yet another option would be to **explicitly link the participation** of some developing countries to the success of reductions taken by developed countries. One proposal would be that developing countries only start to take on further commitments once the global or Annex I average per capita emissions are reduced. An appropriate indicator would have to be found in such a system. (See also the common but differentiated convergence approach, Chapter 7.)

5.4 STRINGENCY OF EMISSION REDUCTIONS

What would be the process to agree on differentiated targets?

The resulting emission reduction percentages of countries in the Kyoto Protocol and the Marrakech Accords were essentially based on the political willingness of the countries themselves. A general formula for setting the emission reductions was not applied. If emission reduction commitments are applied in the future, a *process* on differentiating the emission targets between countries has to be agreed. Three options for such a process are outlined below.

1. In a next round of negotiations, the participating countries could again make **proposals** for their individual reductions on a bottom-up basis. This approach has the risk that these

reductions do not lead to the low emission level needed to reach the desired stabilization levels.

2. Alternatively a **common formula** could be agreed (see also below) according to which the emission targets are determined. This rule could lead to reduction percentages for each individual country, which can then be modified by negotiations.
3. Another approach would be to give an **overall target to a group** of countries and to let the group decide on how to share the target amongst the participants. This could, for example, be applied to the EU, the current group of Annex I countries, the total of the G77 or any other group of countries.

What are the options to determine emission targets for individual countries within a group?

For options 2 and 3 above, a rule would have to be found to share emission allowances between countries within a certain group. Some options are outlined below:

The simplest option is to choose a reference year and to apply equal percentage reductions to all countries ("**flat rate**"). This method is simple but does not take into account structural differences between countries, historic trends and reduction potentials. It is therefore very unlikely that it will be applied.

Several other rules have been proposed that use further indicators to determine "**differentiated**" reductions. Possible differentiation criteria include:

- Historic, current or assumed future emissions
- Contributions to temperature increase (Brazilian Proposal)
- Population (Convergence)
- GDP or other measure of welfare or income
- Geographic area
- Reduction potentials
- Costs and/or benefits of reductions
- Sectoral benchmarks
- Emissions to satisfy basic needs and luxury emissions
- Several sectoral targets added to a national target (e.g. the Triptych approach)

The individual reductions could be fine-tuned to reach a global emissions target. In addition, they could be designed in a way that leads (converges) to a common absolute level of emissions, e.g. a certain amount of emissions per capita, as for the 'contraction and convergence' approach, or per GDP.

Again it will be difficult to satisfy all possible country conditions with one formula. There is a general conflict between a simple transparent formula (such as converging per capita emissions) and incorporating many national circumstances (e.g. the Triptych approach). The Triptych approach provides a formula that can incorporate many structural differences. It derives national targets from sectoral considerations, assuming growth in industrial production and electricity production with improvements in efficiency and assuming convergence of all other emissions to equal per capita levels. However, this approach is relatively complicated and therefore difficult to negotiate (see also 7).

5.5 ADAPTATION

What are the types, stringency and levels of participation of action on adaptation?

The next step on future international action will most likely only be acceptable to some countries if mitigation actions are combined with elements related to vulnerability and adaptation as well as sustainable development. Such a link has been stressed many times, most prominently at the Conference of the Parties in New Delhi in 2002. However, only a few concrete proposals have been made on an explicit link. Müller (2003), for example, proposed a separate adaptation protocol. The issue of adaptation is further considered in section 6.

5.6 NEGOTIATIONS

How should future international action on climate change be negotiated? What is the resulting treaty architecture?

Currently, the Framework Convention on Climate Change is supported by almost all countries in the world. The Kyoto Protocol, as the next international step to mitigate climate change, is rejected by the USA but will enter into force on 16 February 2005. 128 countries have ratified the Kyoto Protocol to date. Especially the European Union and Japan are eager to implement it and do not want to start a parallel discussion forum. Four options for the future forum of the climate negotiations are outlined below:

1. Discussions could **continue under the Kyoto Protocol umbrella** and efforts to bring the USA back into the process could be intensified. However, some observers note that it is very unlikely that the USA will be able to agree to anything that carries the name "Kyoto". Under such circumstances, official discussions on next steps are very difficult. If the Kyoto Protocol should be abandoned, six years or even more of negotiating time and effort to design the Protocol and the associated Marrakech Accords may be lost.

2. Alternatively, the **"Kyoto countries"** that are committed to reducing emissions could implement the Kyoto Protocol and negotiate amongst themselves on their further efforts to reduce emissions. Emphasis would be placed on actions to reduce emission and not on bringing other countries into the regime. As the problem of climate change is widely recognized, it is certain that measures to curb greenhouse gas emissions will have to be taken. There is only a serious debate about the costs and timing. If a critical mass is brought together under such an agreement, other countries may feel under pressure to join. However, such system would raise serious concerns of the internationally competing industries in the participating countries in the beginning, as they may be faced with competitive disadvantages.

3. Instead, it was also proposed that the **major emitters negotiate** a deal only amongst themselves. The 28 largest emitting countries, which include many Non-Annex I countries, cause 80% of global emissions (see Höhne et al. 2003). With a smaller number of negotiators, it may be easier to strike a deal. One intermediary country (e.g. Switzerland) could take the initiative to bring together the major emitting countries to discuss and agree future steps. However, such a separate process would clearly weaken the all-encompassing process under the UNFCCC, which is based on global participation and decisions by consensus of all Parties. Still, an agreement between the major emitters could be carried back into the UNFCCC process.

4. Furthermore, it was proposed that negotiations are **split into several treaties**, e.g. a treaty on reporting, one on mandatory emissions reductions, one on adaptation, one on land-use change and forestry etc. The advantage would be to officially decouple the separate issues and to negotiate each issue separately only with the countries that want to participate. However, the risk still persists that the shortcomings of the one-treaty system remain: Some countries could link the topics unofficially and some countries could participate in the separate treaty negotiations to slow the process down rather than moving it forward, as it happens today under the UNFCCC. One emerging example is the US initiative „Methane to markets", that gathers interested countries to reduce emissions from methane.[8]

5.7 CONCLUSIONS

The negotiations on future international action on climate change will be very complex and have to be conducted on many dimensions. The issues are diverse and inter-linked. However, the large number of options can be broken down into the categories such as those discussed above. Most proposals on future international actions on climate change cover different elements and are therefore difficult to compare. Such division into separate issues can be

[8] See http://www.methanetomarkets.org/ or http://www.epa.gov/methane/international.html

useful for categorizing and discussing the isolated options and proposals. Structuring the negotiations around the distinct issues, which can be discussed one by one, may accelerate reaching an agreement.

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6. ADAPTATION

6.1 INTRODUCTION

Adaptation to climate change is one of the key issues of concern for developing countries, who perceive that although much is being done in the way of mitigation for addressing the climate change issue, adaptation has taken a back seat (Najam et al. 2003, Ott et al. 2004). Indeed, mitigation efforts are already underway in both Annex I and non-Annex I countries and mitigation still dominates the climate change negotiation process. Adaptation issues have advanced much less rapidly and the urgency to achieve progress in this area was re-emphasized in the Delhi Ministerial Declaration resulting from COP8. Discussions to address mitigation efforts of developing countries are likely to be more fruitful, if developed countries can already clearly demonstrate a commitment to addressing adaptation. Adaptation must therefore form part of a final negotiation package.

Despite of the recognition that adaptation is a major key to a solution to the problem of climate change and the impasse of the negotiations, concrete steps to incorporate 'adaptation' in the international climate negotiations are still very rare.

The following chapters discuss the definition of adaptation (6.2), adaptation in the UNFCCC framework (6.3), funding schemes for adaptation (6.4), actions to further advance adaptation (6.5) and further issues (6.6). The discussion on adaptation concludes with some final remarks in chapter 6.7.

6.2 DEFINITION OF ADAPTATION

The problem of global climate change can be addressed with three types of action: reducing greenhouse gas emissions (mitigation), adapting to the changing climate and restoring the remaining impacts of climate change. Adaptation is generally seen as proactive measure while restoration would be rather reactive, but the distinction between adaptation and restoration is not always clear.

The Third Assessment Report of the IPCC defines adaptation as "adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects or impacts" (Burton et al. 2001). This definition still leaves room for interpretation. In principle, three types of adaptation activities could be envisaged:

1. Measures could be *anticipatory of explicit changes in the climatic conditions* to avoid expected damage or to prevent damages that have occurred for the first time in the past. Building dikes against sea level rise or changing agricultural practice to keep production on a sufficient level under drier circumstance would be such proactive measures.
2. Measures could also be taken to ensure *damage repair, restoration or compensation*. Insurance could compensate for the damage that will occur, if no adaptation measures are taken or if adaptation measures are insufficient to avoid damage. Such insurance could be seen as a form of adaptation. If the risks increase, the coverage of the insurance is extended. Any restoration could also include adaptive measures that would soften the impacts of subsequent (extreme whether) events.
3. In addition, measures could be taken to *strengthening the general capacity of communities to adapt* to unexpected or future changes in climate. A country with higher economic development can better adapt to changes in climatic conditions than countries with a lower economic development. Such measures can be interpreted as covering a very broad set of issues, basically covering poverty alleviation and economic development. In such case, only the climate change specific adaptation activities should be considered under the UNFCCC.

It was suggested as one option to first focus on projects that have a mitigation *and* an adaptation component at the same time. Examples could be buildings that are more energy

efficient and at the same time less susceptible to extreme whether events or plantations that store carbon and make the soil more resilient. The number of such projects, however, is very limited and by far not all adaptation or mitigation needs will be covered by such projects. Some argue that resources would be more effective, if spent half on mitigation and half on adaptation (Klein et al. 2003).

Vulnerability, impacts and adaptation to climate change is a topic of intensive research. The regional impacts of climate change and possible adaptation measures are poorly understood. Consequently, the costs of the necessary adaptation measures are not available.

There may also be limits to adaptation to climate change. Certain events, such as the discontinuation of the thermohaline circulation may lead to substantial changes in climate that may be difficult to adapt to.

6.3 ADAPTATION IN THE UNFCCC FRAMEWORK

The issue of adaptation to climate change is treated in a very fragmented manner in the UNFCCC negotiations. It is included in several articles of the UNFCCC and the Kyoto Protocol and is considered in several negotiation items. Funds are established and the issue of insurance against climate related events is discussed.

Several articles of the Climate Change Convention consider adaptation:

- Articles 4.1b, 4.1e and 4.1f of the Convention refer to all Parties committing to 'cooperate in preparing for adaptation to the impacts change' and to 'formulate, implement, publish and update' national 'programmes containing measures to facilitate adequate adaptation to climate change.
- Article 4.4 of the Convention requires Annex II Parties to fund developing country adaptation on climate change (see also Arts. 4.3, 4.7 and 4.9 with respect to funding in general).
- Article 4.5 refers to promoting, facilitating and financing transfer of 'environmentally sound technologies and know-how' to enable developing countries to implement provisions of the Convention. These technologies include adaptation technologies as well as technologies reducing greenhouse gases. A general framework on technology transfer has been adopted, including the formation of an expert group on technology transfer (EGTT), which also considers adaptation technologies.
- Article 4.8 states that all Parties shall give full consideration of needs of developing countries from adverse effects of climate change. It is also the only article that mentions insurance. In this article, the adverse effects of climate change are linked to effects of "response measures" (actions by Annex I Parties to reduce emissions and therefore, e.g., lowering the revenues from oil exports) on developing countries. This explicit link prevented fast progress on these issues, as developed countries are more prepared to fund adaptation activities than to compensate for losses in oil revenues.
- The SBSTA worked also on methods and tools to assess climate change impacts and adaptation options

In June 2004, the SBSTA for the first time considered adaptation as a separate agenda item and organized a in-session workshop on "Scientific, technical and socio-economic aspects of impacts of, and vulnerability and adaptation to, climate change" to focus the discussion on adaptation in one place.

It agreed to further discuss adaptation on a very general sense; concrete 'adaptation commitments' are not on the agenda. The SBSTA agreed to continue focusing its work on exchanging information and sharing experiences and views among Parties on practical opportunities and solutions to facilitate the UNFCCC's implementation and to organize a further workshop for sharing experiences and on the application of methods and tools for

assessing impacts and vulnerability and adaptation and the linkages between adaptation and sustainable development.

As part of the package agreed at COP7, a UNFCCC workshop on insurance was mandated under the discussion related to Articles 4.8 and 4.9 (adverse effects of climate change). It was held in Bonn, May 2003. Due to the linkage of adverse effect of climate change and of response measures in Article 4.8 of the UNFCCC, insurance for both issues were discussed. Subsequently the Subsidiary Body for Implementation (SBI) considered the issues related to adverse effects (Article 4.8 and 4.9, Decision 5/CP.7) including the workshop on insurance, but did not reach a conclusion in June 2003, December 2003 and June 2004. This disagreement is partly due to the link between adverse effects of climate change and of response measures as well as the retarding role of Saudi Arabia (ENB 2003).

6.4 FUNDING FOR ADAPTATION UNDER THE UNFCCC

The **Global Environment Facility (GEF)** of the World Bank provides resources for developing countries as the financial mechanism of the UNFCCC. The GEF provided most of its budget within its focal area "climate change" from 1991 to 2003 for emissions reduction projects and around 7% of this budget for preparation of national communications, which includes assessments of vulnerability and adaptation (GEF 2004a). The GEF also co-funds projects like the "Mainstreaming Adaptation to Climate Change (MACC)" project in Caribbean region. This five-year project started in 2002 with the aim to integrate climate change and variability into sectors such as tourism, agriculture, fisheries and infrastructure.

The Conference of the Parties of the UNFCCC (COP) oversees the activities of the GEF related to climate change. COP 1 (Berlin 1995) requested the GEF to first fund studies on climate change impacts in developing countries through their support for national communications (stage I). COP 4 (Buenos Aires 1998) requested the GEF to fund projects to identify measures to prepare for adaptation (stage II). COP 9 (Milan 2003) requested the GEF to operationalize a new strategic priority "piloting an operational approach to adaptation" (SPA). It will support projects that integrate adaptation into national policy and sustainable development planning. This priority will be funded with US$ 50 million over three years and is to be operational as of 1 July 2004 (GEF, 2004b).

One obstacle for this general GEF funding is that it includes only *incremental* costs of measures to achieve a *global* environmental benefit. The new strategic priority "piloting an operational approach to adaptation also supports only incremental costs and global environmental benefits. Adaptation activities, however, have primarily a *local* benefit. The implementation of the pilot projects will show, how incremental global benefit can be identified for adaptation.

COP 7 (Marrakech 2001) requested the creation of three funds that are additional to the general GEF funding and that are to be administered by the GEF. These funds do not underlie the principle of incremental costs of global environmental benefits:

1. The **special climate change fund (SCCF)** was established (Decision 7/CP.7) to support climate change activities in the areas of: "adaptation (5/CP.7 para. 8); technology transfer (4/CP.7); energy, transport, industry, agriculture, forestry and waste management; and activities to assist developing countries…in diversifying their economies". COP 9 (Milan 2003) requested the GEF to make this Convention fund operational without delay. Adaptation as "top priority" shall include implementation of adaptation activities, improving the monitoring of diseases and vectors affected by climate change, supporting capacity-building, and supporting national and regional centers for rapid response to extreme weather events (Decision 5/CP.9).
2. The **least developed country (LDC) fund**, a fund of the Convention, (established under 7/CP.7) is to support a work programme for LDCs, which includes, amongst others, support in development, preparation and implementation of national adaptation programmes of action (NAPAs) to communicate vulnerabilities and adaptation needs, and the development & transfer of technology (especially adaptation technology).

Contributions to that fund are voluntary. It is currently the only of these three funds, which is operational.

As of 15 April 2004, total contributions received amounted to US$ 16 million, with outstanding pledges in the further amount of US$ 18 million (GEF, 2004c). As of the same date, projects totaling US$ 8 million for the preparation of NAPAs in 37 countries were approved.[9]

The national action plans for adaptation (NAPAs) were established to serve as a 'simplified and direct channel of communication of information relating to vulnerability and adaptation needs of least developed countries', and may act as a first step in the preparation of National Communications to the UNFCCC (5/CP.7, II.15). The NAPA identifies urgent and immediate adaptation needs of LDCs for adapting to the adverse impacts of climate change, and sets out a list of priority activities, as identified by the LDCs themselves (according to justification criteria). Guidelines have been established for the preparation of NAPAs (Decision 28/CP.7).

COP 9 decided that now also the *implementation* of priority activities identified in the NAPAs can be funded by the LDC fund (decision 6/CP.9). The "agreed full costs" of such adaptation projects will be funded, not only the incremental costs.

3. The **adaptation fund** is a Kyoto Protocol fund (Art. 12.8 of KP, (established under 10/CP.7), which is to support "concrete adaptation projects and programmes" in developing countries. It will be financed from the "share of the proceeds" on the clean development mechanism and other sources of funding. It is to be used to "assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation".

   The total envelope of the fund depends on the level of CDM activity (which depends on the level of domestic action of each developed country to reach its Kyoto target). The fund is not yet operational. A rough estimate of the share of proceeds from CDM could be 60 million US$[10] over the first commitment period.

A volume of these funds has not been agreed, but at COP7, a joint political declaration was made by the European Community and its Member States, together with Canada, Iceland, New Zealand, Norway and Switzerland, on their preparedness to collectively contribute €450 Million annually by 2005 with this level to be reviewed in 2008. It includes contributions to all of the activities above, i.e. "contributions to GEF climate change related activities; bilateral and multilateral funding additional to current levels; funding for the special climate change funds, the Kyoto Protocol Adaptation Fund and the LDC fund; and funding deriving from the share of proceeds of the clean development mechanism following entry into force of the Kyoto Protocol."

Developing countries have expressed the wish to have greater consistency and commitment to climate change funding. The new funds only slowly become operational. The COP has not agreed on volumes of contributions. It was also suggested that the provision of funding is linked to responsibility for the impacts of climate change (Ott et al. 2004).

6.5 POSSIBLE ACTIONS TO FURTHER ADVANCE ADAPTATION

Several options are available to further advance international action on adaptation. This section provides an inventory of the diverse proposals, summarized in Table 18.

Implementing first adaptation projects identified in, e.g., NAPAs or National Communications

[9] Bangladesh, Benin, Bhutan, Burkina Faso, Cambodia, Cape Verde, Central African Republic, Chad, Comoros, Congo DR, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Haiti, Kiribati, Lao PDR, Lesotho, Liberia, Malawi, Maldives, Mali, Mauritania, Mozambique, Niger, Samoa, Sao Tome and Principe, Senegal, Sudan, Tanzania, Togo, Tuvalu, Uganda, Vanuatu, Yemen, Zambia

[10] Calculated as 2% of the CDM market from den Elzen and Moor (2001)

The continuation of the process would be to implement priority activities identified in the NAPAs or in national communications. So far 37 countries are preparing NAPAs. It may be expected that completed NAPAs may already be available for 2004 and seeking implementation. National communications are available from 120 Non-Annex I countries.

Developing countries have raised concerns of adequacy of funding several times and the issue of financing NAPA implementation is no different. Submissions from LDCs on views on strategies for NAPA implementations clearly state concern of adequacy of funding for adaptation particularly in view of financial commitments of Annex I countries to date. LDCs and other developing countries are looking for a clear commitment on the level of resources to be dedicated to adaptation (FCCC/SBI/2003/MISC.4).

A way forward would be that developed countries demonstrate the clear willingness to support adaptation projects with concrete funding. The instruments are in place or can enter into place soon, but they have to be filled with the necessary resources. As a first step this could be achieved through a commitment to support NAPA implementation via the LDC fund and the new strategic GEF priority "piloting an operational approach to adaptation". This could help to initiate the funding process for implementation of adaptation projects.

Care has to be taken about the GEF principle to fund incremental costs of global benefits. It remains to be seen how this principle can be implemented for adaptation. The focus could be placed on the new funds, for which this principle does not apply.

Designing insurance schemes

Insurance schemes would be a means to help developing countries to deal with the negative effects and impacts of climate change. Since the attribution of liability for current extreme climate change effects is placed with the historically largest greenhouse gas emitters (the main target amongst these being the developed countries, seen to benefit the most from their emissions), developing countries expect large emitters to compensate.

Article 4.8 of the Convention refers to insurance as a means to minimize adverse effects of climate change and/or the impacts of response measures on developing countries. If a way could be found to establish a system of insurance at international/global level to compensate for the adverse effects of climate change (for e.g. insurance against extreme weather events), then it would provide a vehicle for structured funding of adaptation measures by developed countries, and demonstrate to developing countries a commitment to addressing their adaptation concerns.

Two approaches to establishing an international insurance are described below (A. Michaelowa 2003, M.J. Mace 2003, UNEP 1993):

1. *Insurance based on contributions from emitters (non-risk community):* Taking as an example the increase in number and severity of natural disasters in DCs – on the principle that greenhouse gas emitters are liable for climate-related disasters in developing countries - a system of insurance could be envisaged where the emitters pay the premium of developing country losses from climate change (see also Müller 2003). This could be accompanied by a small share of loss-bearing on the part of the insured developing countries so as to avoid moral hazard.

   This concept was taken further in a proposal put forward by AOSIS (Alliance of Small Island States) in 1991. AOSIS proposed the idea of an "international insurance pool" to cover loss risks experienced by DCs as a result of climate change impacts (in case of small island states, losses will relate to sea-level rise), and to distribute the financial burden amongst developed countries. Under the proposal, the insurance pool would be funded via mandatory contributions from developed countries, based on their level of CO_2 emissions and their GNP (50/50 weighting). The loss-sharing approach in the AOSIS proposal is similar to that used in the OECD Nuclear Damage Convention (1963) and Oil Pollution Damage Convention (1971). Even though the AOSIS proposal addresses the concerns of its members about sea-level rise, the same concept could be applied to other groups of countries and other climate change damages.

2. *Insurance based on contributions from affected countries (at-risk community):* This type of insurance comprises, as a first basis, contributions from the at-risk community (persons, enterprises, governments at risk) e.g. via commercial, public insurance. International bodies, or governments can subsidize this type of system for e.g. by providing forms of reinsurance.

Regardless of the architecture of an international insurance system, more work still needs to be done with respect to determining the actual valuation of damages to be included in the scheme, and ultimately the level of funding required from developed countries.

Given the past discussion, it seems unlikely that a discussion on insurance of climate change damages can be held in isolation from insurance for adverse effects of "response measures". Either both issues have to be de-coupled or progress has to be made on both areas. In addition, it seems likely that any system of insurance can be initiated by the UNFCCC but would then be transferred to a different international regime, such as the regime on e.g. disaster relief.

Mainstreaming adaptation into sustainable development efforts

One option would be to integrate adaptation measures into the funding efforts for sustainable development (Klein at al. 2003, VARG 2003). Mainstreaming is seen as making more efficient and effective use of financial and human resources than designing and implementing adaptation policy separately from ongoing development activities. Development agencies and donors could as a priority select those projects that also have a benefit for adaptation. Developing country governments could integrate adaptation into their poverty reduction strategies.

If climate change, including adaptation, and development are integrated, it will be difficult to assess the incremental actions by countries as a reaction to climate change. Furthermore, it has been argued that development aid and funding for adaptation are principally different, because the development aid is charity based while funding adaptation to climate change can be related to commitments under the UNFCCC (Ott et al. 2004).

Donor agencies have already formed the "Vulnerability and Adaptation Resources Group (VARG)" that analyses such integration (VARG 2003). A further stage could be a target for donor countries to commit to provide funds for climate change, and in particular adaptation, related development assistance equal to a percentage of their GDP (Drexhage 2004).

Mainstreaming adaptation into disaster relief

A new notion would be to integrate adaptation to climate change into international disaster relief. Reacting to natural disasters is the field of the United Nations International Strategy for Disaster Reduction (ISDR). Integrating adaptation into the risk management strategies that are developed under the ISDR could be a major step forward. ISDR and the Vulnerability and Adaptation Resource Group will present a paper on such integration end of 2004.

Table 18. Summary possible actions to advance adaptation

Category	Action	Committed actors	Commitment	Forum
Anticipatory of expected changes	Implementing first adaptation projects identified in NAPAs and national communications	Annex II countries	Provide co-funding	UNFCCC
Damage repair, restoration and compensation	Designing insurance schemes	Developed country governments	Provide guarantees	UNFCCC possibly ISDR
	Mainstreaming adaptation into international disaster relief	Developed country governments	Provide co-funding	ISDR
Enhancement of adaptive capacity	Mainstreaming adaptation into sustainable development efforts	Developed country governments	Commit a percentage of GDP for climate change related development aid	To be discussed
		Developing country governments	Commit to include adaptation into their sustainable development strategies	

Table 18 provides an overview of the options discussed above. The options are grouped along the three categories of activities given in 6.2. Implementing first adaptation projects would be anticipatory of expected changes. Insurance schemes and mainstreaming adaptation into international disaster relief would be activities for damage repair, restoration and compensation. Finally, mainstreaming adaptation into sustainable development efforts would strengthen the adaptive capacity of a country.

The three options can also be applied in parallel or in combinations. E.g. adaptation measures and insurance could be designed to provide for cross incentives between the two: Insurance companies could engage in adaptation projects to manage the risk from loss of insured assets.

6.6 FURTHER ISSUES

Several issues remain open and unclear on the issue of future action on adaptation. The following immediate activities could advance the consideration of adaptation in the international negotiations:

Streamlining of work: The current treatment of adaptation in the UNFCCC negotiation process is very fragmented. Part of it is intentional so that the Subsidiary Body for Scientific and Technological Advice (SBSTA) covers only the scientific aspects and the Subsidiary Body for Implementation (SBI) covers the funding. Considering adaptation under one agenda item under SBSTA is a step forward that has been first tested at the subsidiary body meeting in June 2004. Information exchange on lessons learned on adaptation is the first step, but discussions have to become more concrete than they have been so far. In addition, the various funds have overlapping competences, for example all funds support adaptation activities. A clearer distinction of the each of the funds' mandate could be helpful.

The appropriate forum for adaptation: At COP8, the Indian delegation put forward the idea to include the adoption of a 'Protocol on adaptation' as part of the action for initiating further action for assessment of adverse effects, and steps to facilitate implementation of adaptation measures. Such a legal instrument could provide the dual guarantees needed for agreement: on the one hand developing countries want a commitment to sharing of the burden of climate impacts and assurance that they have recourse to compensation, and on the other hand donor countries will want to ensure that there are boundaries to funding for compensation

(Müller 2003). Such an adaptation protocol could focus all activities on adaptation that are currently undertaken under the UNFCCC.

But the discussion above (Table 18) reveals that several options for action would be placed *outside* of the UNFCCC. Mainstreaming adaptation into sustainable development would be an issue much broader than the UNFCCC. Consideration of adaptation in disaster relief would be placed with the International Strategy for Disaster Reduction. Such options would not be covered in an adaptation protocol under the UNFCCC.

Separation of adverse effects of climate change and effects of response measures: This explicit link in Article 4.8 of the Convention prevented fast progress on adaptation. Developed countries are more prepared to fund adaptation activities but are not prepared to compensate for losses in oil revenues. First attempts from within the G77 at the UNFCCC subsidiary body meetings in June 2004 to separate the issues were not successful, but showed that there could be a resolution in the future (ENB 2004).

Clarifying the definitions: The term "adaptation" is still used for *damage repair* (as is the case with insurance) and for *damage prevention* (increasing adaptive capacity). As a first step a clear definition of adaptation should be agreed. Or at least constituencies should always make clear, which kind of adaptation they refer to.

Although some work has been done in the past to define *vulnerability* there is still no clear perception of what this means to individual countries. Questions such as - What is the nature of vulnerability? How is it to be measured and addressed? Is it possible to create a common yardstick for vulnerability? How can vulnerability best be reduced? - were put on the agenda some time ago, but a clear and commonly shared interpretation is still missing. Some suggest that health, education and particularly governance indicators can provide reasonable assessment of vulnerability to climate hazard (Tyndall Center 2004).

In addition, the term *adaptive capacity* needs further evaluation. The adaptive capacity of societies depends largely on the ability to act collectively in the face of threats posed by climate variability (Tyndall Center, 2004). These concepts and definitions have not yet been translated into more concrete examples or indicators (e.g. when is the adaptive capacity of a farmer low, medium, high?).

Adaptation needs and cost: Despite the body of work that has already been done in respect of the adaptation issue – risk identification, geographic distribution, ability to cope (vulnerability) – it is clear that not enough is known about the level of adaptation needs, in terms of quantified costs of adaptation for developing countries. This is partly due to the uncertainty of which activities adaptation includes. Further studies are still required to determine what adaptation activities are required, where, with what urgency, and ultimately at what financial cost.

The costs of implementation of the NAPAs can provide a useful reference for the costs of certain adaptation activities – in particular those aimed at preventing or reducing potential future damages and associated future costs. But NAPAs are currently only developed for the least developed countries. Introducing NAPAs for all Non-Annex I countries may warrant consideration.

On a more long-term basis further work will need to be done into estimation of costs associated with damage repair and compensation as well as the magnitudes of funding required to effectively address these, e.g., within an international insurance system.

6.7 CONCLUSIONS

Adaptation covers a broad range of considerations from immediate measures against expected changes in climate via strengthening adaptive capacity (i.e. development) to damage repair and compensation.

Many of these issues are broader than what the UNFCCC regime could cover. Of the four options presented in Table 18, the most powerful ones are likely to be the mainstreaming adaptation into development and disaster relief. But the effective implementation would occur

outside of the UNFCCC regime. As a consequence a separate adaptation protocol under the UNFCCC may not seem adequate. The issues are too broad to be covered only under the UNFCCC. In addition, it could distract attention from the urgent need to address mitigation.

On the other hand the issue of damage repair and restoration is clearly a matter related to climate change and the UNFCCC. Within the UNFCCC regime, narrowly defined adaptation projects could be implemented through the available funds. In addition, a clear commitment of developed countries could be voiced to support adaptation activities outside of the UNFCCC.

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7. COMMON BUT DIFFERENTIATED CONVERGENCE

This chapter was written jointly by Niklas Höhne (Ecofys), Michel den Elzen (RIVM) and Martin Weiss (German Environmental Agency).[11]

7.1 INTRODUCTION

This chapter describes a new concept for an international climate regime for differentiation of future commitments called the "Common but Differentiated Convergence" approach. It is based on the principle of "common convergence", assuming all countries' per capita emissions converge, but "differentiated". "Differentiated" means that developing countries would commit to the same target as developed countries but at some later point in time and conditional to developed country action.

Before discussing the details of the approach, we first discuss the principle of equal per-capita distribution of emission rights, from which this approach was motivated.

Current per capita emissions vary widely between countries (see Table 19). They range from below 1 $tCO_2eq.$ in e.g. Bangladesh, the Non-Annex I average of 4 $tCO_2eq.$, the Annex I average of 15 $tCO_2eq.$ to the as high as 25 $tCO_2eq.$ in the USA and several oil producing countries.

Table 19: Per capita emissions of countries and of different regions for the year 2000

	ALL GHG Excl. LUCF tCO_2eq/cap	**ALL GHG Incl. LUCF tCO_2eq/cap**		**ALL GHG Excl. LUCF tCO_2eq/cap**	**ALL GHG Incl. LUCF tCO_2eq/cap**
UNFCCC Annex I	15.3	15.3	13 MEX	5.0	5.2
UNFCCC Non Annex I	3.2	3.9	14 VEN	10.2	18.5
World total	5.6	6.1	15 RLA	5.2	8.5
01 USA	25.0	25.0	16 EGY	2.4	2.4
02 EU15	11.4	11.4	17 ZAF	8.6	8.7
03 EU+10	10.0	10.0	18 NGA	1.7	1.9
04 RWEU	10.2	10.2	19 RNA	3.6	3.6
05 RUS	14.1	14.1	20 RAF	1.3	2.7
06 REEU in Annex I	8.2	8.2	21 SAU	17.8	17.8
07 JPN	10.9	10.9	22 ARE	47.7	47.7
08 RAI	24.8	26.3	23 RME	6.8	6.8
09 TUR	4.6	4.6	24 CHN	3.6	3.6
10 REEU	6.4	6.4	25 IND	1.8	1.8
11 ARG	8.2	9.2	26 IDN	2.1	3.1
12 BRZ	4.3	10.2	27 KOR	10.7	10.7

[11] Please reference this chapter as Höhne, Niklas; Michel den Elzen; Martin Weiss, 2004: "Common but differentiated convergence", in Niklas Höhne, Dian Phylipsen, Simone Ullrich, Kornelis Blok, 2004: "Options for the second commitment period for the Kyoto Protocol", Research report for the German Federal Environmental Agency.

	ALL GHG Excl. LUCF tCO_2eq/cap	ALL GHG Incl. LUCF tCO_2eq/cap
28 MYS	6.3	10.9
29 PHL	1.6	2.3
30 SGP	10.8	10.8
31 THA	4.3	4.9
32 RAA	2.1	2.6

Source: this study, see Appendix E.

The concept of equal per-capita emission rights is based on the principle to share the common good of the atmosphere equally among all people of the world. It is a concept traditionally supported by many developing countries, which have so far "used" the atmosphere by far less than developed countries. Many developed countries, however, led by the USA, have very strongly opposed such an approach in the international climate negotiations. As a result, Annex I Parties are not even required to report per-capita emissions in their National Communications to the UNFCCC. Developing country negotiators were successful for the first time with the Marrakech Accords 2001, to introduce a first mention of per-capita emissions as a trade off against their rejection of the Kyoto Mechanisms.[12]

The implementation of equal per capita emission rights could be achieved in many different ways, which can be described as *progressive approximations* (see also Ecoequity):

The *first order approximation* would be to allocate equal emissions per capita to all countries for the first possible year (Agarwal and Narain, 1991). The changes between current per-capita emissions and allocated per-capita emission rights would be drastic. Emission trading could smoothen these differences, but still, such an approach would be beyond any realism. The Global Compromise approach as proposed by Müller (1999), which allocates the emission permits from a population-weighted preference score voting for either grand-fathering or per capita allocation, intends to smoothen the differences, but they still remain very large.

A *second order approximation* would be that per-capita emissions converge from the current level to a level equal for all countries within a defined period. This concept is most elaborated in the *Contraction & Convergence (C&C)* approach, which originated from the Global Commons Institute (GCI) in London (Meyer, 2000). It aims at an equal per capita distribution of emission entitlements or allowances *in the long run.* All countries participate and per-capita emission allowances converge from the current level to a level equal for all countries until a predefined date, e.g. 2030 or 2050. Convergence takes place, so that global emissions follow a predefined emission profile that leads to a predefined stabilization level (contraction). International emission trading would allow the countries to acquire additional emission rights and other countries to sell surplus emission rights, if needed.

Converging per capita emissions for differentiating mitigation commitments among Annex I countries were also proposed during the negotiations of the Kyoto Protocol (French proposal to the Ad Hoc Group on the Berlin Mandate (AGBM), UNFCCC (1996))

The Centre of Science and Environment (CSE) in India also supports the Contraction & Convergence concept (CSE, 1998), but has suggested a variant, in which the concept is combined with basic sustainable emission right.[13] The methodology assumes that there is a global sustainable emission level, defined as the amount of CO_2 that can be emitted in the very long term without raising the atmospheric CO_2 concentrations.[14]

[12] Preamble of decision 15/CP.7 on the Kyoto Mechanisms: "… Emphasizing that the Parties included in Annex I shall implement domestic action in accordance with national circumstances and with a view to reducing emissions in a manner conducive to narrowing per capita differences between developed and developing country Parties while working towards achievement of the ultimate objective of the Convention" (document FCCC/CP/2001/13/Add.2)

[13] This approach also leads to a sudden re-allocation of the per capita emissions of all countries.

[14] This sustainable level of anthropogenic CO_2 emissions would ultimately have to be reduced to the level of persistent natural sinks, which is around zero, although the level is not clearly defined (Prentice et al., 2001).

It is the general perception that under C&C, large resource transfers will take place through emission trading from the developed countries (which drastically need to reduce emissions) to developing countries (which will receive more emission allowances than they would need to cover their emissions, so called "tropical hot air" or surplus emissions) (e.g. Nakicenovic and Riahi (2003); van Vuuren et al. (2003)).

However, several recent studies providing detailed calculations (den Elzen et al., 2003; Höhne et al., 2003) show that for relatively strict long-term targets (e.g. lower than 450 ppmv CO_2) and relatively late convergence by, e.g., 2050, while also considering non-CO_2 greenhouse gases, not all developing countries would benefit from this approach: only the low-income countries would receive excess allowances. As the per-capita emissions have to converge to a level below the current average of developing countries, those developing countries above or close to the average (e.g. Argentina, Brazil, Venezuela, Mexico, South Africa, South Korea, Thailand, China) will soon (for some already after 2012) receive fewer allowances than their business as usual projections. More excess allowances would be available under a higher concentration target, e.g. 550 ppmv CO_2, or under earlier convergence, e.g. by 2030.

The main strengths of the C&C approach are its clear concept, transparency and comprehensiveness. Furthermore, it provides certainty regarding global emission levels as all countries participate with binding quantitative limitations. It is furthermore cost-effective due to the option of immediate global participation in emission trading. Reaching relatively strict long-term targets (e.g. lower than 450 ppmv CO_2) requires less reductions by Annex I countries, if all non-Annex I countries participate immediately (converging per capita emissions), compared to a gradual phase-in of developing countries receiving commitments (a "Multi-Stage" approach).[15] Under less strict long-term targets (e.g. 550 ppmv CO_2), it may be the other way around due to the introduction of surplus emission allowances, which is sometimes referred to as "tropical hot air".

While there are many advantages of the C&C approach, several obstacles prevent the approach from being globally acceptable: C&C does not take national circumstances into account other than current per-capita emissions. In particular, it does not take into account the historical contribution of particular countries to the problem (i.e. past emissions) and is therefore likely to meet objections from key developing countries with low emission in the past but relatively high per-capita emissions today. They will argue not to be responsible for the problem although they currently have relatively high per-capita emissions. Many developed countries will reject C&C, because of expected large resource transfers and "tropical hot air", as well as political opposition against the global commons and egalitarian concepts underlying the approach. An early participation of especially the least developed countries may cause implementation problems with reporting emissions and compliance due to their technical and institutional requirements, that are particularly missing in less developed countries at the moment. Involving these countries in international emission trading will be difficult due to lack of reliable emission data, capacity to generate data to meet eligibility requirements, and sufficient capacity for verification and enforcement (Baumert et al., 2003).

A *third order approximation* of the per-capita concept could be to amend the C&C approach with additional rules that consider, for example, potential for renewable energy, differences in climatic conditions and historical responsibility. The "Per Capita Plus" approach is currently being developed by the NGO community (Ecoequity, (Aslam, 2002)). This approach is based on the overarching principles of adequacy, to ensure climate stabilization, and equity, to ensure fairness between nations. It would specifically allocate emission allowances within a framework of equal per capita rights, as modified by a systematic quantification of relevant national circumstances. Another modification to C&C would be to allow countries that have less economic capability and relatively low emissions to voluntarily not participate in the system (an 'opt-out clause') (WBGU, 2003). Countries would only need to accept absolute

[15] The Multi-Stage approach is basically a system for a gradual broadening of the group of countries taking on quantified emission limitations and reduction objectives and deepening of their commitments over time (Berk and den Elzen, 2001).

emission limits, if they pass a certain threshold value of per-capita emissions or per-capita income or both. Countries below this threshold are allowed to make use of the opt-out clause upon prior approval and do not have to comply with absolute emission limits for the time being.

However, a major downside of allowing for an exception for particular national circumstances is, that it will automatically be followed by various claims for other exceptions by other countries. Countries are so diverse that a vast number of different national circumstances could be claimed (e.g. the size of the country, natural resources, cultural habits).

Finally, many other proposals include per capita emissions and convergence as one of more elements. Jihua Pan (2003), for instance, argues that luxury emissions and emissions to satisfy basic needs should be distinguished. He proposed that, as a first approximation, luxury emissions could be all those above the world average. Further, more complex differentiation schemes, such as the Triptych approach (Groenenberg, 2002; Phylipsen et al., 1998), include elements of convergence in, e.g., the domestic sectors, in addition to many other additional criteria for differentiation. Such a more comprehensive approach could also be used in the future, as it has served in 1997 as the approach for sharing the Kyoto targets among the EU member states. Finally, a Multi-Stage approach can also include elements of per capita convergence, e.g., when the group of emission reducing countries would share emission reductions proportional to their per capita emissions (e.g. den Elzen (2002)).

In this chapter, we propose a new approach called “Common but Differentiated Convergence” approach (CDC) to implement the concept of converging per capita emissions somewhere between the second and third order approximation. The fundamental characteristics of this approach is “common convergence”, because all countries’ per capita emissions converge to an equal level, but the *timing* of convergence is “differentiated”: Some countries’ converge later than others, based on their current state of development and conditional to emission reductions in Annex I countries. More specifically and similar to the opt-out clause, countries start to converge their emissions according to predefined thresholds for participation. Furthermore, the approach is compatible with global emissions aiming at stabilization of atmospheric greenhouse gases concentrations. It is intended to eliminate the major criticism of existing proposals on converging per capita emissions, while at the same time remain a simple and transparent approach.

In chapter 7.2 we first explain how the approach is designed and how it works. We then quantify emission allowances for the approach and compare them to emission allowances under C&C. Further, we provide a sensitivity analysis of the results. The chapter concludes with a discussion of the pros and cons of the new approach.

7.2 A NEW APPROACH: “COMMON BUT DIFFERENTIATED CONVERGENCE”

7.2.1 Description

The “common but differentiated convergence” approach (CDC) can be described by the following rules:

- Annex I countries’ per capita emission allowances converge within, e.g. 40 years (2010 to 2050), to an equal level for all countries.
- Individual Non-Annex I countries’ per capita emissions also converge within 40 years to the same level but convergence starts from the date, when their per capita emissions reach a certain percentage threshold of the (gradually declining) global average.
- Non-Annex I countries that do not pass this percentage threshold do not have binding emission reduction requirements. Either they take part in the Clean Development Mechanism or they voluntarily take on “positively binding” emission reduction targets. Under such positively binding targets, emission allowances may be sold, if the target

is overachieved, but no emission allowances have to be bought, if the target is not reached.

These rules of the CDC approach result in the following characteristics of the system:

- **Common,** because all countries eventually participate with the same type of target and similar trajectories of emissions. All countries converge to the same per capita emission level.
- **Differentiated,** because countries follow these common trajectories but delayed depending on their responsibility (i.e. their current per capita emission level).
- **Conditional,** because Non-Annex I countries' mitigation actions are explicitly linked to Annex I actions: The entrance into the regime depends on the global average per capita emission level, which can significantly be influenced by mitigation actions in Annex I counties.
- **Without excess emissions,** because only countries participate, whose per capita emissions are above the threshold (percentage of global average). Therefore, all participating countries need to reduce their emissions. No country will receive more allowances than it would need to satisfy its baseline emissions, "hot air" is avoided.
- **Efficient,** because before developing countries pass the threshold and participate with binding targets, emission limitations and reductions are encouraged through the "positively binding" targets. The per capita emission threshold further acts as a backstop, if those "positively binding" targets should not be effective.
- **Simple,** because countries at low development stage with low per capita emissions do not participate. They can pursue development to secure their basic needs (basic need principle). In addition, they do not need to prepare detailed national greenhouse gas inventories, avoiding problems with the related technical and institutional requirements.
- **Bottom-up,** the emission allowances are allocated among regions in a way that the global emissions are compatible with a predefined global emission profile aiming at stabilising atmospheric greenhouse gas concentrations.

While the CDC approach, similarly to C&C, aims at equal per capita allowances in the long run, it provides for more short and medium term equity in line with principles like the "polluter pays" and the "capability to act" principles.

The typical feature of CDC is the use of a dynamic threshold expressed as percentage of global average per capita emissions. As this average is declining over time, the threshold for participation declines as well. We prefer a per capita emissions threshold to other indicators, e.g. a GDP/capita threshold, since this is more in line with the concept of per capita convergence. Furthermore, such a per capita emission threshold has three advantages (see Berk and den Elzen (2001)): (1) it ensures timely participation of developing countries to keep total emissions below a global emission ceiling for meeting stabilization targets, (2) it rewards developing countries that keep emissions low (while growing economically) that they do not have to participate and (3) it rewards Annex I mitigation action by bringing the threshold-level down.

Setting the equal convergence level of per capita emissions is quite challenging. As countries would only need to accept absolute emission limits, if they pass a certain threshold value, the participating countries have to commit themselves to share the reduction burden to remain within the global emissions profile for stabilization of global greenhouse gas concentrations. The increasing emissions of the non-participating countries dominate the avoided surplus emissions in comparison to C&C. The convergence level would therefore have to be lower than the allowed emissions in a target year (e.g. 2050) divided by the global population, as it would be used in the C&C approach. The participation threshold would need to be set such that the burden is bearable for the participating countries. According to C&C per capita emissions would gradually decline after convergence. For CDC, however, we have implemented a constant convergence level for simplicity (see Table 2).

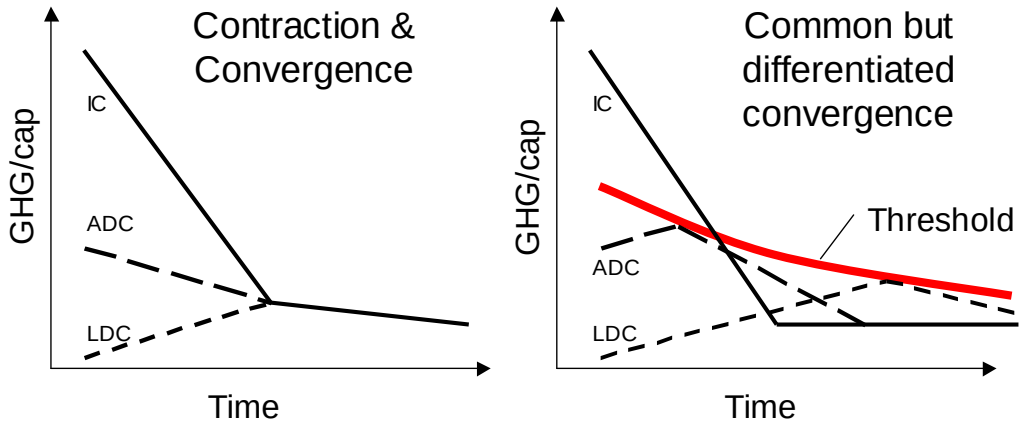

Figure 10. Schematic representation of greenhouse gas emissions per capita for three countries (an industrialized country (IC), an advanced developing country (ADC) and a least developed country (LDC)) under Contraction & Convergence (left) and under Common but Differentiated Convergence (right)

Illustrative paths of greenhouse gas emissions per capita under the C&C and the CDC approach are shown in Figure 10 (schematically) and for CDC in Figure 11 and Figure 12 (with real data). Average per capita emissions of all Annex I countries are currently, and also in 2010, 2.5 times above the world average. Per capita emission of the EU and Japan are the lowest in Annex I but are still around twice the global average.

Under both approaches, Annex I countries drastically reduce emissions from 2010 to 2050 to the required convergence level. Per capita emissions of some Non-Annex I countries are already above the world average, e.g. for South Korea, the some oil producing countries in the Middle East and South Africa. These countries would reduce emissions as Annex I countries under both approaches.

Under C&C, developing countries with relatively low per capita emissions would converge to the defined equal per capita convergence level in 2050. As the required convergence level is very low, advanced developing countries (middle per capita emissions) need to reduce emissions very soon. Least developed countries (lowest per capita emissions) would receive surplus allowances under C&C. The required path in per capita emissions under C&C is not necessarily linear, as total global emissions follow a predefined emissions path. Depending on this profile, the convergence can be faster or slower than linear (a convex or concave curve). For simplicity, it is depicted as linear in Figure 10.

Under CDC, as time progresses and non-Annex I countries develop further and increase their per capita emissions, one after the other country surpasses the threshold and starts to reduce its per capita emission levels to the same level as Annex I countries within 40 years. Advance developed countries are allowed to further increase emission. Least developed countries will not receive surplus emission allowances as under C&C. As a result, the average per capita emissions of current Non-Annex I countries surpasses that of Annex I countries by the middle of the century and remains close to the world average, while the average Annex I per capita emission level remains below the world average.

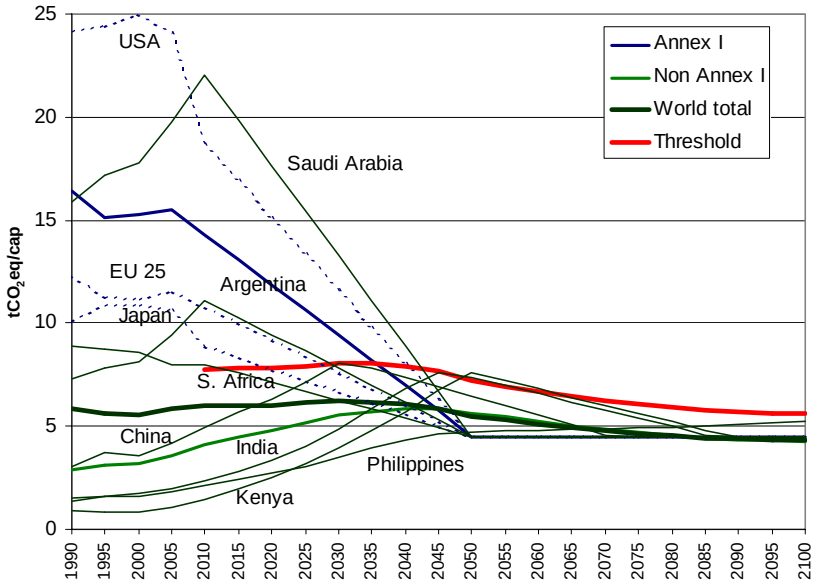

Figure 11. Example of development of per capita emissions under the CDC approach for several groups of countries for an illustrative parameterisation and scenario (towards 550 ppmv CO_2 under the A1B scenario, threshold 30% above world average, convergence level of 4.5 tCO_2eq/cap)

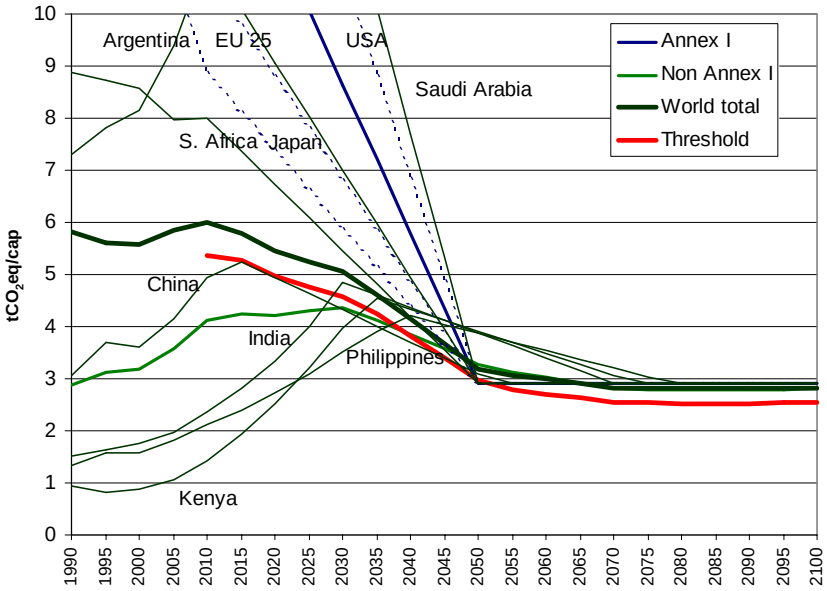

Figure 12. Example of development of per capita emissions under the CDC approach for several groups of countries for an illustrative parameterisation and scenario (towards 450 ppmv CO_2 under the A1B scenario, threshold 10% below world average, convergence level of 2.9 tCO_2eq/cap)

As a consequence, individual countries follow an idealized Kuznets curve. The environmental Kuznets curve (Kuznets 1955, Grossman and Krueger 1991) describes the theory that environmental impact per economic activity of a country increases with economic growth at low

income per capita, reaches a maximum and then decreases at higher levels of income (inverted U-shape). If several economies take the same development paths one after the other, the maximum of environmental impact per economic output is reached at a lower level for those countries that are developing at a later point in time (Bernardini & Galli, 1993), because countries that are developing at a later stage benefit from the technological developments that occurred in other countries.

Figure 11 shows this effect, not in terms of economic output, but in terms of per capita emissions over time. Under the CDC approach the "followers" have to start reducing emissions earlier (at lower per capita emission levels) than countries that developed before.

7.2.2 Methodology of quantification

The following methodology was used to quantify the emission allowances under the CDC approach:

The group of participating countries comprises those that are in Annex I plus countries with per capita emissions at a certain percentage above the global average.

The participating countries start to linearly converge their per capita emissions towards the convergence level within e.g. 40 years. The formula is as follows:

$$pce_c(t) = pce_c(t_{start,c}) - \left(pce_c(t_{start,c}) - pce_{conv}\right) \cdot \tau_c(t)$$

$$\tau_c(t) = \frac{t - t_{start,c}}{40} \quad \text{for} \quad t < t_{start,c} + 40$$
$$= 1 \qquad\qquad \text{for} \quad t > t_{start,c} + 40$$

with
$pce_c(t)$: Per capita emissions at time t of country c
pce_{conv}: Convergence level of per capita emission
$t_{start,c}$: Year in which the country c starts to participate, that is when the per capita emissions are above a threshold.

Before Non-Annex I countries meet this participation threshold they may commit to "positively binding" emission targets. These are not particularly quantified: All countries below the threshold follow their reference scenario.

The parameters for the CDC approach (threshold and convergence level) can be chosen such as to best fit a given stabilization scenarios (see below).

For comparison, we also model the original "Contraction & Convergence", where per capita emissions converge from 2010 to 2050. The formulas are as follows:

$$se_c(t) = se_c(2010) - \left(se_c(2010) - sp_c(t)\right) \cdot \tau_c(t)$$

$$\tau_c(t) = \frac{t - 2010}{40} \quad \text{for} \quad t < 2050$$
$$= 1 \qquad\qquad \text{for} \quad t > 2050$$

$$e_c(t) = e_{total}(t) \cdot se_c(t)$$

with
$se_c(t)$: Share of global emissions of country c at time t
$sp_c(t)$: Share of global population of country c at time t
$e_{total}(t)$: Total emissions allowed at time t
$e_c(t)$: Emissions of country c at time t

We evaluate the regional emission targets corresponding to the new CDC approach and the C&C approach aiming at two alternative global anthropogenic GHG emission profiles (Figure 13). The two stabilisation levels were chosen as to represent cases of early and stringent mitigation, e.g. to meet the EU long-term climate target of limiting global average temperature increase to maximum 2 degrees Celsius above pre-industrial levels (European Council, 1996), versus a less stringent profile for global greenhouse gas emissions.

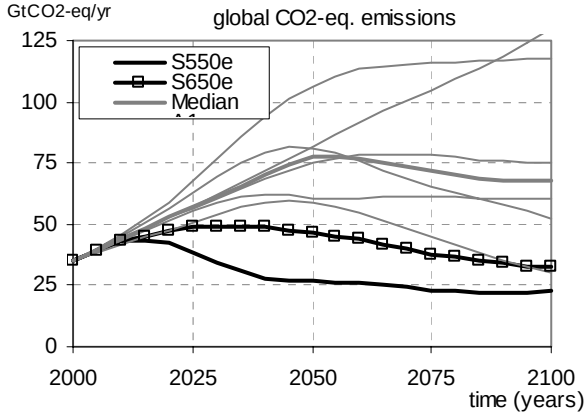

Figure 13: Global CO_2-equivalent emissions (all GHG incl. LUCF CO_2) for the S550e and S650e profiles (black) and the six IMAGE 2.2 IPCC SRES baseline scenarios (A1b, A1F, A1T, A2, B1, B2) (grey) and their median (dark-grey). Source: IMAGE 2.2 model

The profiles were developed with the integrated climate assessment model IMAGE 2.2 (IMAGE-team, 2001). They correspond to stabilizing total greenhouse gas concentrations at the level of about 650 and 550 ppmv CO_2-equivalent[16] in 2100 and 2150 respectively, for the set of six greenhouse gases considered in the Kyoto Protocol (S550e and S650e profiles). These levels are more or less consistent with stabilizing concentrations of CO_2 only at about 450 and 550 ppmv (Eickhout et al., 2003). Up to 2010, the constrained emission profiles take into account the Annex I Kyoto Protocol targets and the proposed emission intensity targets for the US. The profiles also assume that the major part of the excess emission quotas in the hands of some Annex I countries is banked for use in the following periods. Non-Annex I countries are assumed to emit according to their baseline emissions in this initial period.

In the S550e and S650e profiles depicted in Figure 13, greenhouse gas emissions continue to rise in the first decades of the simulation. However, after this initial period emissions need to be reduced. Global emissions are in 2020 34% above, in 2050 25% below the 1990 level for the S550e profile, while global emissions are in 2020 52% and in 2050 43% above the 1990 level for the S650e profile. In the S650e case there is some flexibility in the timing of emission reductions. Flexibility is very limited in the S550e case, as this target requires reductions from 2020 onwards.

7.3 COMPARISON OF EMISSION ALLOCATIONS

The model was used to quantify the emission allocations under the “Common but Differentiated Convergence” and under Contraction & Convergence. For each reference scenario, we first select parameters for the CDC approach (convergence level and threshold), so that the stabilization scenarios are best approximated. We then use the resulting global emissions from the CDC approach as input global emission profile for the C&C approach. Thus, for each reference scenario, global emissions from 2010 to 2100 are exactly the same under CDC and C&C.

[16] This is a measure of the contribution of the various GHGs to the radiative forcing in any given year expressed in the CO_2-equivalent concentration that would give the same level of (additional) radiative forcing.

As an indication, which parameters to choose, we first analyse the C&C under the given stabilization profiles. C&C under the stabilization profiles would require per capita emissions to converge to an equal level in 2050 to around 3 $tCO_2eq./cap$ for S550e. Thereafter until 2100, they would then stay stable under declining population or decline under stable population to around 2.5 $tCO_2eq./cap$. For S650e, the convergence level is 5 to 5.5 $tCO_2eq./cap$ in 2050 and 3.5 to 5 $tCO_2eq./cap$ in 2050. These values are used as staring points for setting the parameter in the CDC approach.

The selected parameters for the CDC approach and the resulting convergence levels for C&C are shown in Table 20. For CDC, we first selected the convergence level and then a corresponding participation threshold. In the S550e case we selected the convergence level so that it is slightly below the required 3 $tCO_2eq./cap$ under C&C in the long term and adjusted the participation threshold accordingly to around world average. In the S650e case, the convergence level for CDC is slightly below the 5 $tCO_2eq./cap$ under C&C. The resulting threshold for participation is around 50% above world average for the S650e case.

Table 20: Parameters for CDC and resulting convergence levels for the C&C for six reference scenarios (IPCC SRES)

550e		**A1B**	**A1FI**	**A1T**	**A2**	**B1**	**B2**
CDC	Threshold (% above world average)	-10%	-10%	-10%	-10%	10%	-10%
	Convergence level ($tCO_2eq./cap$)	2.9	2.9	2.9	2.0	2.9	2.9
C&C	Convergence level 2050 ($tCO_2eq./cap$)	3.2	3.2	3.1	2.4	3.4	2.9
	Convergence level 2100 ($tCO_2eq./cap$)	2.8	2.9	2.8	1.9	2.7	2.7

650e		**A1B**	**A1FI**	**A1T**	**A2**	**B1**	**B2**
CDC	Threshold (% above world average)	30%	30%	50%	50%	300%	70%
	Convergence level ($tCO_2eq./cap$)	4.5	4.5	4.5	3.0	6.0	4.0
C&C	Convergence level 2050 ($tCO_2eq./cap$)	5.5	5.6	5.7	3.6	5.3	4.3
	Convergence level 2100 ($tCO_2eq./cap$)	4.3	4.4	4.8	3.3	4.0	4.0

Figure 14 shows the resulting global emission paths compared to the S550e and S650e profiles. For the given parameters, the global emissions under CDC resemble the profiles relatively well. For the S550e case, most resulting emissions are above the stabilization profile in 2030 and 2040. This is due to the linear convergence and the delayed entry of individual countries. Under a plain C&C approach with the S550e profile, the convergence would be faster than linear in the early part of the century.

Figure 14: Global GHG emissions pathways (excl. LUCF CO_2) of CD convergence compared to the S550e and S650e profile

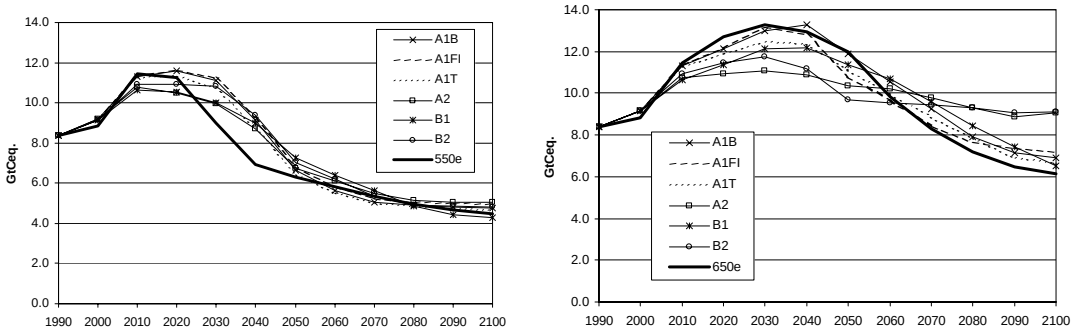

Figure 15 shows the percentage change in emissions compared to the 1990-levels for CDC and C&C for the 550e and 650e cases and the baseline scenarios. Error bars show the possible spread due to the use of different baseline scenarios.

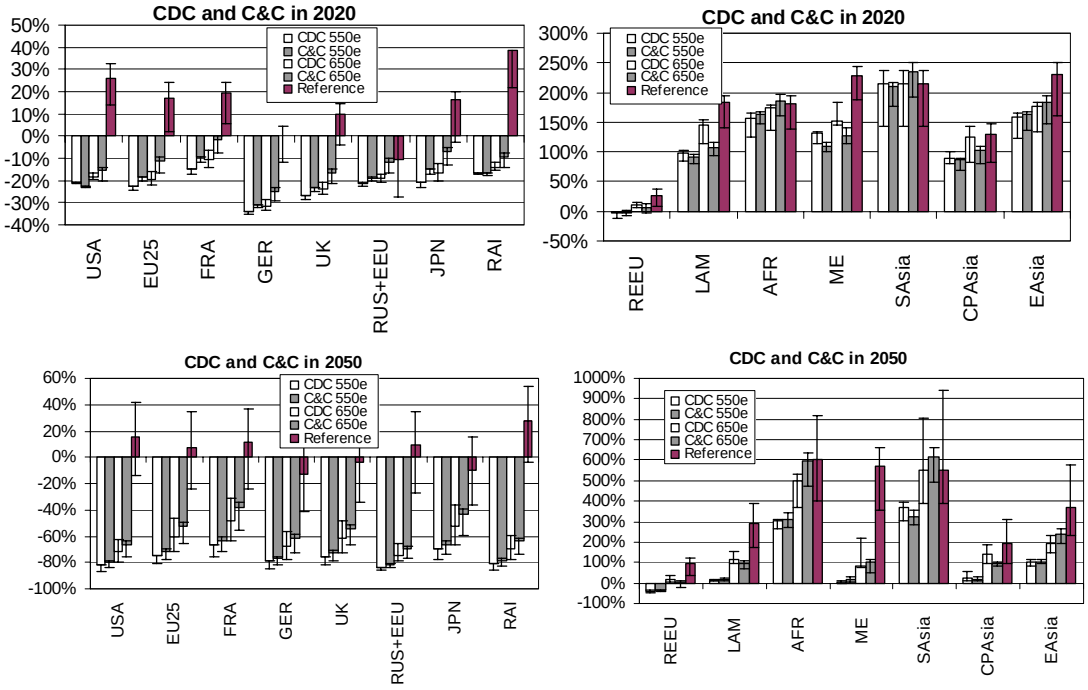

Figure 15: Percentage change compared to the 1990-levels for CDC and C&C for the S550e and S650e profile and the reference scenarios. The error bars show the spread for different reference scenarios (IPCC SRES scenarios). The solid bars are the median over all six SRES scenarios.

Table 21 and Table 22 show the likely date of entry into the regime for several countries and regions. The time of entering the scheme strongly depends on the reference scenario chosen. For the 550e case, only a few countries and regions will not participate until the end of the century, however, major developing countries would have to enter in the first half of this century. The situation is much more relaxed for the 650e case, where only a few most advanced developing countries would participate early this century, many will not have to enter at all.

Table 21. Likely date of entry into the regime under the S550e profile. The six IPCC scenarios are assumed to have equal probability. For regions the population-weighted average is given.

Region	2020	2030	2040	2050	2060	2070	2080	2090	2100
Annex I	100%	100%	100%	100%	100%	100%	100%	100%	100%
Rest of Eastern Europe	71%	74%	80%	85%	90%	91%	91%	92%	92%
Argentina	100%	100%	100%	100%	100%	100%	100%	100%	100%
Brazil	67%	100%	100%	100%	100%	100%	100%	100%	100%
Mexico	100%	100%	100%	100%	100%	100%	100%	100%	100%
Venezuela	100%	100%	100%	100%	100%	100%	100%	100%	100%
Rest of Latin America	18%	69%	74%	81%	89%	89%	89%	89%	89%
Egypt	0%	0%	67%	100%	100%	100%	100%	100%	100%
South Africa	100%	100%	100%	100%	100%	100%	100%	100%	100%
Nigeria	0%	0%	50%	67%	100%	100%	100%	100%	100%
Rest of North Africa	34%	58%	60%	87%	100%	100%	100%	100%	100%
Rest of Africa	2%	2%	9%	28%	48%	52%	65%	71%	71%
Saudi Arabia	100%	100%	100%	100%	100%	100%	100%	100%	100%

Region	2020	2030	2040	2050	2060	2070	2080	2090	2100
United Arab Emirates	100%	100%	100%	100%	100%	100%	100%	100%	100%
Rest of Middle East	73%	85%	88%	88%	88%	88%	88%	88%	88%
China	0%	67%	83%	100%	100%	100%	100%	100%	100%
India	0%	0%	33%	67%	100%	100%	100%	100%	100%
Indonesia	0%	0%	67%	67%	83%	83%	83%	83%	83%
South Korea	100%	100%	100%	100%	100%	100%	100%	100%	100%
Malaysia	100%	100%	100%	100%	100%	100%	100%	100%	100%
Philippines	0%	0%	0%	50%	83%	83%	83%	83%	83%
Singapore	100%	100%	100%	100%	100%	100%	100%	100%	100%
Thailand	67%	100%	100%	100%	100%	100%	100%	100%	100%
Rest of Asia	8%	8%	10%	28%	41%	48%	51%	52%	53%

Table 22. Likely date of entry into the regime under the S650e profile. The six IPCC scenarios are assumed to have equal probability. For regions the population-weighted average is given.

Region	2020	2030	2040	2050	2060	2070	2080	2090	2100
Annex I	100%	100%	100%	100%	100%	100%	100%	100%	100%
Rest of Eastern Europe	38%	53%	57%	58%	58%	59%	60%	62%	62%
Argentina	83%	83%	83%	83%	83%	83%	83%	83%	83%
Brazil	0%	0%	50%	50%	50%	50%	50%	50%	50%
Mexico	0%	33%	67%	67%	67%	67%	67%	67%	67%
Venezuela	83%	100%	100%	100%	100%	100%	100%	100%	100%
Rest of Latin America	7%	13%	16%	29%	37%	37%	37%	39%	41%
Egypt	0%	0%	0%	33%	33%	33%	33%	33%	33%
South Africa	33%	67%	67%	67%	83%	83%	83%	83%	83%
Nigeria	0%	0%	0%	0%	0%	33%	33%	33%	50%
Rest of North Africa	6%	6%	19%	40%	42%	42%	49%	49%	49%
Rest of Africa	1%	1%	2%	3%	11%	16%	23%	28%	32%
Saudi Arabia	83%	100%	100%	100%	100%	100%	100%	100%	100%
United Arab Emirates	100%	100%	100%	100%	100%	100%	100%	100%	100%
Rest of Middle East	31%	41%	50%	64%	65%	65%	65%	65%	65%
China	0%	0%	17%	33%	33%	33%	67%	67%	67%
India	0%	0%	0%	0%	33%	33%	33%	33%	33%
Indonesia	0%	0%	0%	0%	0%	17%	17%	33%	33%
South Korea	83%	83%	83%	83%	83%	83%	83%	83%	83%
Malaysia	33%	83%	83%	83%	83%	83%	83%	83%	83%
Philippines	0%	0%	0%	0%	0%	0%	0%	17%	17%
Singapore	83%	83%	83%	83%	83%	83%	83%	83%	83%
Thailand	0%	0%	33%	67%	83%	83%	83%	83%	83%
Rest of Asia	7%	6%	6%	6%	7%	11%	16%	17%	17%

Legend:

= not entered
= entered under one scenario
= entered under two scenarios
= entered under three scenarios
= entered under four scenarios
= entered under five scenarios
= entered for all six reference scenarios

The following observations can be made from the calculations:

- **Annex I countries** need to reduce more emissions in the short-term under CDC than under C&C. Annex I countries would benefit from the immediate participation of all countries under C&C. In the long-term, the necessary reductions for Annex I countries are similar for CDC and C&C for the S550e case: in the order of –80% of 1990 levels in 2050. The necessary reductions for Annex I countries under the S650e case are less under CDC (in the order of –40% of 1990 levels in 2050), compared to C&C (-60%), since no "hot air" is introduced in the system.
- **Non-Annex I countries** would have to participate very early in the S550e case. The threshold for participation would have to be set at around world average per capita emissions. In the S650e case, Non-Annex I countries would have to participate later than under the S550e case, the threshold for participation would have to be set at around 50% above world average per capita emissions.
- **Africa and South Asia (India)** would under C&C receive more emission allowances than needed under the reference scenario in the early part of the century under the 550e case and substantially more by 2050 in the S650e case. Such "hot air" is eliminated in the CDC approach. Most of these countries would not participate until the middle (S550e) or the end (S650e) of the century.
- **Latin America, Middle East and South East Asia** have already now relatively high per capita emissions, around the world average, and would therefore have to reduce more under C&C, where they participate immediately, than under CDC, where they participate with a delay. The difference is particularly pronounced in 2050 in the S650e case. For S550e, mot countries need to reduce emissions below their baselines in the short term for both, C&C and CDC. For S650e, only the most advanced developing countries participate in the CDC approach by 2020. By 2050 most countries of Latin America, Middle East and South East Asia participate in the CDC approach.

The approach therefore eliminates two major reservations of the C&C approach often voiced by two country groups:

- Advanced non-Annex I countries often do not accept that they have to reduce emissions as Annex I countries with the same per capita emissions under C&C although their historical responsibility is smaller. Under CDC, advanced developing countries only have to reduce emissions delayed compared to Annex I countries. Therefore also the historical responsibility converges more than under C&C.
- Annex I countries often do not accept the concept of "hot air" under C&C. CDC eliminates such hot air.

These advantages are more pronounced for the S650e profile than for the S550e profile. Under the S650e there is more room for delayed entry into the system under CDC, but also for hot air under C&C.

7.4 PROS AND CONS OF CDC AND C&C

Table 23 provides an overview over the main characteristics of the Contraction & Convergence approach and the Common but Differentiated Convergence approach in a comparative manner.

Table 23. Main characteristics of the Contraction & Convergence approach and the Common but Differentiates Convergence approach

Contraction & Convergence	Common but differentiated convergence
• Very simple rules	• Simple rules
• Emission levels derived top-down (based on a stabilization profile)	• Emission levels derived bottom-up (based on per capita emission levels of individual countries)
• One form of commitments: quantified emission targets	• Two forms of commitments: quantified emission targets and quantified "positively binding" targets
• Current per capita emissions is the only criterion for differentiation, does not consider historical responsibility	• Per capita emissions is the only criterion for differentiation, but the delay of Non-Annex I countries takes account of the responsibility for past emissions
• Excess allowances for low emission countries - "hot air"	• No excess allowances for low emission countries - no "hot air"
• All countries participate	• Stepwise delayed participation of Non-Annex I countries, conditional to Annex I action
• Full encouragement of use of reduction opportunities in developing countries	• Encouragement of use of reduction opportunities in developing countries through "positively binding" targets
• Resource transfers to least developed countries, but institutional capacity, e.g. greenhouse gas inventories, needed	• Least developed countries are exempt

Both approaches are defined by a simple set of basic rules, which make both approaches transparent and comprehensive. They are therefore *conducive to trust building* between the Parties as decisions are made in a fair and transparent way. In both approaches, per capita emissions converge to a sustainable level in the long term. Under C&C all countries participate with the same form of target while under CDC one additional form, the "positively binding" target, is introduced.

Both approaches are environmentally effective, if fully implemented by all countries. C&C is based on a global emission profile (top-down) and all countries participate in binding quantitative emission limitations. For CDC emission limits are defined based on emission levels of individual countries (bottom-up) but in a way that also leads to long-term stabilization of greenhouse gas concentrations. The element that countries need to participate, if their per capita emissions reach the threshold, ensures that the global emission limit is met, even if counties' emissions develop unexpectedly. However, the environmental effectiveness of the bottom-up CDC approach is a little less certain as in the top-down C&C approach, due to the delayed convergence. If the effectiveness of the approach falls short, it can be compensated in subsequent commitment periods, but at the price of policy delay.

The C&C approach is expected to meet resistance from those developing countries that already now have high per capita emission levels (Latin America, Middle East and South East Asia). They have to reduce emissions in a same way as developed countries with equal per capita emissions (this is the case, e.g., for France and South Korea). The approach does not consider the historical responsibility of the countries. The CDC approach accommodates this major concern by delaying the binding action of the developing countries by several years and in the interim providing incentives for their voluntary participation. Both approaches take into account the sovereignty principle (starting from current emission levels) and the egalitarian principle (convergence to an equal level), but both approaches do not consider national circumstances that do not relate to population size.

The C&C approach is expected to also meet the resistance from those developed countries that already now have high per capita emission levels (USA, Oceania,…). This resistance will

be based on both economic concerns related to the large resource transfers to developing countries as well as political opposition against the global commons and egalitarian concepts underlying the approach. The CDC approach accommodates part of this concern as it eliminates the component of "hot air". Annex I countries need to reduce slightly more (compared to C&C) in the short term, but less in the long term, as they do not have to provide for the "hot air". But CDC will lead to the situation that per capita emissions of developing countries, like China, will be at some point higher than those of developed countries, like the USA, which will meet their resistance. The general concern about the concept of per capita emissions, which is often voiced by several developed countries, is still valid for both approaches.

Both approaches provide incentives for developing countries to take action to limit their greenhouse gas emissions because they create emission allowances that can be sold on the market. In the case of large amounts of excess emission allowances under C&C, this incentive may be weak. For CDC, the magnitude of the first incentive (the "carrot") lies in the way the "positively binding" targets are set for the developing countries. In addition, the second incentive (the "stick") is provided by the element that countries receive binding reduction targets, if their per capita emissions reach a threshold.

Up to now there has been a clear policy divide between the developed and developing countries in the climate change negotiations, with developing countries having a joint position through the "Group of 77 and China" notwithstanding clear differences in their interests (e.g. between the Alliance of Small Island States (AOSIS) and OPEC member states). This historic North-South policy divide will have to be overcome in the CDC approach in order to differentiate developing country commitments in the climate change regime.

Under the C&C approach, least developed countries strongly benefit from participating in the regime. They would receive large resource transfers, which could be used for economic development or adaptation measures. But they also would have to have the institutional capacity to participate in the regime, e.g. prepare robust national greenhouse gas inventories and to be capable to participate in emissions trading. In the CDC approach, this element of support for least developed countries is not included. The need for development and adaptation to climate change would have to be ensured through additional mechanisms.

7.5 CONCLUSIONS

With the "Common but Differentiated Convergence" approach we have provided a new concept for an international climate regime. On the one hand it could be acceptable to a wider range of countries and on the other hand it could ensure stabilization of greenhouse gas concentrations. It is based on the principle that Annex I countries' per capita emissions converge within several decades to a low level. Individual non-Annex I countries also converge to the same level within the same time period years but starting when their per capita emissions are a certain percentage above global average. Until then they may voluntarily take on "positively binding" targets.

This approach is almost as simple as the Contraction & Convergence approach but eliminates two concerns often voiced in relation to C&C: Under CDC, advanced developing countries start reducing emissions at a later point in time compared to Annex I countries. In addition, CDC avoids the political problems related to the resource sharing concept and financial transfers, because it does not provide excess emission allowances to low emission countries as C&C does. It thus might be more acceptable to major developing countries than C&C and possibly also the USA (taking into account that the current administration of the USA is very reluctant to agree to any proposal on further international action on climate change).

We have shown that with the CDC approach stabilization at 550 CO_2eq. and 650 CO_2eq. in 2100 and 2150 can be reached with participation threshold at roughly 0% and 50% above global average and a convergence level of around 3 and 4.5 tCO_2eq./cap within 40 years.

It is recognized that under the CDC approach, additional mechanisms have to be implemented that can accommodate the need for vulnerable developing countries to adapt to climate change.

We think that the global community will probably adopt a climate regime in step-by-step decisions, the rules will not be fixed for the next century. Even if the CDC approach is not implemented in its entirety, we strongly believe that these step-by-step decisions can be guided by the principles provided in the CDC approach: That developed countries per capita emissions converge and that developing countries do the same but delayed and conditional to developed country action.

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8. TRIPTYCH VERSION 6.0

8.1 INTRODUCTION

The Triptych approach is a method to share emission allowances among a group of countries, taking into account main differences in national circumstances between countries that are relevant to emissions and emission reduction potentials. The Triptych approach as such does not define, which countries should participate. It was originally developed as an approach to share emission allowances for the first commitment period under the Kyoto Protocol within the European Union.

In the original Triptych approach, three broad categories of emissions were distinguished: The power sector, the group of energy-intensive industries and the 'domestic' sectors. The selection of these categories was based on a number of differences in national circumstances raised in the negotiations: differences in standard of living, in fuel mix for the generation of electricity, in economic structure and the competitiveness of internationally-oriented industries. For each of the categories a reasonable amount of emission allowances is calculated by applying a defined set of rules to all countries. The allowances for each category are added up to a national target for each country. Only one national target per country is proposed, no sectoral targets, to allow countries the flexibility to pursue any cost-effective emission reduction strategy.

Since the original Triptych approach was developed, a number of different versions have been developed (Groenenberg et al. 2001; Groenenberg et al. 2002; RIVM, 2003 (FAIR 2.0); Höhne et al. 2003), that started to include more gases, more countries and more sectors. However, there are some methodological differences between the different versions.

On the basis of a review of existing Triptych methodologies, we developed a new version of the approach, version 6.0, which is described in Section 8.2. Parameter settings for two example stabilization scenarios are elaborated in Section 8.3, followed by conclusions in Section 8.4. A full description of the methodology and model can be found in the separate report called "Implementing Triptych 6.0 – technical report" (Phylipsen et al. 2004), that was prepared on behalf of RIVM.

8.2 DESCRIPTION

On the basis of a review of previously developed versions of the Triptych approach, we developed an updated version (version 6.0). All used input data has been generated as described in Appendix E.

The methodology can be described as follows.

Power sector

In the power sector, CO_2 emissions differ greatly from country to country due to large differences in the shares of nuclear power and renewables and in the fuel mix in fossil-fuel-fired power plants. The potential for renewable energy is different for each country, as is the case for the public acceptance of nuclear energy.

To calculate the emission allowance for the power sector of a country, we make assumptions about the future electricity generation. Similar to previous versions, requirements are set for the share of renewables and combined heat and power in total electricity production in a certain year, e.g. 30% in 2050. The shares of solid and liquid fossil fuels have to be reduced by a user-defined percentage from the current level. Electricity production from nuclear power is assumed to stay at the same level. The remaining electricity generation is assumed to be filled with natural gas. It is further assumed that the power generation efficiencies (CO_2 per kWh for each fuel) converge by a certain year. These requirements are the same for all countries. In addition, assumptions are made about the growth in electricity consumption for

each country. With these requirements and assumptions about the growth in electricity consumption, emissions are calculated, which represent the limits of that country.

The main differences of the updated approach compared to earlier versions are the assumed convergence of fossil fuel-based power generation efficiencies and the use of a 'normative, but scenario-derived approach' to determine the electricity production growth rate for each country. A "descriptive approach" simply using growth rates from a scenario would describe a likely development based on the "current" situation rather than a "normative" development on how it is desired. Descriptive means that e.g. EIT countries will receive lower allowances for industry, because of the economic downturn during the nineties with a slow rate of recovery, rather than being based on an emission allowance entitlement. Similarly, developing countries would receive emission allowances for industry on the basis of expected growth rates, which may be very low for some, e.g. African countries, and high for others, e.g. China, rather than emission entitlements. On the other hand, using a fully normative approach as applied by Groenenberg et al. (2002) could lead to the introduction of large amounts of "hot air" for low-emission countries or very unrealistic scenarios for high-emission countries.

We therefore use a "normative but scenario-derived" approach, which consist of the following steps:

- Countries grouped in 4 groups on the basis of a country's GDP per capita level (see Table 24)
- Growth rates per country are taken from the reference scenario
- For countries with a higher GDP per capita level, the scenario growth rate will be reduced by a certain percentage. For countries with a low GDP per capita level, the scenario growth rate will be increased by a certain percentage (see Table 24). Limits are set for the maximum deviation of total power production at the country level and the maximum deviation of total power production at the global level.

Table 24. GDP_{ppp}/capita groups

Group	GDP/capita Range [US$(1995)/cap/yr]	Possible growth rate adjustment
Very Low	0 to 2000	+2%
Low	2001 to 7000	+1%
Medium	7001 to 15000	0%
High	15001 or more	-1%

Industry

Industrial activities differ substantially between countries. Countries with a high share of industrial activities will have higher national CO_2 emissions than countries that focus primarily on e.g. services. Although these countries have high emissions, their emission reduction potential may be small.

To calculate a country's emission allowances for this sector, growth rates for physical production of goods are used together with assumptions on efficiency improvement rates for the future. The main differences compared to the previous versions for the industrial sector are that:

- A "normative but scenario-derived" approach is used as in the electricity sector to determine industrial production growth rates
- A convergence of current energy efficiency levels is assumed in the longer term
- The industry sector is treated as a whole and not split into heavy industry and light industry due to data availability.

Domestic sectors

The 'domestic' sectors comprise the residential sector, the commercial sector, transportation, energy-related CO_2 emissions from agriculture and all emissions from HFCs, PFCs and SF_6 as a joint category for a number of reasons. First, countries are assumed to be more homogeneous in these sectors. Second, emission reductions can be achieved by means of national policies and measures. Third, emissions in this category are likely to be correlated with the number of people that live in dwellings, have a workplace, require and consume transportation services.

To calculate the emission allowances for the domestic sector in each country, it is assumed that emissions in the domestic sectors will converge to a globally equal level due to a convergence of the standard of living (e.g. number of cars, number of appliances) and a reduction in existing differences in energy efficiency of devices.

Fossil fuel production

Some fossil fuel producing countries have high fugitive emissions from that sector. However, emission reduction options are available, such as tighter gas pipelines, a reduction in venting or flaring of gas or reduction of coal bed methane. Due to this different expected future behaviour, emissions from fossil fuel production are treated as a separate sector. Emissions from the fossil fuel production sector (excluding fossil fuel combustion emissions) are assumed to decrease linearly from the current level to a small percentage in a certain year (after 2020), after which emissions remain stable at the same level (relative to the reference scenario).

Agricultural sector

This sector includes the non-energy-related emissions from the agricultural sector, which are expected to grow substantially. Substantial emission increase is expected in the first half of this century for developing country regions and a stabilization of emissions for developed country regions while for all countries stabilization will be reached in the second half of the century. Substantial emission reduction options are available at relatively moderate costs to decrease emissions below the reference scenario (Graus et al. 2004). Hence, emissions are assumed to be reduced by a certain percentage below the reference scenario. Two groups of countries are distinguished: Countries with higher GDP/cap have to reduce more than countries with a lower GDP/cap.

Land use change and forestry

According to the reference scenarios, the net effect of the land use change and forestry sector is in the first half of the century mostly an emission (deforestation), while in the second half of the century mostly a removal (sequestration of carbon). In the first half of the century, this sector is dominated by the emissions in Africa and South America. In the second half of the century, it is dominated by the removal in Africa and the former USSR. Further deforestation and thus net emission is assumed to occur in South America and South East Asia.

In the Triptych Version 6.0, per capita emissions from land use change and forestry have to decrease to zero by a user-specified year (e.g. 2050). This means that large emitters stop deforestation by that time. Large removals in the reference scenario after that period are also not accounted for in the model. This can be justified by the complication of separating human induced emissions and natural emissions/sequestration, especially in the second half of the century, when plant growth is influenced by elevated CO_2 concentrations and warmer climate.

We have also implemented the option to exclude the land-use change and forestry emission completely from the Triptych analysis. Emissions from this source are highly uncertain and emission estimates from various sources are often not consistent. It therefore has also been suggested to treat emissions from deforestation with a different instrument separate from other emissions.

Waste

Emissions from waste are substantial but many emission reduction options exist (e.g. capture of methane from landfills). Hence, these emissions are treated as a separate sector. Emissions from the waste sector are assumed to converge to a certain per capita level in a certain convergence year.

The emission allowances of the various categories are added to obtain a national target.

Table 24 summarises the methodology used for the "Triptych 6.0" approach, the data requirements and the exogenous parameters that have to be chosen.

The main differences with the previous Triptych versions are:

- The harmonised data set and clear data hierarchy based on the IPCC SRES scenarios
- Calculation on the basis of 192 individual countries
- The (possibility of) inclusion of the 6 Kyoto gases and sinks
- Expansion to 2050 (and beyond)
- Variable base year between 1990 and 2010
- The use of normative but scenario-derived growth rates for electricity demand and industrial production based on GDP per capita levels

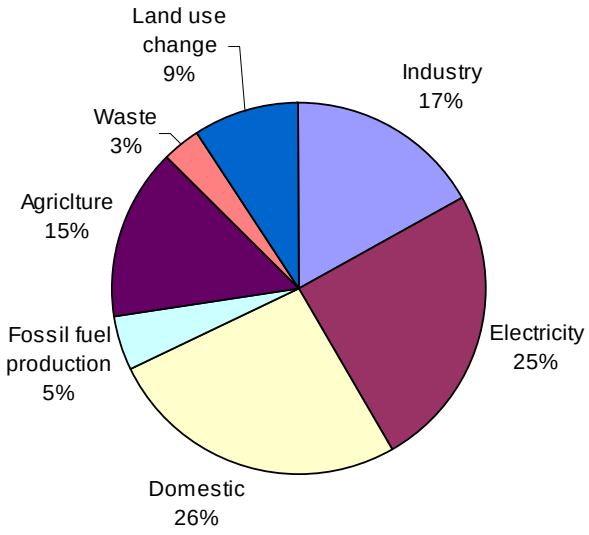
Table 25. Summary of the Triptych 6.0 methodology

Sector	**Approach selected**	**Data needs**	**User choices**
General			
Target year	2000 to 2050 (2051 to 2100 are also calculated, but only for illustrative purposes)		
Base year	Any between 1990 and 2010		Base year
Emission level in 2010	- Kyoto countries: same share of sectors in 2010 as in reference scenario, with an exception for transport - USA reaches its Kyoto target or its national target - Two options: 1) Countries reach the lower of the Kyoto target and the reference scenario 2) Countries reach the Kyoto targets		
Gases	CO_2, CH_4, N_2O, HFCs (sum), PFCs (sum) and SF_6		Choice for - CO_2 only, 3 gases or 6 gases - including LUCF or not - including international transport or not
Countries	Up to 192 (dependent on data availability)		
Base year emissions	Emissions in the base year are collected from various sources. The data available from the source highest in a hierarchy is be chosen (see Appendix E)		
Reference scenario	6 IPCC scenarios (A1B, A1FI, A1T, A2, B1, B2). The choice of reference scenario is used consistently throughout the calculations, i.e all required scenario elements are taken from the same scenario.		Choice of scenario
Internationally Operating Energy-Intensive Industries			

Growth rates of industrial production	The growth rates used are normative but are scenario derived. Countries with low GDP/cap are allowed higher growth rates than provided in the scenario, countries with high GDP/cap are allowed lower growth rates than in the scenario.	- Industrial production growth rates (used industrial value added, IVA) - per capita GDP, both derived from IMAGE	Choice of using the normative growth rates or the reference growth rates. Maximum deviation of normative growth rate from scenario value
Energy efficiency	Energy efficiency index (EEI) converges and subsequently further improves over time. Such convergence includes decarbonisation of fuels	Initial energy efficiency index for regions, taken from from Groenenberg (2002)	- Convergence year and level - EEI levels after convergence year
Sectoral change	Industrial value added, IVA, grows faster than industrial production, caused by shift in economic structure to higher value added sectors over time. A structural change factor is applied to account for this		Structural change factor
Sectors/Gases	"Energy: Manufacturing Industries and Construction" plus "Industrial processes" as one sector (CO_2, CH_4 and N_2O)		
Domestic Sectors			
Convergence	Linear convergence of per capita emissions	Population (UN 2002)	Convergence year and level
Sectors	CO_2, CH_4 and N_2O emissions from energy use in: ▪ Transport ▪ Commercial ▪ Residential ▪ Agriculture All emissions from HFCs, PFCs and SF_6		
Power Sector			
Production growth rates	The growth rates used are normative but scenario derived. Countries with low GDP/cap are allowed higher growth rates than in scenario, countries with high GDP/cap are allowed lower growth rates than in scenario. See Section 3.3.	- Electricity demand, per capita GDP, derived from IMAGE - Current efficiencies / emission factors per fossil fuel type, from IEA 2002	- Choice of using the normative growth rates or the reference growth rates. - Maximum deviation of normative growth rate from scenario value
Method	Shares or changes in shares of electricity sources are defined. Fossil fuel-based power generation efficiencies converge and further improve over time		Shares of different electricity sources Convergence level Efficiency levels after convergence year
Fossil Fuel Production	Reduce emissions by x% in target year		Target year, reduction percentage

Agriculture	A technical, cost-effective emission reduction potential compared to the reference scenario is assumed, accounting for activity growth and progress in technology development. Different reduction potentials for countries with low GDP/cap are applied compared to countries with high GDP/cap.	Reference scenario emissions	Reduction percentages compared to reference scenario in various years for two groups of countries
Deforestation	Per capita emissions from deforestation are assumed to converge to zero	Population	Convergence year
Waste	Linear convergence of per capita emissions to x $tCO_2eq./cap$	Population	Convergence year Convergence level

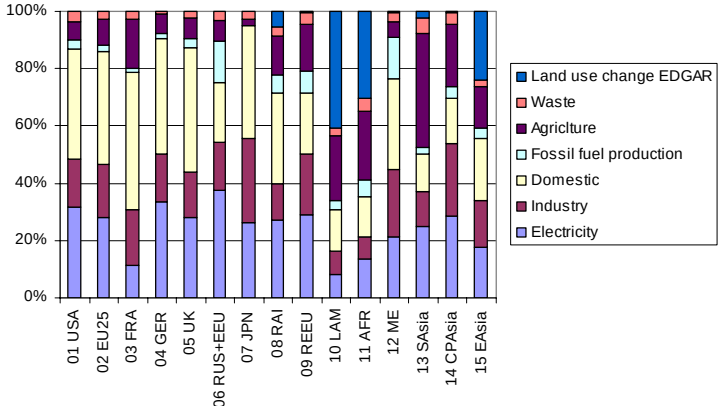
Figure 16 shows how global emissions were split between the sectors in the year 2000. The domestic sectors and electricity make up half of the emissions. Industry and agriculture have around 15% each. Waste and fossil fuels production have a relatively minor contribution. Different estimates are available for emissions from land use change. The value provided here is taken from the EDGAR database (Olivier & Berdowski 2001) and are relatively low. Other estimates would result in a share of 19% (Houghton 2003).



(Source: This study, see Appendix E, including CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 from submissions to the UNFCCC, IEA and others. Land-use change from EDGAR)

Figure 16. Sectoral split of global emissions in the year 2000

The variation of the sectoral split between countries may be large. Figure 17 provides the split for several countries or groups. While emissions in Annex I countries are dominated by the fossil fuel components (electricity, industry and domestic sectors), the emissions of some countries are dominated by deforestation (Latin America, Africa or East Asia) or agricultural emissions (South Asia, which includes India).



Source: This study, see Appendix E, including CO_2, CH_4, N_2O, HFCs, PFCs and SF_6

Figure 17. Sectoral split of emissions

8.3 RESULTS

We determined the parameter set for the Triptych approach, for which the resulting global emissions could lead towards stabilization of CO_2 concentrations at 450 and 550 ppmv. The default setting include:

- Base emission data according to hierarchy
- Including CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6
- Including international aviation and marine transport
- Excluding emissions from land-use change and forestry
- All Annex I countries (including the USA) reach their Kyoto target

8.3.1 450 ppmv case

An example case towards a stabilization level of 450 ppmv CO_2 or 550 ppmv CO_2 equivalent has been calculated using the parameters shown in Table 26. On average over the six reference scenarios, the Triptych approach with these parameters leads to emissions of 24 Gt CO_2-eq in the year 2050 (excluding LULUCF), or roughly 30% *below* 1990 levels. Emissions in 2020 are roughly 20% *above* 1990 levels. The results of the scenario are shown in Table 27. Figure 18 shows the resulting regional emissions for the A1B scenario. Figure 19 shows the global sectoral emissions.

Table 26 Parameter choices for the example case aiming at 450 ppmv CO_2 concentration

Sector	Quantity	2050	2100
Electricity	Differentiation in growth rates used	Yes	
	Maximum deviation of total power production at the country level		90%
	Maximum deviation of total power production at the global level		20%
	Share of renewables	60%	80%
	Share of CHP	35%	20%
	Reduction of solid fuels compared to base year	75%	100%
	Reduction of liquid fuels compared to base year	75%	100%
	Nuclear power generation remains constant in…	Absolute terms	
	Efficiency of CHP	90%	90%
	Power generation efficiency of solid fuels	50%	60%
	Power generation efficiency of liquids fuels	50%	55%
	Power generation efficiency of gas	65%	70%
Industry	Differentiation in growth rates used	Yes	

Sector	Quantity	2050	2100
	Maximum deviation of total industrial production at the country level		90%
	Maximum deviation of total industrial production at the global level		20%
	Structural change indicator	0.30	0.10
	Energy Efficiency Indicator	0.50	0.40
Domestic sector	Domestic convergence level - per capita emissions	0.7 t CO_2/cap/yr	
	Domestic convergence year - per capita emissions	2050	
Fossil fuel production	Fossil fuel emission level – % total emissions below base year	90%	
	Fossil fuel emission year – total emissions	2050	
Agriculture	Reduction below reference scenario emissions – low GDP/cap	50%	60%
	Reduction below reference scenario emissions – high GDP/cap	70%	80%
LUCF	LUCF convergence year	Analysis excluding LUCF	
Waste	Waste convergence level – per capita emissions	0	
	Waste convergence year – per capita emissions	2050	

Table 27. Results of the 450 ppmv CO_2 case for the A1B scenario, based on the parameters listed in Table 26

	1990	2000	2020	2020	2050	2050
	MtCO$_2$eq.	MtCO$_2$eq.	MtCO$_2$eq.	Relative to 1990	MtCO$_2$eq.	Relative to 1990
Annex I	18508	17907	14889	-20%	5553	-70%
Non-Annex I	11526	15030	23391	103%	17723	54%
World total	30500	33611	39332	29%	24091	-21%
USA	6252	7178	4811	-23%	1727	-72%
EU15	4360	4323	3345	-23%	1316	-70%
New EU Members	1096	746	939	-14%	358	-67%
Rest of Western Europe	115	123	183	60%	60	-47%
Russia	2825	2053	2450	-13%	851	-70%
Rest of eastern Europe in Annex I	1520	778	1295	-15%	466	-69%
Japan	1245	1386	968	-22%	413	-67%
Rest of Annex I	1104	1332	913	-17%	370	-66%
Turkey	230	306	472	106%	417	81%
Rest of former soviet states	1023	687	902	-12%	402	-61%
Argentina	238	302	433	82%	217	-9%
Brazil	560	726	1126	101%	816	46%
Mexico	378	499	727	92%	421	11%
Venezuela	194	247	461	137%	234	20%
Rest of Latin America	698	951	1350	93%	889	27%
Egypt	116	166	297	155%	315	170%
South Africa	323	371	466	44%	402	25%
Nigeria	142	195	381	169%	493	248%
Rest of North Africa	209	270	448	115%	364	75%
Rest of Africa	533	612	1205	126%	1809	239%
Saudi Arabia	244	362	530	117%	320	31%
United Arab Emirates	86	124	178	108%	95	10%
Rest of Middle East	619	1001	1482	139%	1017	64%
China	3500	4545	6572	88%	3649	4%
India	1269	1769	3483	174%	3519	177%
Indonesia	280	445	700	150%	534	91%
South Korea	303	499	762	152%	374	24%
Malaysia	70	139	229	228%	168	140%
Philippines	81	120	214	163%	196	141%
Singapore	29	43	70	141%	55	89%
Thailand	167	273	437	162%	347	108%
Rest of Asia	874	1125	1594	82%	1520	74%

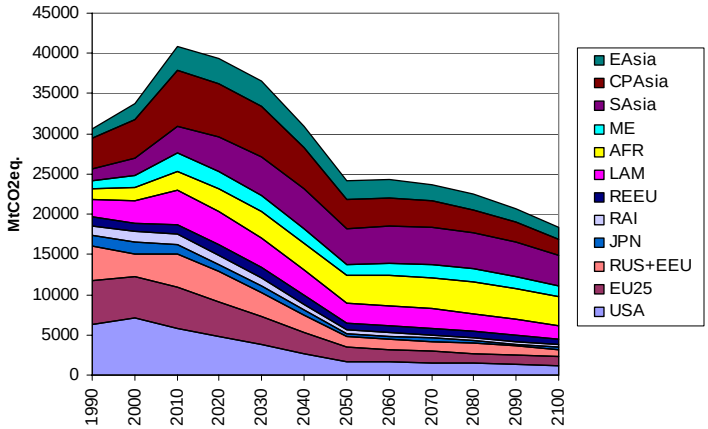


Figure 18. Regional emissions under the A1B scenario for the 450 ppmv CO_2 case

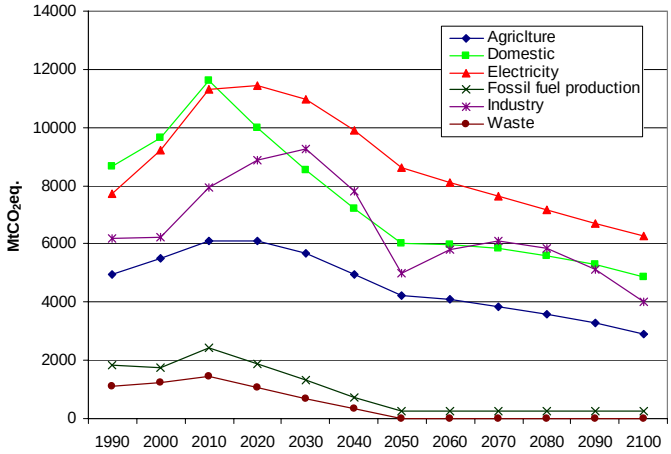


Figure 19. Global sectoral emissions under the A1B scenario for the 450 ppmv CO_2 case

From the results we make the following observations:

Methodology

- Reaching this scenario is very ambitious, stretching the limits of such a bottom-up analysis and lead to results for both developing countries (no growth after 2010) and developed countries (steep reductions) that may be difficult to accept.

Emission developments in regions/countries

- Most developing countries have to deviate from their business as usual paths already after 2010, only substantial exception seems to be India and some sub-Saharan African countries, some small island states. This is due to the dominance of the domestic emissions per capita.
- Emission developments in India are very dominant in total world emission development. These are largely determined by the large population, the large growth in population and the currently low CO_2 emissions per capita.

- The target for EU-25 for 2020 is a reduction of 23% compared to 1990 in our analysis. For Annex I, the results are -20%. Highest figures +300-400% for Togo, Seychelles, Niger, Mozambique, Mauritania (1000% Maldives). Lowest figure are -60% to -80% (Armenia, Baltics, Moldova, Belarus, Belize).
- With this parameterization and assumptions, developing counties have to deviate from their reference scenarios relatively early, leaving room for slightly less reductions from developed countries.

Relation of parameters to technological developments

- In the electricity sector there is initially a large difference between Triptych and the reference scenario, which later converges.
- The large share of renewables would include CO_2-neutral production of electricity from fossil fuels, e.g. through CO_2 capture and storage, hydrogen route, fuel cells, etc.
- The CHP efficiency (heat + electricity) is applied to electricity to take into account the additional saving in emissions from co-generated heat. Actual emissions from the electricity sector would be higher.
- The share of nuclear electricity is assumed to stay unchanged at the current percentage. Equally a reduction or increase could be plausible.
- The energy efficiency indices have relatively low values, they also include decarbonisation (including biofuels/hydrogen).
- Domestic per capita emissions are very low in 2050. This can only be reached if transport will be based on hydrogen/fuel cells or biofuels. The use of heat pumps for residential heating may be necessary.

8.3.2 550 ppmv case

An example stabilization scenario towards a level of 550 ppmv CO_2 or 650 ppmv CO_2 eq. has been calculated using the parameters shown in Table 28. On average over the six reference scenarios, the Triptych approach with these parameters leads to emissions in the year 2050 46% above 1990 levels. Emissions in 2020 are 38% above 1990 levels. The results of the scenario are shown in Table 29. Figure 20 shows the resulting regional emissions for the A1B scenario. Figure 21 shows the global sectoral emissions.

Table 28 Parameters choices for the 550 ppmv CO_2 case

Sector	Quantity	2050	2100
Electricity	Differentiation in growth rates used	Yes	
	Maximum deviation of total power production at the country level		90%
	Maximum deviation of total power production at the global level		20%
	Share of renewables	40%	80%
	Share of CHP	20%	20%
	Reduction of solid fuels compared to base year	40%	100%
	Reduction of liquid fuels compared to base year	40%	100%
	Nuclear power generation remains constant in…	Absolute terms	
	Efficiency of CHP	80%	90%
	Power generation efficiency of solid fuels	45%	60%
	Power generation efficiency of liquids fuels	45%	55%
	Power generation efficiency of gas	60%	70%
Industry	Differentiation in growth rates used	Yes	
	Maximum deviation of total industrial production at the country level		90%

Sector	Quantity	2050	2100
	Maximum deviation of total industrial production at the global level		20%
	Structural change indicator	0.70	0.20
	Energy Efficiency Indicator	0.80	0.40
Domestic sector	Domestic convergence level - per capita emissions	1.3 tCO_2/cap/yr	
	Domestic convergence year - per capita emissions	2050	
Fossil fuel production	Fossil fuel emission level – % total emissions below base year	95%	
	Fossil fuel emission year – total emissions	2050	
Agriculture	Reduction below reference scenario emissions – low GDP/cap	20%	60%
	Reduction below reference scenario emissions – high GDP/cap	40%	80%
LULUCF	LUCF convergence year	Analysis excluding LULUCF	
Waste	Waste convergence level – per capita emissions	0	
	Waste convergence year – per capita emissions	2050	

Table 29 Results of the 550 ppmv CO_2 case for the A1B scenario, based on the parameters listed in Table 28

	1990	2000	2020	2020	2050	2050
	$MtCO_2eq.$	$MtCO_2eq.$	$MtCO_2eq.$	Relative to 1990	$MtCO_2eq.$	Relative to 1990
Annex I	18508	17907	16100	-13%	10365	-44%
Non-Annex I	11526	15030	27086	135%	38138	231%
World total	30500	33611	44389	46%	50326	65%
USA	6252	7178	5133	-18%	2953	-53%
EU15	4360	4323	3608	-17%	2302	-47%
New EU Members	1096	746	1020	-7%	792	-28%
Rest of Western Europe	115	123	234	104%	100	-13%
Russia	2825	2053	2675	-5%	1779	-37%
Rest of eastern Europe in Annex I	1520	778	1395	-8%	1084	-29%
Japan	1245	1386	1059	-15%	719	-42%
Rest of Annex I	1104	1332	993	-10%	656	-41%
Turkey	230	306	543	136%	937	308%
Rest of former soviet states	1023	687	978	-4%	887	-13%
Argentina	238	302	484	104%	430	81%
Brazil	560	726	1301	132%	1721	207%
Mexico	378	499	842	123%	884	134%
Venezuela	194	247	518	167%	585	201%
Rest of Latin America	698	951	1529	119%	1775	154%
Egypt	116	166	348	199%	693	495%
South Africa	323	371	537	67%	842	161%
Nigeria	142	195	436	207%	916	545%
Rest of North Africa	209	270	512	145%	822	294%
Rest of Africa	533	612	1422	167%	3168	494%
Saudi Arabia	244	362	589	141%	837	243%
United Arab Emirates	86	124	198	131%	256	198%
Rest of Middle East	619	1001	1671	170%	2532	309%
China	3500	4545	7572	116%	8415	140%
India	1269	1769	4267	236%	7716	508%
Indonesia	280	445	809	189%	1113	298%
South Korea	303	499	848	180%	870	187%
Malaysia	70	139	264	277%	386	452%
Philippines	81	120	258	217%	397	387%
Singapore	29	43	81	178%	119	308%
Thailand	167	273	505	203%	746	347%
Rest of Asia	874	1125	1861	113%	2986	242%

Figure 20. Regional emissions under the A1B scenario for the 550 ppmv CO_2 case

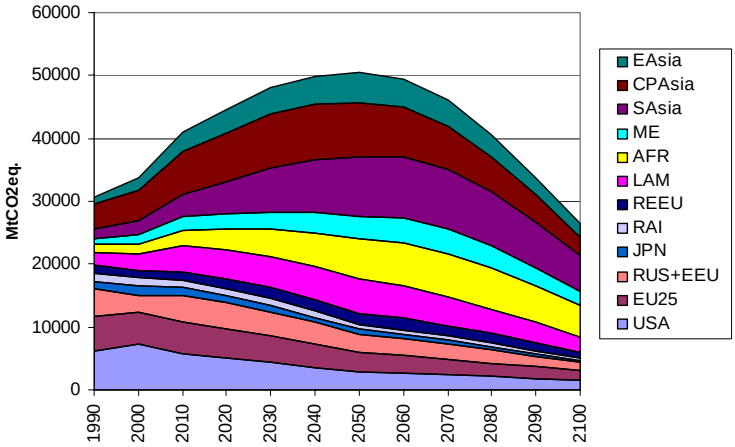
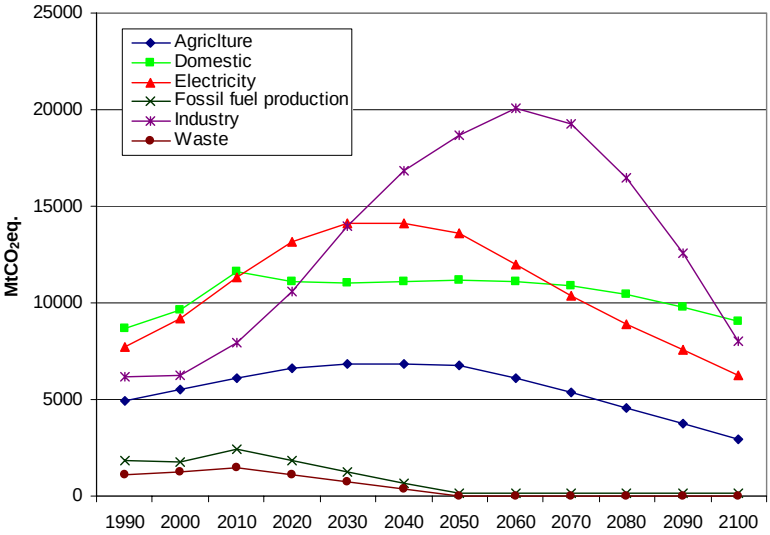


Figure 21. Global sectoral emissions under the A1B scenario for the 550 ppmv CO_2 case



8.4 CONCLUSIONS

The Triptych approach (here described in its Version 6.0) is the most sophisticated approach to share emission allowances between countries based on sectoral considerations. It can be applied globally to all countries or to any subset of countries. An earlier version has already been applied successfully within the EU, when sharing the Kyoto targets for individual countries within the EU.

Due to the sectoral detail, it accommodates many national circumstances and concerns of many countries: Countries that rely on coal today may further use coal, but have to increase their efficiency. Countries that rely on the export of energy intensive goods may continue to produce those, but have to improve their efficiency. The general standard of living and individual consumption would converge.

Stabilization at 450 ppmvCO_2 or 550 ppmvCO_2 requires global emission growth to come to a halt. Consequently, the Triptych parameters have to be set in a relatively stringent way to

leave room for production growth. Applying this approach leads to substantial reduction requirements for the industrialised countries, in particular those countries with carbon intensive industries such as in Central and Eastern Europe and the Russian Federation. In contrast, substantial emission increases are allowed for most developing countries, however, mostly below their reference scenarios.

The Triptych has several strengths: It is able to consider and accommodate national circumstances. It explicitly allows for incorporating economic growth and improving efficiency in developing countries. It has been successfully applied (on EU level) as a basis for negotiating targets.

On the other hand weaknesses exist: The approach in itself is rather complex and requires many separate decisions, requires much data on a sectoral level and may therefore be perceived as not transparent. In addition, projections of production growth rates for heavy industry and electricity are required. An agreement on all these issues on a global level may be difficult.

In sharing emission allowances, there is a general conflict of being simple and not able to accommodate many national circumstances and concerns (e.g. converging per capita emissions) on the one hand and being sophisticated and able to accommodate them on the other hand. The Triptych approach clearly belongs to the more sophisticated methods. The experience with sharing the EU Kyoto target among member states EU has shown, that also complex solutions can be the basis for an agreement. Hence the Triptych approach can also in the future provide the basis for the sharing of emission allowances between countries within a group (see also Chapter 9).

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9. A COMPROMISE PROPOSAL

With the insight from the previous chapters, we develop in this section an overall concept that combines many elements of the approaches discussed. This proposal aims to satisfy most demands and concerns, while still being able to meet the anticipated environmental goal. We believe that this overall concept could be a possible way forward in the multilateral international climate policy.

Basically two types of approaches can be distinguished:

On the one hand there are the rather simple approaches based on a simple set of rules derived from one basic principle. Contraction & Convergence and also the Common but Differentiated Convergence Approach would be examples. These frameworks are very relevant from the conceptual point of view but are not able to consider, for example, differences in national circumstances.

On the other hand there are complex settings with detailed rules and exceptions such as the multistage approach (Den Elzen et al. 2003) or the multi-sector convergence approach (Sijm et al. 2001) or the proposal of the South North Dialogue (Ott et al. 2004). These proposals also include the simple elements but are designed to be realistic and to accommodate the diverse national circumstances. The compromise proposal described in this chapter is of that second kind.

The compromise proposal is first described (9.1). We then quantify the emission allowances in section 9.2. After a discussion of the assessment criteria of chapter 3 (9.3), we draw conclusions (9.4).

9.1 DESCRIPTION

The compromise proposal consists of four parts:

1. Multistage agreement on emission reductions[17]

It seems likely that the international climate regime will continue to be designed in sequential steps. Although the emission reduction scheme “contraction and convergence” is very attractive from a conceptual point of view, it seems unlikely that the international community will make decisions on an overall architecture that will be valid for the next 50 years to come. Therefore, sequential decision-making will ultimately lead to a sequential system. In addition, countries’ capabilities and responsibilities are so different that a single formula is politically not realistic. Thus differentiation will have to be included in a flexible way, also with regard to timing: a multistage setting is necessary.

Differentiating types of targets: The diverse needs and expectations by all countries can only be satisfied by allowing several forms of targets aimed at reducing greenhouse gas emissions, including those that provide quantitative limits on emissions, as well as those that are formulated in terms of action or policies.

Absolute reduction targets: Stabilization of greenhouse gas concentration requires substantial emission reductions in developed countries in the short term. Reductions can best be achieved and monitored with quantitative emission reduction targets. Absolute emission reduction targets could be supplemented, if necessary, with additional rules aimed at providing flexibility, such as price caps or indexing to GDP.

The multistage setting would include 4 stages:

[17] Various multistage proposals and proposals for differentiation between countries have been proposed before: e.g. Gupta 1998, 2003, den Elzen et al. 2003, Höhne et al. 2003, Michaelowa et al. 2003, Criqui et al. 2003, Ott et al. 2004

- ***Stage 1- No commitments:*** Countries with low level of development do not have climate commitments. At least all least developed countries (LDCs) would be in this stage.
- ***Stage 2 - Enhanced sustainable development:*** At the next stage, countries commit in a clear way to sustainable development. The environmental objectives are built into the development policies. Requirements for such a sustainable pathway could be defined, e.g., that inefficient equipment is phased out and requirements and certain standards are met for any new equipment or a clear deviation from the current policies depending on the countries. The implementation of such sustainable development pathway has to be monitored and verified. The additional costs could be borne by the country itself or by other countries, e.g. official development aid supplemented by additional climate related funds.
- ***Stage 3 - Moderate absolute target:*** Countries commit to a moderate target for absolute emissions. The emission level may be increasing, but should be below a business as usual scenario. The target could also be positively binding, meaning that allowances can be sold, if the target is exceeded, but no allowances have to be bought, if the target is not achieved. An incentive to accept such target would be the possibility to participate in emissions trading.
- ***Stage 4 - Absolute reduction:*** Countries in stage 4 have to reduce absolute emissions substantially until a low per-capita level is reached. As time progresses, more and more countries enter stage 4.

Countries move through these stages based on defined thresholds, e.g. their level of emissions per capita. Since "followers do better" (they benefit from technological developments of others), the threshold for entering the last group decreases with time (as under "Common but differentiated convergence", Chapter 7).

2. New technology development and implementation:

In addition to immediate emission reductions, the development and implementation of those appropriate technologies has to be stimulated, which can reduce emissions substantially in the long term. The emission reduction agreement described above may not be sufficient to provide this technology "push". Hence, countries need to commit to develop and to implement new greenhouse gas mitigation technologies, in a clearer sense as already with the Convention and the Kyoto Protocol.

Such commitments must be defined clearly as measurable and verifiable goals. An example could be to express them in terms of the amount of a dedicated research budget or financial support provided for the implementation of the new technologies. In addition, countries could promise an amount of innovation that is equivalent to a certain amount of emission reductions in e.g. 2050. A respective roadmap should include quantitative estimates, timetables and mechanisms to monitor progress.[18]

When negotiating the absolute emission reduction commitments, countries will be given the opportunity to make a commitment to technology development and its implementation and diffusion. They can expect a relaxation of their absolute emission reduction commitments in return. Of course, the verifiability of the technology commitment is crucial as not to create a loophole for being exempt from emission reactions.

[18] A new idea could be, for example, to assist with the implementation of a feed-in law: A developed country could assist a developing country to implement a feed-in law for renewable electricity, where a fixed price is paid for each kWh from renewable sources fed into the grid. The additional resources to pay the slightly elevated prices for the feed-in tariff will be added to the developed country general electricity price or might shared between developing and developed country electricity price. For the developed country, this would be a commitment for action that could be at the same time favourable for its exporting renewables industry. In addition, it supports the transfer of technologies to developing countries.

3. Adaptation

In addition, the agreement must include substantial activities on adaptation (see also chapter 6).

Adaptation covers a broad range of considerations from narrowly defined immediate measures against expected changes in climate via strengthening adaptive capacity (i.e. development) to damage repair and compensation. Many of these issues are broader than what the UNFCCC regime could cover. Mainstreaming adaptation into development and disaster relief seem to be feasible options, but they best will be implemented outside of the UNFCCC regime.

The issue of damage repair and restoration is clearly a matter related to climate change and the UNFCCC. Within the UNFCCC regime, narrowly defined adaptation projects could be implemented through the available funds. In addition, a clear commitment of developed countries could be voiced to support adaptation activities outside of the UNFCCC.

4. Additional emission reduction efforts

Reaching stabilization targets, such as maximum temperature increase of 2°C, will only be possible, if all considerable efforts are made on many levels to reduce emissions in industrialized countries and to keep emissions low in developing countries. The emission reduction agreement described above needs to be supported by other activities:

Agreements of like-minded countries on sustainable development themes: In addition to emission reduction commitments, groups of interested countries and industries are encouraged to jointly take up action on themes, sectors or technologies that are relevant for both, sustainable development (especially in Non-Annex I countries) and the limitation of global emission of greenhouse gases. One example is the Johannesburg Renewable Energy Coalition (JREC), where like-minded countries support the theme of renewable energy. Similar activities could be started in other areas, such as:

- Improvement of industrial energy efficiency through modern technology (e.g. iron and steel, cement)
- Application of natural-gas fired CHP for power generation, fuel switch or efficiency improvements
- Introduction of clean and efficient cars
- Use of energy-efficient appliances

Stopping deforestation: Emissions from the biosphere are different to those related to energy and industry for three reasons.

- The anthropogenic part of forestry emissions (deforestation) and removal (newly planted vegetation) is very small compared to the natural turnover of CO_2 in the atmosphere, making it difficult to separate the human induced part from the natural part.
- Quantification of forestry emissions and removal is uncertain. Still, within the bands of uncertainty, the emissions and removals from forestry may be potentially higher compared to fossil fuels emissions (one quarter to one third of emissions of global CO_2 emissions today)
- Forestry can also remove CO_2 from the atmosphere (negative emission). These removals are however not permanent, but can be reversed, by e.g. harvesting the forest.

The multistage agreement on emission reductions described above may or may not include emissions from land-use change and forestry. In any case, separate action on avoiding and limiting deforestation has to be undertaken. This could be of the form agreeing to keep deforestation at current levels in 2020 or to decrease the deforestation rate (emissions) by e.g. 10%.

9.2 QUANTIFICATION OF EMISSION ALLOWANCES

In this section we present the quantification of emission allowances according to this proposal. We have only implemented the multistage agreement on emission reductions of the compromise proposal in the model for quantification of emissions allowances (EVOC). The effects of the other parts could not be quantified. We have implemented the four stages as follows:

- All countries in the first stage follow their reference scenario, as no emission reductions are required.
- All countries in stage 2 (Enhanced sustainable development) reduce emissions a percentage below their reference scenario within 10 years (a very simple representation). Countries will move into this stage, if their per capita emissions are higher than a certain level.
- All countries in stage 3 (Moderate absolute target) reduce emissions by a percentage further below their reference scenario within 10 years. Countries will move into this stage, if their per capita emissions are higher than a certain level.
- All countries in stage 4 (Absolute reduction) need to reduce absolute emissions by a given percentage per year. Those countries with higher emissions per capita reduce more compared to those with lower emissions per capita. The sensitivity to other options such as the Triptych approach for the countries in this stage is assessed. Countries with per capita emissions above a threshold will enter this stage. This threshold is decreasing from 2010 to 2100. Countries do not further reduce (stage 5), once they reach a very low level of per capita emissions.

Each 10 year step, it is assessed, whether a country should move to a next stage. We have introduced the condition, that movement into stage 4 is only possible after a country has been one decade in stage 3. This is to avoid the situation that a developing country jumps from stage 1 directly to stage 4. Hence, all current Non-Annex I countries will be at maximum in stage 3 in 2020 and in stage 4 in 2030.

The free parameters (threshold and reduction levels) are set in a way so that resulting global emissions aim at 400, 450 and 550 ppmv CO_2 concentration in the long term (see Chapter 10). Table 30 shows the parameters that are used for the different scenarios. For each of the six reference scenarios, we have chosen the parameters to meet the required emission levels in the long term for 400, 450 and 550 ppmv CO_2. In all of those cases emissions in 2020 will be lower than immediately required. We therefore prepared additional cases with slightly relaxed parameters only until 2020, where the emission levels in 2020 are met.

There are several degrees of freedom when selecting the parameters. The same global emission level can be reached by choosing low participation thresholds and relaxed reductions for the participating countries or equally by choosing high participation thresholds and ambitious reductions for the participating countries. We aimed at balancing the parameters, but other parameter sets could also be applied.

Table 30. Parameters used for the multistage approach. Ranges are due to the use of different reference scenarios.

Parameter	Unit	400 ppmv		450 ppmv		550 ppmv	
		Only until 2020	Long term	Only until 2020	Long term	Only until 2020	Long term
Threshold to enter stage 2	tCO_2eq /cap	3	3	3-4	3	5 - not entering	4-8
Threshold to enter stage 3	tCO_2eq /cap	4-6	3.5	5-8	3.5-4	8 - not entering	6-10
Threshold to enter stage 4 in 2010	tCO_2eq /cap		4		5-5.5		9-12
Threshold to enter stage 4 in 2100	tCO_2eq /cap		1.5		2-3		3
Threshold for no further reduction in stage 4	tCO_2eq /cap		1.5		1.5		2
Stage 2 (enhanced sustainable development) reduction below reference scenario in 10 years	%	20	20	10	15	5-10	5
Stage 3 (Moderate absolute target) reduction below reference scenario in 10 years	%	30-35	30-35	20-25	30-35	10-15	10-15
Stage 4 (Absolute reduction) reduction per year*	%	4-6.7	7.5-9	1.5-4.2	4.5-5.2	0-2.2	1.5-4

*: The reduction percentages per year are applied to the absolute emissions in the previous year and therefore lead to an exponential decline in absolute emissions. Other slopes (e.g. linear) could be possible.

The parameters for 400 and 450 are very stringent (Table 30). Early participation and stringent reductions by countries in stage 4 are necessary.

Figure 22, Figure 23 and Figure 24 show the emission allowances under the multistage approach aiming at 400, 450 and 550 ppmv CO_2 in the long term for the A1B reference scenario. In order to reach stabilization of greenhouse gas concentrations, global emissions need to decline. While emissions of developing countries are growing, emissions of Annex I countries need to be reduced significantly. Even for the 550 case, we assumed a reduction of 1.5% to 4% per year, which is very substantial. But also developing countries have to deviate from their reference scenario early. We assumed that countries move to stage 2 at 3-8 tCO_2eq/cap and reduce emissions 5% to 20% below their reference. They move to stage 3 at 3.5-10 tCO_2eq/cap and reduce 10% to 35% below reference. Countries move to the group that reduces absolute emissions at 4 to 12 tCO_2eq/cap.

Table 31, Table 32 and Table 33 show the likely date of entry into the different stages for the cases aiming at 550, 450 and 400 ppmv in the long term. Numbers represent the stage, averaged over six cases, one for each IPCC scenario. For regions, the population-weighted average is given. It can be observed that for the 550 case only the most advanced developing countries significantly participate as of 2020. For the 450 case, significantly more countries move to higher stages in 2020 and 2030. For the 400 case, most advanced but also medium developing countries participate as of 2020/2030. The tables show the results of the long-term cases. For the more relaxed short-term 550 case, ascending countries are roughly one stage lower in 2020 than in the long-term 550 case. For 450 the difference is up to half a stage and for 400 less than half a stage.

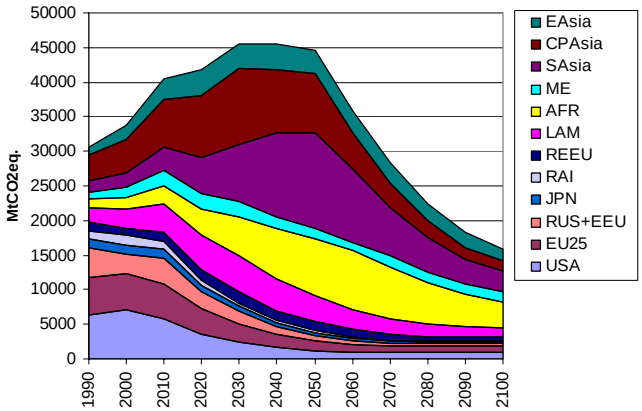

Figure 22. Emission allowances under the Multistage approach for the A1B scenario aiming at approximately 550 ppmv CO_2 concentration

Table 31. Likely date of entry into the different stages aiming at 550 ppmv in the long term. Numbers represent the stage, averaged over six cases, one for each IPCC scenario. For regions, the population-weighted average is given.

	2020	2030	2040	2050	2060	2070	2080	2090	2100
Annex I	4.0	4.0	4.0	4.0	4.0	4.0	4.4	4.6	4.7
Rest of Eastern Europe	2.1	2.4	2.6	2.9	3.0	3.0	3.1	3.5	3.7
Argentina	2.8	3.7	4.0	4.0	4.0	4.0	4.5	4.7	4.7
Brazil	1.7	1.8	2.3	2.5	2.7	2.7	2.8	3.3	3.8
Mexico	1.8	2.3	2.7	2.8	3.0	3.0	3.2	3.8	4.2
Venezuela	3.0	4.0	4.0	4.0	4.0	4.0	4.2	4.5	4.7
Rest of Latin America	1.3	1.7	1.9	2.1	2.1	2.1	2.2	2.5	2.9
Egypt	1.0	1.0	1.5	1.8	2.3	2.5	2.5	2.7	3.3
South Africa	2.3	2.5	2.7	3.2	3.5	3.7	4.0	4.3	4.7
Nigeria	1.0	1.0	1.0	1.2	1.5	1.8	2.3	2.5	2.8
Rest of North Africa	1.3	1.5	1.8	2.1	2.4	2.5	2.5	2.8	3.3
Rest of Africa	1.0	1.0	1.1	1.2	1.3	1.5	1.8	2.0	2.3
Saudi Arabia	3.0	4.0	4.0	4.0	4.0	4.0	4.5	4.7	4.7
United Arab Emirates	3.0	4.0	4.0	4.0	4.0	4.0	4.5	4.7	4.7
Rest of Middle East	2.2	2.3	2.6	2.9	3.2	3.2	3.5	3.8	4.0
China	1.0	1.5	1.7	2.2	2.5	2.7	2.8	3.2	4.0
India	1.0	1.0	1.0	1.5	1.8	2.2	2.3	2.3	2.5
Indonesia	1.0	1.0	1.0	1.3	1.5	1.7	2.0	2.0	2.3
South Korea	3.0	4.0	4.0	4.0	4.0	4.0	4.2	4.2	4.5
Malaysia	2.5	3.0	3.5	3.7	3.8	4.0	4.2	4.3	4.5
Philippines	1.0	1.0	1.0	1.0	1.2	1.2	1.3	1.7	2.0
Singapore	3.0	3.8	4.0	4.0	4.0	4.0	4.0	4.5	4.7
Thailand	1.5	1.8	2.3	2.8	3.0	3.3	3.7	4.0	4.3
Rest of Asia	1.2	1.2	1.2	1.3	1.4	1.5	1.5	1.7	1.8

Note: “Stage 5” denotes the state, where a country has reached a very low per capita emission level and does reduce emissions further.

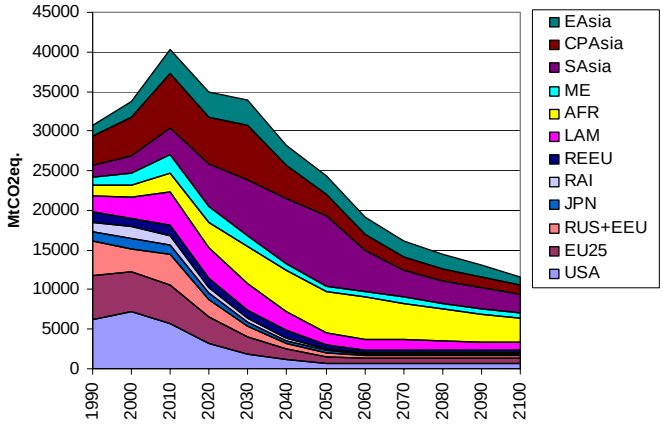

Figure 23. Emission allowances under the Multistage approach for the A1B scenario aiming at approximately 450 ppmv CO_2 concentration

Table 32. Likely date of entry into the different stages aiming at 450 ppmv in the long term. Numbers represent the stage, averaged over six cases, one for each IPCC scenario. For regions, the population-weighted average is given.

	2020	2030	2040	2050	2060	2070	2080	2090	2100
Annex I	4.0	4.0	4.0	4.0	4.1	4.9	5.0	5.0	5.0
Rest of Eastern Europe	2.6	3.2	3.4	3.4	3.6	4.1	4.2	4.3	4.3
Argentina	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
Brazil	3.0	3.0	3.8	4.0	4.2	5.0	5.0	5.0	5.0
Mexico	3.0	3.8	3.8	3.8	4.3	4.8	5.0	5.0	5.0
Venezuela	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
Rest of Latin America	2.4	2.7	2.8	3.2	3.2	3.5	3.8	3.9	4.0
Egypt	1.8	2.0	2.8	3.3	3.7	3.8	4.7	4.8	5.0
South Africa	3.0	4.0	4.0	4.0	4.7	5.0	5.0	5.0	5.0
Nigeria	1.0	1.0	1.7	2.0	2.5	3.3	3.7	4.3	4.7
Rest of North Africa	2.2	2.3	2.8	3.4	3.4	3.9	4.0	4.1	4.2
Rest of Africa	1.1	1.2	1.4	1.6	1.9	2.2	2.4	2.7	3.0
Saudi Arabia	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
United Arab Emirates	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
Rest of Middle East	2.8	3.4	3.4	3.6	3.9	4.4	4.5	4.5	4.5
China	3.0	3.0	3.2	3.7	3.7	4.2	4.7	5.0	5.0
India	1.0	1.5	2.0	2.3	3.2	3.3	3.8	4.0	4.3
Indonesia	1.0	1.7	2.0	2.3	2.3	2.5	2.7	3.0	3.7
South Korea	3.0	4.0	4.0	4.0	4.2	4.5	5.0	5.0	5.0
Malaysia	3.0	4.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0
Philippines	1.0	1.0	1.5	1.7	1.8	1.8	1.8	2.3	2.8
Singapore	3.0	4.0	4.0	4.0	4.2	4.7	5.0	5.0	5.0
Thailand	3.0	3.2	3.7	3.8	4.2	4.8	5.0	5.0	5.0
Rest of Asia	1.2	1.3	1.5	1.7	1.7	1.8	1.9	2.1	2.3

Note: “Stage 5” denotes the state, where a country has reached a very low per capita emission level and does reduce emissions further.

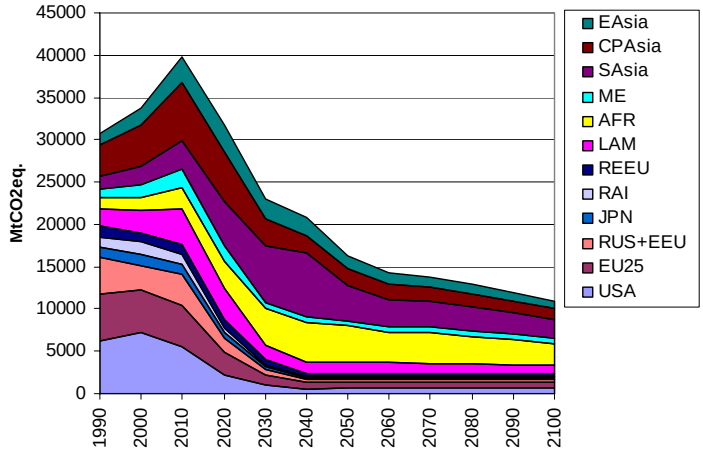

Figure 24. Emission allowances under the Multistage approach for the A1B scenario aiming at approximately 400 ppmv CO_2 concentration

Table 33. Likely date of entry into the different stages aiming at 400 ppmv in the long term. Numbers represent the stage, averaged over six cases, one for each IPCC scenario. For regions, the population-weighted average is given.

	2020	2030	2040	2050	2060	2070	2080	2090	2100
Annex I	4.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0
Rest of Eastern Europe	2.6	3.4	3.5	4.1	4.3	4.5	4.5	4.6	4.6
Argentina	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0
Brazil	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0
Mexico	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0
Venezuela	3.0	4.0	4.0	4.3	5.0	5.0	5.0	5.0	5.0
Rest of Latin America	2.5	3.1	3.3	3.9	4.2	4.2	4.3	4.4	4.6
Egypt	1.8	2.0	2.7	3.7	4.0	5.0	5.0	5.0	5.0
South Africa	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0
Nigeria	1.0	1.0	1.7	2.5	3.3	4.0	4.8	5.0	5.0
Rest of North Africa	2.2	2.7	3.1	4.0	4.3	4.5	4.7	4.7	4.8
Rest of Africa	1.1	1.2	1.4	1.8	2.1	2.5	3.0	3.3	3.7
Saudi Arabia	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0
United Arab Emirates	3.0	4.0	4.0	4.3	5.0	5.0	5.0	5.0	5.0
Rest of Middle East	2.8	3.6	3.6	4.5	4.5	4.5	4.5	4.5	4.5
China	3.0	3.7	3.7	4.7	4.8	5.0	5.0	5.0	5.0
India	1.0	1.5	2.3	3.0	3.3	4.3	4.8	5.0	5.0
Indonesia	1.0	1.7	2.3	3.0	3.2	3.8	4.2	4.5	4.7
South Korea	3.0	4.0	4.0	4.2	5.0	5.0	5.0	5.0	5.0
Malaysia	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0
Philippines	1.0	1.0	1.5	2.0	2.5	3.0	3.7	3.8	4.3
Singapore	3.0	4.0	4.0	4.5	5.0	5.0	5.0	5.0	5.0
Thailand	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0
Rest of Asia	1.2	1.3	1.5	1.7	2.1	2.3	2.6	2.9	3.2

Note: “Stage 5” denotes the state, where a country has reached a very low per capita emission level and does reduce emissions further.

Figure 25 shows the change in emissions from 1990 to 2020 and 2050 under the compromise proposal for aiming at different long-term stabilization levels. Error bars show the range for using different reference scenarios. The bar on the far right shows the spread of the reference

emissions. Shown are the results for the groups, results for individual countries may differ. Annex I countries are assumed to increase emissions under the reference by a few to 30% until 2020, but are around the 1990 levels in 2050. Under the multistage approach, they would have to reduce emissions in 2020 around 5 to 50% below 1990 levels, in 2050 around 60% to 90% below 1990 levels. For higher stabilization goals, less reductions are necessary, e.g. around -10% for 550 ppmv CO_2 in 2020 vs. around -40% for 400 ppmv CO_2 in 2020.

Non-Annex I countries are expected to increase their emissions by 2020 and 2050 manifold compared to their 1990 levels. For stricter stabilization goals, they would participate in the emission reduction effort earlier than under less ambitious stabilization goals. The region South Asia (including India) does not participate in 2020 under any stabilization goal, as their per capita emissions are very low. They would increase their emissions by 200% above 1990 levels in 2020. Africa does basically not participate in the 550 case in 2020 but starts to participate for lower stabilization goals. In 2050 all developing country regions have to participate, but still would be allowed to increase emissions substantially above 1990 levels.

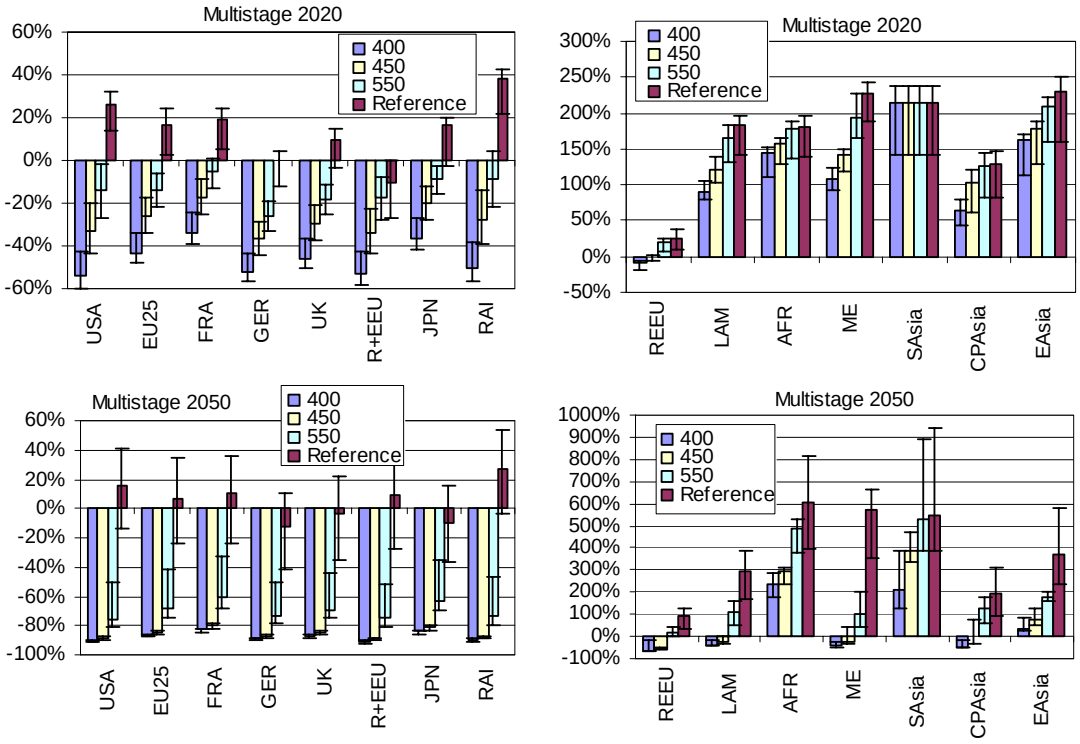

Figure 25. Change in emissions from 1990 to 2020 and 2050 under the compromise proposal. Error bars show the range for different reference scenarios.

Countries in stage 4 are assumed to share the emission reductions proportional to their per capita emissions. Those that have high per capita emissions reduce more compared to those with low per capita emissions. Alternatively, all countries could reduce emissions with the same percentage (see Figure 26). Then countries with high per capita emissions would reduce less (e.g. USA) and countries with low per capita emissions would reduce more (e.g. France). Yet another alternative would be that countries in stage 4 reduce emissions according to the Triptych methodology (same group reduction). In such a case, not only the per capita emissions are relevant but also the current energy efficiency and the expected development of electricity and industrial production. Countries with higher efficiency and with higher expected growth would have to reduce emission less. In the given example (Figure 26), the higher efficiency in European countries is balanced by the stronger growth in electricity and industrial production assumed for the USA. Both have to reduce at the same percentage.

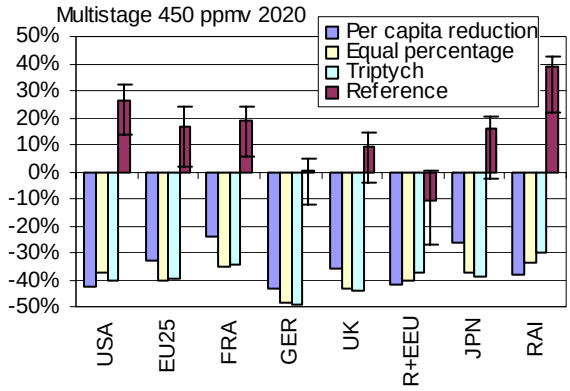

Figure 26. Sensitivity to different reductions in stage 4 (reference scenario A1B, results are close to the lower bound given in Figure 25)

9.3 DISCUSSION OF THE CRITERIA

In this section we assess, how the compromise proposal could satisfy the evaluation criteria for post 2012 approaches on future action as listed in chapter 3.1.

Environmental criteria: The proposal has the potential to safeguard the fulfilment of the ultimate objective of the Convention provided that the interactions between absolute emission reduction commitments and technology development commitments are properly negotiated. Since the criterion of participation is crucial for meeting the environmental effectiveness, the proposal incorporates incentives for Parties to participate. Developing countries would either start with no commitments or sustainable development commitments and thus would be integrated in the system according to their current capabilities to act towards mitigating climate change. Those countries would perceive the system much fairer than if they were confronted with emission cuts right away. Stage 3 provides an additional intermediary step with moderate reductions. Countries in stage 4, in particular most developed countries, will commit to absolute emission reductions. Those countries will also be given the opportunity to make a commitment to technology development and its implementation and diffusion. If so, the respective country can expect a reduction of its absolute emission reduction commitments. By providing this level of flexibility further emission cuts on the long term are likely to occur due to technology development and thus would indirectly contribute to the global system. Developed countries such as the US could consider such flexibility as an interesting feature, which could stimulate negotiators from the US coming back to the international negotiating table.

It must be noted that many countries might in fact prefer taking a commitment for technology development rather than taking a commitment for absolute emission reductions. Such development could jeopardise meeting the environmental criteria. To avoid such development, system design should provide a clear indication to what extent a country could change a commitment taken in absolute emission cuts for taking a commitment in technology development.

The proposal covers the need for an agreement to be made on adaptation and provides for certain countries to pursue sustainable development targets. The proposal thus would also be in line with this particular environmental criterion.

Economic criteria: The proposal is aimed to minimize the aggregated global costs and provides countries with sufficient flexibility to reach their commitments e.g. through emissions trading, thus minimising the negative economic effects. By allowing for taking technology development commitments, technology change is stimulated which in itself would generate positive economic side effects, growth and sustainable development of developing countries. By differentiating various stages with certain actions involved in each stage, structural differences of countries are addressed.

Technical criteria: There is no doubt that this proposal requires considerable negotiations and fine-tuning if pursued. However, it can build upon fundamental agreed elements of the existing Kyoto system in particular the monitoring and reporting arrangements. Certainly, monitoring mitigation measures would need to be extended by monitoring progress achieved with meeting technology development targets or commitments of countries, sustainable development targets, progress with adaptation measures etc. If negotiated for a more than one commitment period, say for instance for the next 15 years with 5 year interval targets, the outcome would communicate stability of the system and would ensure a continued participation of countries. In addition, such longer timeframes would provide a clear signal to industry that is the driving force to materialise technology development.

Political criteria. The proposal meets the 'capability', 'responsibility', and 'comparable efforts' criteria. In terms of the criteria 'needs', developing countries in stage 1 and 2 are given the opportunity to satisfy basic development needs. The proposal furthermore takes current national emission levels as the basis for a future climate policy into account.

The proposal is addressing fundamental and controversial positions of the major players discussed in this report such as the EU, USA, advanced developed countries and least developed countries. For instance, by the inclusion of LDCs and ADCs in stage 1 and 2 with the longer-term perspective to enter stages with more commitment, a fundamental requirement voiced by the US for developing country participation is met. On the other hand, LDCs would see big emitters taking a leading role in emission reductions and would see the inclusion of fostering sustainable development and adaptation measures. Further, the proposal satisfies the EU 's position of meeting environmental effectiveness and utilizing the established monitoring and reporting schemes developed under the Kyoto Protocol.

9.4 CONCLUSIONS ON COMPROMISE PROPOSAL

The compromise proposal has several strengths:

- The proposal is designed as a compromise to accommodate many different viewpoints on specific issues and to satisfy multiple demands. Many countries or country groups can find elements of their concern in this proposal.
- The proposal allows for a gradual phase-in of countries in the mandatory emission reduction effort, which is in line with the UNFCCC spirit, and takes into account national circumstances (esp. if Triptych is chosen as the burden sharing concept for stage 4).
- The proposal allows flexibility to implement immediate emission reduction measures or to develop technologies that are able to reduce emissions in the future.
- The proposal allows for gradual decision making, which seems the most likely way of reaching an international agreement.
- The proposal builds trust, as industrialised countries take the lead in emission reduction efforts.

The proposal however has some weaknesses:

- The overall proposal describes a relative complex system that requires many decisions.
- The risk that countries enter too late in the emission reduction effort is high, so that some long-term stabilization options may be lost. Hence, incentives are needed for countries to participate in a certain stage, not just thresholds. The flexibility provided for countries in stage 3 and/or 4 to take a commitment in technology development while receiving a reduction of their commitment of absolute emissions in return adds additional uncertainty on the global emission levels.

Critical in this setting would be the participation of the USA. Their current point of view can be incorporated through the commitment for technology development. Here the USA would have

to demonstrate serious actions for the development of new technologies. In return, the USA could receive a relatively moderate emission reduction target.

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10. COMPARISON OF EMISSION ALLOWANCES

In this chapter, we provide a comparison of emission allowances under the various approaches addressed in Chapters 7, 8 and 9. For the comparison we use the Evolution of Commitments Model (EVOC) developed by Ecofys, which includes emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 for 192 individual countries. Historical emissions are based on national emission inventories submitted to the UNFCCC and, where not available, other sources such as the International Energy Agency. Future emissions are based on the IMAGE implementation (IMAGE team 2001) of the IPCC Special Report on Emissions Scenarios (Nakicenovic et al. 2000). Further details of the model are described in Appendix E.

First, we address stabilization of greenhouse gas concentrations in general (10.1). Then we summarise results of the quantification under different stabilization scenarios on a regional level (10.2) and take a closer look at individual European countries (10.2.4). Final conclusions are drawn in section (10.3).

10.1 STABILIZATION OF GREENHOUSE GAS CONCENTRATIONS

The long-term objective of the UN Framework Convention on Climate Change is expressed in Article 2 as stabilization of greenhouse gas concentrations. Figure 27 provides an illustrative example pathway of global emissions that lead to stabilization of greenhouse gas concentrations (IPCC 2001d). The chart illustrates four steps of the cause-effect chain that result in climate change: emissions, CO_2 concentrations, change in global mean temperature and sea level rise. In all cases, global emissions peak and decline within the next century, leading eventually to stabilising concentrations within 100 to 300 years, which in turn leads to stabilising temperatures within a few centuries and sea level rise within centuries to millennia.

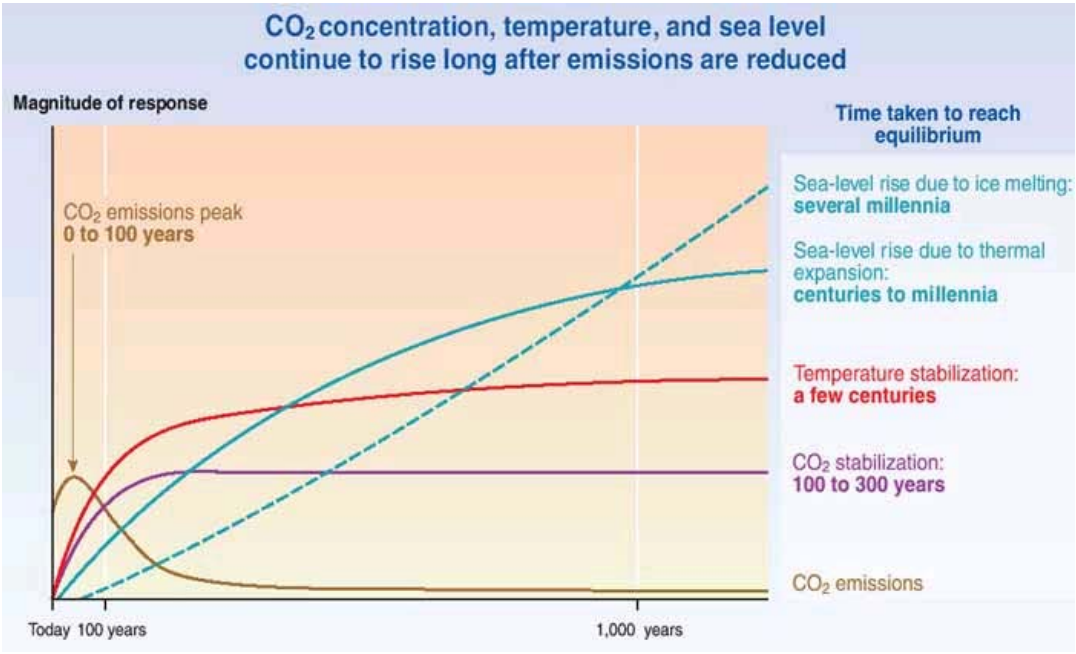

Figure 27: Generic illustration of the time scales involved for stabilization of CO_2 concentrations at any level between 450 and 1000 ppmv (Source: IPCC 2001d, figure SPM-5)

Four aspects are important for stabilization (see also Corfee-Morlot & Höhne 2003):

- Stabilization of atmospheric concentrations in the 21st Century at any level requires a significant departure from current emission levels. Global emissions will need to drop radically compared to today, dropping below 1990 levels and declining to almost zero

over time (Figure 27). The earlier the emissions peak and decline, the lower the stabilised concentration level, the lower the absolute level of climate change and the earlier that climate change is attenuated.

- If, in the short term, emissions rise above a certain level, low long-term stabilization levels may no longer be reachable.
- Due to the inertia and delays in the global climate system and even with stabilised concentrations the world will still see some significant climate changes for centuries to come. For higher stabilization levels and delayed stabilization, the longer the time period, in which there will be a "commitment to climate change".
- The rate of warming is important as it drives ecosystem impacts and possibly other impacts such as non-linear, abrupt climate changes. Curbing the rate of warming requires reversing the trend of growing emissions so that they decline in the near term. With increasing emissions, the rate of change in global-average temperature will remain high, whereas with decreasing emissions, the rate of increase in global-average temperature will be rather slow.

In order to achieve stabilization of greenhouse gas concentrations CO_2 and other greenhouse gases have to be included. Historically, emissions have increased the CO_2 concentration from 280 ppmv to the current level of 360 ppmv. CO_2, CH_4 and N_2O together produce an amount of radiative forcing that is equivalent to the forcing of CO_2 alone at roughly 400 ppmv (400 ppmv CO_2eq.) today. Stabilising the CO_2 concentration at 450 ppmv and reducing emissions of the other gases at similar rates would lead to a radiative forcing equivalent to a concentration 550 ppmv of CO_2 alone (550 CO_2eq. ppmv).

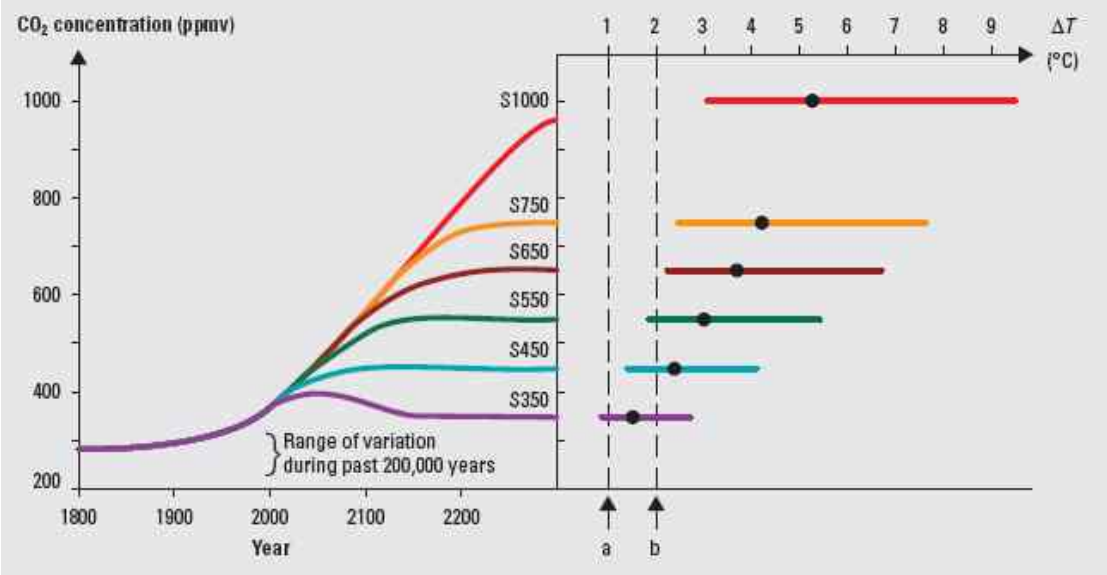

Figure 28. Stabilization scenarios and resulting temperature increases at equilibrium for different climate sensitivities (source: Azar & Rhode 1997)

Figure 28 shows the translation of CO_2 concentration to temperature increase (Azar & Rhode 1997). On the right the chart shows the full possible range of temperature increase resulting from uncertainty in the climate sensitivity (i.e. the temperature increase is in the range of 1.5°C to 4.5°C for a doubling of CO_2 concentrations).[19] The scenario for 350 ppmv CO_2 concentration leads to an equilibrium temperature increase of 1.5°C at a mean climate sensitivity, while the 450 ppmv scenario leads to an equilibrium temperature increase above 2°C at a mean climate sensitivity, when the climate system is in balance (here year 2200).

[19] Recent work suggests a higher range of 2.0 to 5.1°C, IPCC working group I workshop July 2004 (Kerr 2004)

The temperature increase in 2100 will be lower, due to the delay between increase in concentrations and temperature.

To ensure that the EU target of a maximum increase of 2°C above pre-industrial levels is kept within reach, stabilizing CO_2 concentration below 450 ppmv has to be aimed for (according to current knowledge).

Figure 29 (left) provides an overview of the range of global CO_2 emissions according to the standard set of possible baselines of the Special Report on Emission Scenarios (SRES) of the IPCC (as implemented in our model) in comparison to historical emissions. The spread of future emissions is quite substantial in the next few decades. The figure also shows the possible range of global CO_2 emissions under the assumption that the Kyoto targets are reached by all Annex I Parties (including the USA). Even assuming the emissions of Annex I countries are constrained to the levels inscribed in the Kyoto Protocol, the range of the global emission level is still wide, since the future emissions of the developing countries are uncertain.

Figure 29 (right) shows the resulting range of possible global CO_2 emission pathways that lead to different stabilization levels adapted from the post-SRES mitigation scenarios (Morita et al. 2001). Since the post SRES scenarios were not harmonized, absolute global emissions of the scenarios in 1990 and 2000 are not the same for all scenarios. We therefore applied the emission growth rates of the scenarios to the absolute emissions estimated for the year 2000. Included are all post-SRES scenarios that do not include a decrease of emissions in the latter part of the century of more than 3.5% annually. The result is only an approximation and further research is needed on the required emission corridors to a certain stabilization level.

The spread of paths that lead to the same concentration levels is large. Due to the long lifetime of CO_2 in the atmosphere (order of 100 years), it is approximately the aggregated emissions irrespective of the time of emission that define the concentration level. Significant differences in the timing of required emission reductions under various stabilization scenarios permit many alternative pathways. Two example pathways are shown in the 450 ppmv corridor. Global emissions could increase rapidly now, peak and then decrease rapidly (by 3% per year over a period of 20 years to 2040); or they could increase moderately and then decrease also moderately. Both paths lead to the same concentration level by the end of the century. Paths to concentration levels lower than 450 ppmv (the current level is 360 ppmv) need to involve very rapid emission reductions or global removal, i.e. negative emissions. The lowest path included in Figure 29 would lead to 350 ppmv CO_2 concentrations if emissions were negative in the latter half of the century. Without this assumption it could lead to 400 ppmv.

We can assume that, if global CO_2 emissions are above the 450 ppmv corridor in 2020 (Figure 29), a 450 ppmv CO_2 concentration will be no longer be reachable. As the SRES range for 2020 is above the 450 corridor, we conclude that if no efforts to reduce emissions are made, and if the Kyoto Protocol is not implemented, there is a significant chance that the option of 450 ppmv CO_2 would be out of reach already as of 2020.

Another reason for the large range in emission pathways to a certain concentration level is the uncertainty associated with the carbon cycle. This aspect of uncertainty is not included in Figure 29. Within the carbon cycle, plants absorb carbon from the atmosphere. Changes in climate can change the global vegetation and therefore the important sink mechanism for CO_2. Recent findings from analyses conducted with climate coupled carbon cycle models (Cox 2000) mention the possibility that the sink mechanism of the global vegetation would decrease substantially due to changes in climate. If this effect were included in the calculations, the above-described pathway for 550 ppmv would then lead to 780 ppmv (Metoffice 2002). While this result still needs to be validated with other models, it suggests the need for leaving some margin for error in setting policy.

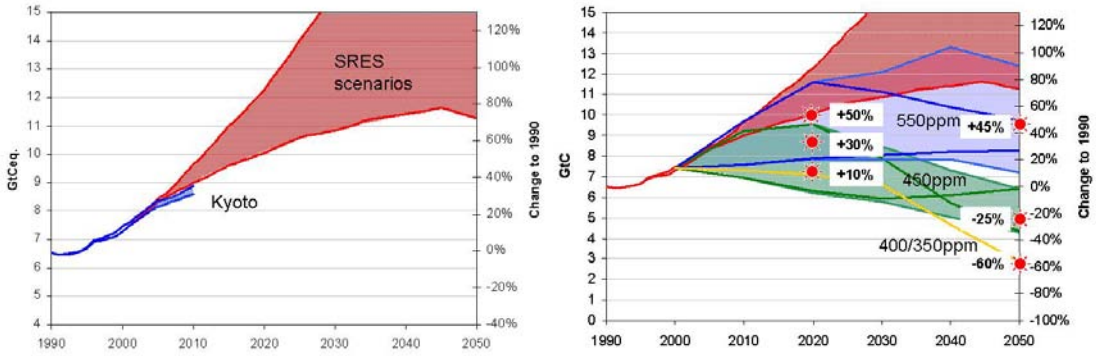

Figure 29. Possible CO_2 emission pathways until 2050

Notes: For the case of Kyoto implementation, it is assumed that all countries reach their Kyoto targets. On the one hand, the current emissions of the USA are far above its national Kyoto target. On the other hand, emissions of the Russian Federation and of several other economies in transition are far below their Kyoto target. Since the post SRES scenarios were not harmonized, absolute global emissions of the scenarios in 1990 and 2000 are not the same for all scenarios. We therefore applied the emission growth rates of the scenarios to the absolute emissions estimated for the year 2000. Included are all post-SRES scenarios that do not include a decrease of emissions in the latter part of the century of more than 3.5% annually.

We selected global emission levels in 2020 and 2050, which have to be met by all approaches for the following quantification of emission allowances for the various proposals. These are taken from Figure 29 to be in line with 550 ppmv CO_2 (roughly 650 ppmv CO_2eq.), 450 ppmv CO_2 (roughly ppmv 550 CO_2eq.) and towards 400 ppmv (roughly 450 ppmv CO_2eq).

These global targets are only based on considerations of the most important greenhouse gas (CO_2). Stabilization scenarios considering all greenhouse gases are rare in the literature (e.g. Eickhout et al. 2003). In assessing emission pathways to stabilise climate, however, other greenhouse gases are also important. Non-CO_2 emissions are a significant part of the Kyoto basket, even more so for Non-Annex I countries. In addition, non-CO_2 gases provide some low cost reduction options. For simplicity, we assume that for a given concentration level, emissions of the non-CO2 gases need to be reduced with the same percentage as the CO_2 emissions.

Hence, we assumed here as a case towards 550 ppmv that *global greenhouse gas emissions*, weighted with global warming potentials, can be 50% above 1990 levels in 2020 and 45% above 2050, decreasing steadily thereafter. For a 450 ppmv case, it would be +30% in 2020 and -25% in 2050. In the direction of 400/350 ppmv it would be +10% in 2020 and -60% in 2050.

10.2 RESULTS

In the following sections, we provide the emission allowances under different approaches for the global emission levels given in Figure 29, which aim towards CO_2 concentration of 550, 450 and 400 ppmv. We use the following default settings (see also Appendix E):

- Including emissions of CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6
- Including international aviation and marine transport
- Excluding CO_2 emissions from land-use change and forestry
- All Annex I countries (including the USA) reach their Kyoto target in 2010
- Future emissions are based on the six marker scenarios of the IPCC special report on emission scenarios (IPCC 2000)

We have included the following approaches:

- **Contraction and Convergence (C&C):** Per capita emissions converge from 2010 to 2050 (see Chapter 7.2.2). The countries' emissions share of the global total converges from the share in 2010 to an equal per capita share in 2050. These shares are applied to the prescribed global emission levels in 2020 and 2050. Hence all six cases for the different reference scenarios have the same global emission level.
- **Common but Differentiated Convergence (CDC):** Annex I countries' per capita emissions converge within several decades to a low level. Individual non-Annex I countries also converge to the same level within the same time period years but starting when their per capita emissions are a certain percentage above global average (see Chapter 7). The parameters described in Chapter 7 were slightly changed so that the prescribed global emission levels are met. The parameters are chosen so that on average over the six scenarios, the prescribed global emission levels are met.
- **Compromise Proposal (multistage):** Countries participate in several stages with differentiated commitments. The parameters and results are the same as described in chapter 9.2. All six cases for the different reference scenarios have the same global emission level.
- **Triptych:** Common rules are applies to the sectoral emissions of all countries (see Chapter 8). For the long term (2050), the parameters are chosen as provided in Chapter 8. For 2020 additional cases were calculated that are slightly more relaxed so that the global emission level in 2020 is met. For 2020 and 2050, the parameters are chosen so that on average over the six scenarios, the prescribed global emission levels are met.

In the following sections, the results will be displayed as reductions below or increases above 1990 emission levels. Already from 1990 to 2000 the emissions have changes substantially (see Figure 30). USA, Japan and the Rest of Annex I have increased emissions substantially. The EU is slightly below 1990 levels and Russia and Eastern European States are well below 1990 levels. Most developing countries have increased emissions substantially.

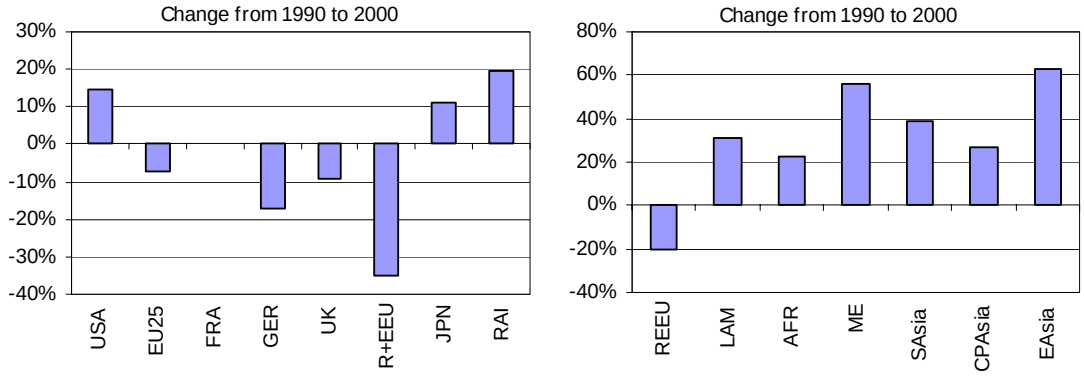

Figure 30. Change in emissions from 1990 to 2000

10.2.1 550 ppmv CO_2

Figure 31 provides the change in emissions from 1990 to 2020 and 2050 under Contraction and Convergence, Common but Differentiated Convergence, the Compromise Proposal (Multistage) and Triptych aiming at 550 ppmv CO_2 concentration. In all cases, global emissions in 2020 are 50% above 1990 levels, in 2050 45% above 1990 levels. The error bars show the spread using different reference scenarios.

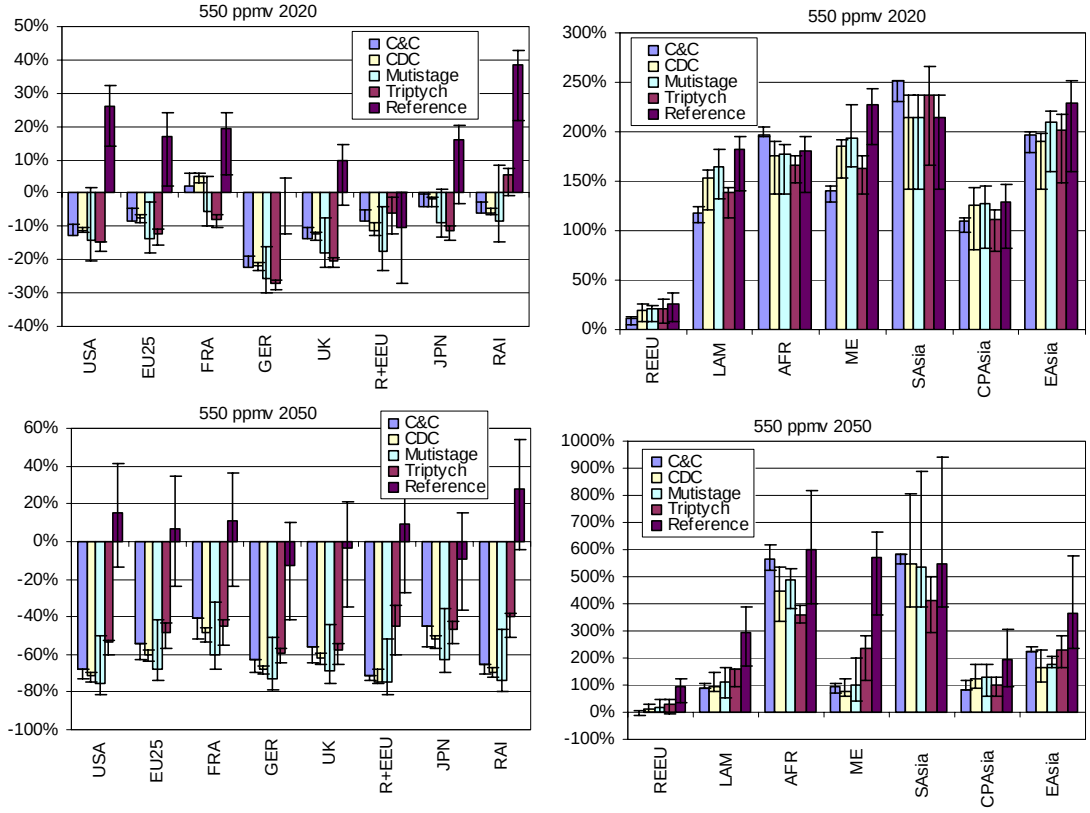

Figure 31. Change in emissions from 1990 to 2020 and 2050 under various approaches aiming at 550 ppmv CO_2 concentration. Error bars show the spread using different reference scenarios

Under all approaches, Annex I countries need to reduce emissions substantially. Under the approaches shown here, Annex I countries need to reduce emissions below 1990 levels in the order of 5% to 25% in 2020 and 50 to 70% in 2050.

Some Non-Annex I counties do not yet participate in 2020 (mainly in South Asia, Africa, Centrally Planned Asia), e.g. in the CDC and multistsage approach. The may even receive more allowances than their reference scenarios, e.g. under Contraction and Convergence (in South Asia and Africa) or under Triptych (South Asia in 2020). Yet many Non-Annex I countries (especially in Latin America, Middle East and East Asia) would need to deviate from their reference scenarios under these approaches already in 2020. In 2050 most countries need to deviate from the reference, especially in Latin America and Middle East.

As we have kept the global emission level constant over all approaches, one can observe how the approaches distribute these global emissions over the countries regions. E.g. under C&C, all countries participate and developing countries with high per capita emissions may need to reduce substantially, Annex I countries as a group have to reduce less relative to other cases. This is even more pronounced for the results of the Triptych approach. For the particular assumptions used, especially on future economic growth, developing countries (especially the coal intensive countries in Africa and South Asia in 2050) have contribute more to the global reduction effort than for other cases. On the other hand, the multistage and the CDC approach assume action by developed countries first and action by developing countries later. Hence, the reductions necessary for Annex I under these approaches are higher in 2020 than for the other approaches.

Most approaches depend on many free parameters, so it often depends on the setting of these parameters whether one approach is favourable for a country or not.

10.2.2 450 ppmv CO_2

Figure 32 also provides the change in emissions from 1990 to 2020 and 2050 under Contraction and Convergence, Common but differentiated convergence, Multistage and Triptych but aiming at 450 ppmv CO_2 concentration. In all cases, global emissions in 2020 are 30% above 1990 levels, in 2050 -25% below 1990 levels. The error bars show the spread using different reference scenarios.

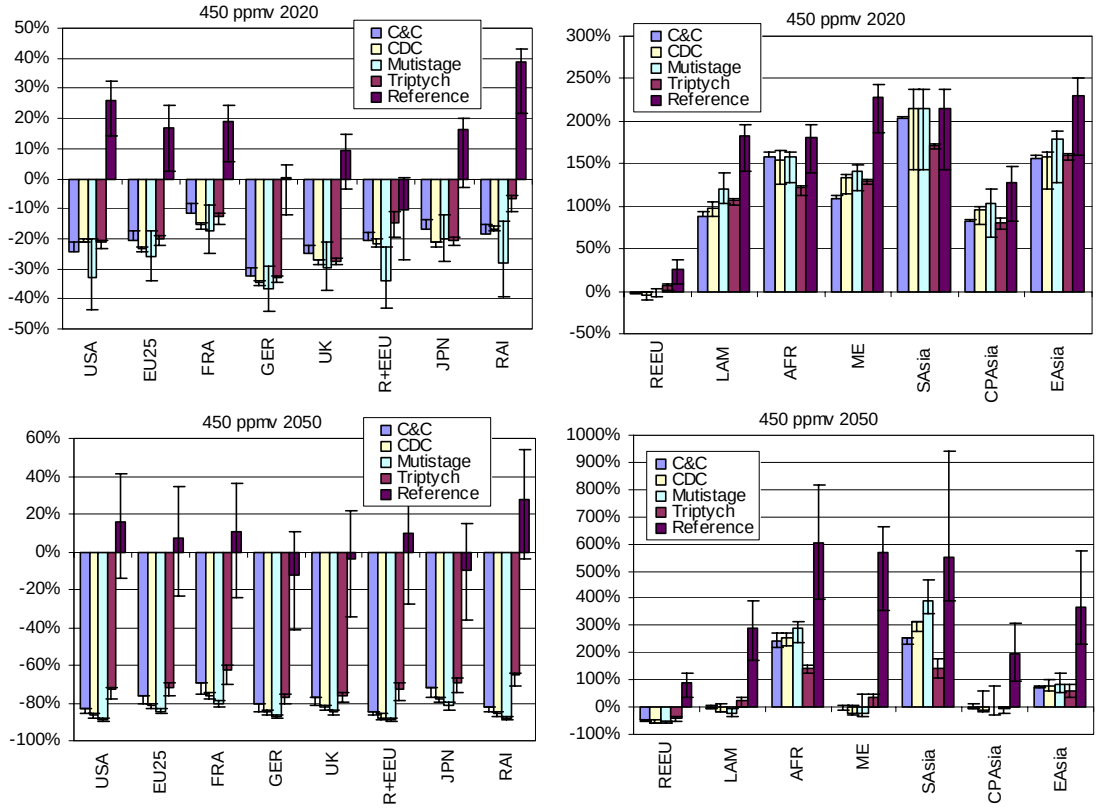

Figure 32. Change in emissions from 1990 to 2020 and 2050 under various approaches aiming at 450 ppmv CO_2 concentration. Error bars show the spread using different reference scenarios

One can observe that more reductions are required for all countries compared to the 550 case described above. Annex I countries need to reduce emissions below 1990 levels in the order of -10% to -30% in 2020 and 70 to 90% in 2050.

Fewer non-Annex I counties do not yet participate in 2020 (mainly in South Asia and Africa). Only under a few scenarios countries receive more allowances than required under the reference scenarios with Contraction and Convergence (in South Asia and Africa). Many Non-Annex I countries (especially in Latin America, Middle East, East Asia and Centrally planned Asia) would need to deviate from their reference scenarios under these approaches already in 2020. In 2050 most countries need to deviate from the reference, especially in Latin America and Middle East.

We have assumed that all countries reached their Kyoto target in 2010. As the USA has rejected the Kyoto Protocol, one could also assume that the USA will reach the target that it has voluntarily committed to: an improvement in intensity (emissions/GDP) of 18% from 2002 to 2012. At an annual GDP growth rate of 3%, this would translate to an emission increase of around 23 percent from 1990 to 2020. Figure 33 shows a multistage case, where only this assumption was changed. The USA would have to reduce emissions substantially less, if they

start in 2010 from their national target. Resulting global emissions in 2020 would be 3% higher. A further assumption could be made that the economies in transition start in 2010 not from their Kyoto target but from their reference scenario, which is usually lower. In such a case these countries would have to reduce emissions substantially more (Figure 33).

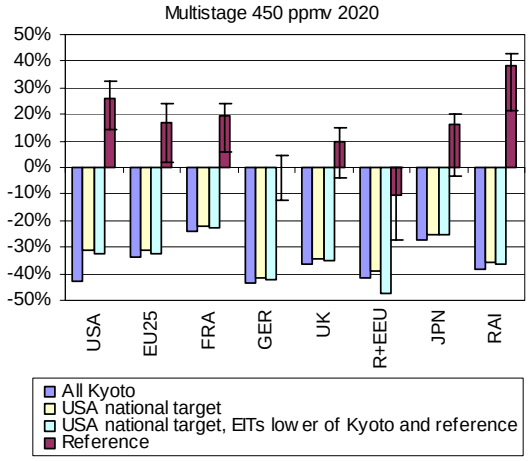

Figure 33. Sensitivity of the results for the multistage approach (for the A1B scenario) altering the assumption on the emission path until 2010

10.2.3 400 ppmv CO_2

Figure 34 provides the change in emissions from 1990 to 2020 and 2050 aiming at 400 ppmv CO_2 concentration. In all cases, global emissions in 2020 are 10% above 1990 levels, in 2050 -60% below 1990 levels. The error bars show the spread using different reference scenarios.

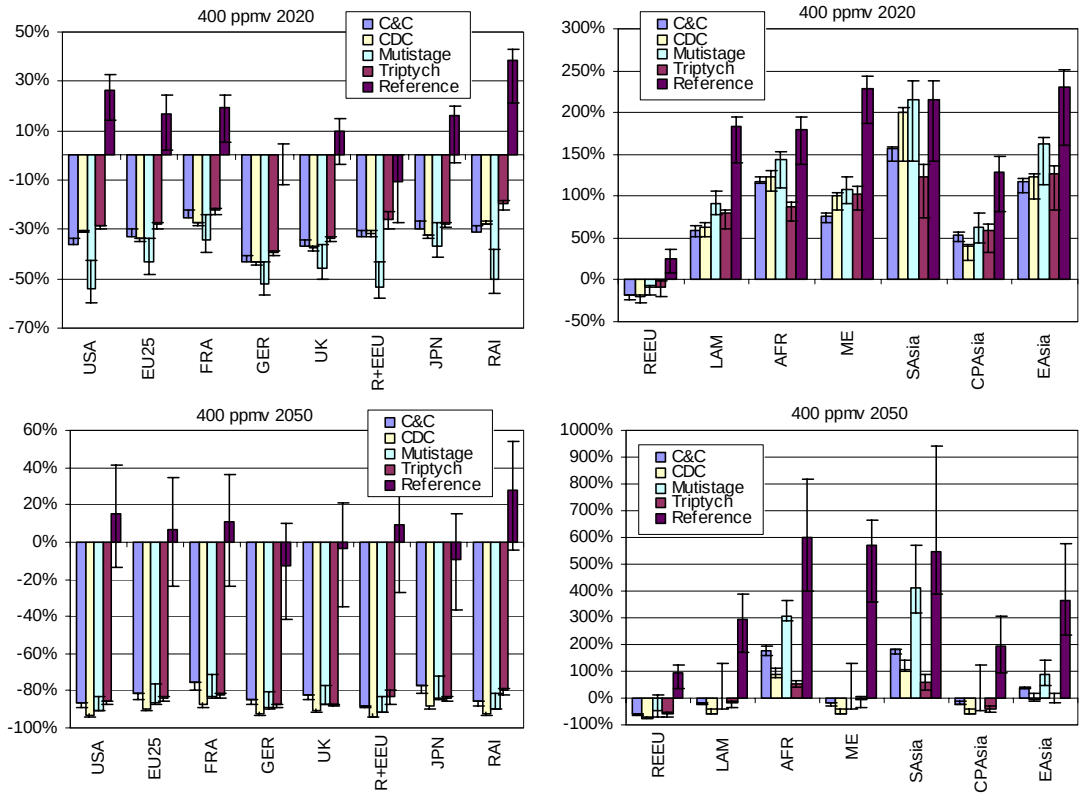

Figure 34. Change in emissions from 1990 to 2020 and 2050 under various approaches aiming at 400 ppmv CO_2 concentration. Error bars show the spread using different reference scenarios

One can observe that even more reductions are required for all countries compared to the 450 case. Annex I countries need to reduce emissions below 1990 levels in the order of -25% to -50% in 2020 and -80 to -90% in 2050.

Now only very few countries do not participate in 2020 and no country receives more allowances than required under the reference scenarios with Contraction and Convergence. Many Non-Annex I countries (especially in Latin America, Middle East, East Asia) would need to substantially deviate from their reference scenarios under these approaches already in 2020.

10.2.4 Individual country long-term targets

Several European countries have announced medium and long-term targets to reduce emissions.

UK announced to aim at a -60% reduction by 2050[20]. According to this analysis, this target would be aiming at a stabilization at 550 ppmv CO_2. It would not be ambitious enough for 450 ppmv CO_2 (Figure 31 and Figure 32).

Germany has announced to reduce emissions by -40% by 2020, if EU is agreeing to reduce by -30%[21]. According to this analysis, a 40% reduction for Germany would be aiming towards 450 ppmv CO_2 target or even below, if further reductions follow afterwards (Figure 32 and Figure 34).

[20] Royal Commission on Environmental Pollution (RCEP) recommendation adopted by Prime Minister Tony Blair 2003
[21] Coalition contract between the Social Democrat Party and the Green Party 2002.

France is willing to reduce emission by a factor 4 (-75%) by 2050[22]. According to this analysis, this would be aiming at a 450 ppmv CO_2 target (Figure 32).

10.3 MITIGATION COSTS

This sub-chapter we briefly describe the current understanding of mitigation costs to meet long-term stabilization goals based on a literature analysis.

The IPCC TAR points out that level of stabilization and the timing of emission reductions is expected to significantly influence the marginal and absolute costs of mitigation. Many studies of the cost of mitigation exist (for surveys see Weyant and Hill 1999; Hourcade et al. 2001). Often these studies focus on nearer-term rather than longer-term mitigation strategies. OECD (1999) found that the method of allocation of emission allowances influenced aggregate costs less than the level and the timing of meeting the concentration target and whether emission trading was available as a means to "reallocate" the costs of required abatement. Hourcade et al. (2001) concluded that costs[23] of mitigation jump dramatically for scenarios that stabilise at 450 ppmv CO_2 compared to 550 ppmv due in large part to the required early timing of abatement, however, this study also came to the conclusion that costs depend significantly on the assumed baseline and on the level of stabilization.

An alternative view on global costs is provided by Roehrl & Riahi (2000). This study only looks at the total investment costs of the energy system, not at other costs within the economy. For the scenarios of similar demographic and economic development, they consider a wide range of possible emissions within the IPCC SRES framework. On the extremes, the A1T scenario would lead to 550 ppmv CO_2 in 2100 and the A1C scenario to 950 ppmv. Roehrl & Riahi calculate the cumulative discounted investment costs for the energy system, including the investment costs, fixed and variable maintenance cost, excluding investments in research and development. The analysis does not include costs through welfare losses as usually included in economic models. For the A1T scenario leading to 550 ppmv, cumulative investment costs are only half of those of the A1C scenario leading to 950 ppmv. They conclude that looking at the total energy system, efficient use of energy pays off in low energy fuel costs in the long run.

Azar and Schneider (2002) also suggest that mitigation costs need to be compared to expected growth rather than being presented simply as discounted, present value sums for the period to 2100. As the economy is expected to grow substantially to 2100, they note that estimated mitigation costs are relatively small when compared to the increase in welfare in this period. For example, the IPCC (2001c) reports on studies showing mitigation costs of up to 4% in GDP (upper bound) in 2050 for stabilization at 450 ppm, while these studies also assume GDP growth rate of 2-3% per year. According to Azar and Schneider (2002), even the "worst case" loss of 4% would be overtaken in less than two year, slightly delaying (rather than suppressing) impressive economic growth in this century.

The numerical estimates from modelling studies remain uncertain. They are therefore not of as much interest as the underlying relationships between various drivers and assumptions and future emissions. A robust result appears to be that any decision to achieve low stabilization levels will require significant emission reductions in the near-term and this carries potentially high economic stakes in absolute and marginal terms (OECD 2001a, 2001b, OECD, 1999 and IPCC 2001c). However, the estimates of the cost appear to have decreased over the recent years (e.g. Criqui et al. 2003). The trade-offs between avoided costs of mitigation and avoided impacts or damages are not well understood (Wigley et al. 1996; Pearce 2003). A delay in global mitigation efforts because of mitigation costs could preclude the achievement of stricter long-term climate targets. Mitigation requirements of stabilizing at 400 or 450 ppmv, however, show, that delaying is not an option when aiming a 2°C temperature target.

[22] Government adopted "Plan Climat 2004"
[23] Presented as present value discounted at 5% per year for the period 1990–2100.

10.4 CONCLUSIONS

From the analysis we draw the following conclusions:

- To ensure that the EU target of a maximum increase of 2°C above pre-industrial levels is kept within reach, stabilization of CO_2 concentration below 450 ppmv has to be aimed for (according to current knowledge and medium climate sensitivity).
- If no efforts are made to reduce emissions and if the Kyoto Protocol is not implemented, there is a significant probability that the option of 450 ppmv CO_2 would be out of reach already as of 2020.
- To keep 450 ppmv CO_2 within reach, developed country emissions would need to be reduced substantially. For the exemplary global emission levels leading to stabilization and for the parameters of the approach chosen here, Annex I countries would need to reduce emissions in the order of -20% below 1990 levels in 2020 to aim at 450 ppmv CO_2. For 550 ppmv CO_2 it would be roughly -15%, and for 400 ppmv CO_2 roughly -35%. These values are significantly influenced by the ambition level set for Non-Annex I countries. Almost all approaches leave room to alter this balance by varying some of the parameters.
- To keep 450 ppmv CO_2 within reach, the USA needs to be involved in the system most likely with stronger action than the national target of 18% intensity improvement. As this target can lead to US emissions 20% above 1990 levels in 2010, the ambitious reduction levels given above for the group of Annex I may be out of reach. For 550 ppmv, the US national target may be sufficient, if other Annex I countries would undertake more ambitious reductions.
- To keep 450 ppmv CO_2 within reach, developing country emissions need to deviate from the reference as soon as possible, for some countries even as of 2020 (Latin America, Middle East, East Asia). For 550 ppmv CO_2 it would be less, for 400 ppmv CO_2 more countries. Actions from Annex I countries, such as technology transfer or financial contributions would be needed to keep emissions in Non-Annex I countries below their reference.
- For most countries, the difference in reductions between stabilization targets (400, 450 and 550 ppmv) is larger than the difference between the various approaches aiming at one stabilization target. The choice of the long-term ambition is more significant than the choice of the approach.
- National long-term emission targets of individual countries of the EU are ambitious, but differ in which stabilization levels could be reached.

The reductions that are necessary to reach are summarized in Table 34.

Table 34. Difference between emissions in 1990 and emission allowances in 2020/2050 for various CO_2 concentration levels

		2020	2050
400 ppmv CO_2	**Global***	+10%	-60%
	Annex I	-25% to -50%	-80% to -90%
	Non-Annex I	Substantial deviation from reference in Latin America, Middle East, East Asia and Centrally planned Asia	Substantial deviation from reference in all regions
450 ppmv CO_2	**Global***	+30%	-25%
	Annex I	-10% to -30%	-70% to –90%
	Non-Annex I	Deviation from reference in Latin America, Middle East, East Asia and Centrally Planned Asia	Substantial deviation from reference in all regions
550 ppmv CO_2	**Global***	+50%	+45%
	Annex I	-5% to -25%	-40% to –80%
	Non-Annex I	Deviation from reference in Latin America and Middle East, East Asia	Deviation from reference in most regions, specially in Latin America and Middle East

*: Global reduction values are chosen to represent one possible path towards the given stabilization level. Other global emission levels in 2020 and 2050 would be possible to reach the same stabilization levels and their choice would influence the necessary reductions for the country groups.

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11. NEGOTIATION STRATEGY

11.1 INTRODUCTION

With the long awaited entry into force of the Kyoto Protocol on 16 February 2005 there is hope that the deadlock in international climate negotiations can be overcome. Still, the USA, as the largest emitter, has rejected emission reductions and developing countries will not act before industrialized countries (including the USA) have demonstrated substantial action.

This chapter provides information on various aspects of a strategy to negotiating a future climate regime to come into effect after 2012. This strategy is written from the viewpoint of the European Union. The national government of any Member State, including Germany, can in principle work towards the proposed EU strategy in future negotiations.

While this section looks at the EU and its possible actions in general, intra-EU Member States discussions are not covered. It must be noted that as of 1 May 2004 the enlarged EU with 25 Member States has different characteristics than the former EU with only 15 Member States. The accession of new Member States will add interests and complexity and thus agreeing on a joint EU position on future climate change might become more difficult than within EU15 at the time a position was formulated regarding the Kyoto Protocol. A possible tension is that the new members are not included in Annex II of the UNFCCC and therefore have other financial commitments than the original members.

For this strategy, we assume that the 2°C target agreed by the European Council in 1996 should be kept within reach. It roughly corresponds to stabilization of CO_2 concentrations below 450 ppmv (see also Chapter 10.1). This means that

- Developed country emission reductions would need to be in the range of roughly 20% below 1990 levels in 2020
- The USA needs to be involved in the system, most likely with stronger action than the national target to improve the emissions per GDP by 18% from 2002 to 2012
- Developing country emissions need to deviate from the reference as soon as possible, for some countries even before 2020.

The negotiation strategy should avoid situations that may jeopardise negotiation efforts and further enhance the blockage in the negotiations. For instance, the EU needs to avoid that it is seen as pushing developing countries into commitments, as it unintentionally was the case at COP8 in New Delhi. At that meeting, the EU called for a “dialogue to kick off a process for future action” stating explicitly that such dialogue would not be about developing country commitments. Still, some developing countries interpreted this (intentionally or inadvertently) as a call for developing country commitments and rejected inclusion of any reference to future actions in the political declaration of that conference. This incident had negative impact on the relationship between the EU and developing countries.

In addition, it should be avoided that the EU is being seen to break promises. The joint political declaration was made in June 2001 by the EU together with Canada, Iceland, New Zealand, Norway and Switzerland, to collectively contribute €450 Million/US$ 410 Million annually by 2005 has to be implemented in a transparent way in order to be credible.

This chapter first discusses the framework architecture of the Kyoto Protocol as well as alternative frameworks and related timeframes (Section 11.2) followed by a discussion of the various elements a strategy could include (Section 11.3). These elements include the need and potential for EU leadership in future climate change activities (Section 11.3.1), a number of recommendations, how issues discussed in Chapters 3.2 and 5 can be approached by the EU (11.3.2), suggestions how the EU could approach other Parties and intensify dialogue processes on a post-2012 climate regime (Section 11.3.3) and finally outlines important supporting activities to accompany the negotiations are suggested (Section 11.3.4). The

section closes with final conclusions and recommendations drawn from the discussion above (Section 11.4).

11.2 FRAMEWORK ARCHITECTURE

The framework of the UNFCCC and the Kyoto Protocol is the only fully multilateral effort underway to address climate change. No alternative framework exists to date. Nevertheless, the Kyoto Protocol is rejected by the USA and Australia and has not been ratified for a long time by Russia, prohibiting its entry-into-force. At the time of writing of this report, the ratification process in Russia has advanced and an entry into force is expected for 16 February 2005. As the Kyoto Protocol is rejected by the USA and Australia, it warrants considering how this framework can be strengthened. However, in case the Kyoto Protocol is still rejected as a model for future international effort, alternative frameworks may have to be addressed as well.

For both, the pre-2012 period (Section 11.2.1) and the post-2012 period (Section 11.2.2) the UNFCCC/KP framework as well as alternative frameworks are discussed. In Section 11.2.3, links of the UNFCCC / Kyoto Protocol framework with other possible treaties are discussed.

11.2.1 Action until 2012

The future of the Kyoto Protocol has long been uncertain due to the rejection by the USA and the hesitation of Russia to ratify it. At the time of writing of this report (November 2004) Russia had finally completed its ratification process and the Kyoto Protocol will enter into force on 16 February 2005. The first Meeting of the Parties of the Kyoto Protocol (COP/MOP) will be held in conjunction with the first UNFCCC COP after the entry into force of the Kyoto Protocol, which would be November 2005. Although it is now certain that the Kyoto Protocol will enter into force, it is still rejected by the USA.

While starting to implement the Kyoto Protocol, a gradual expansion of the EU Emission Trading System (ETS) would further strengthen this framework. Currently, discussions with non-EU countries about joining are already ongoing, e.g. with Canada and Japan. The EU, as the party with the strongest negotiating position, could require from applying countries to adhere to their respective Kyoto targets as a condition to joining the EU ETS. This would lead to a slowly expanding carbon market. A well-functioning market would lower the reluctance to climate commitments, especially when carbon prices are relatively low. In addition, it will also lead to pressure from companies outside the EU ETS on their national governments, as they want to be able to profit from the opportunities in this market. In this context it might also be interesting to assess the possibilities of certain progressive US States to join the EU ETS.

11.2.2 Negotiations on post-2012 action

The framework of the UNFCCC and the Kyoto Protocol would be the natural home of future climate negotiations. Once the Kyoto Protocol enters into force, it will become binding for all countries that ratified it and future negotiations would be held under the same umbrella. The Meeting of the Parties to the Kyoto Protocol would include only those countries that are committed to the Protocol.

In the past, an official start of the negotiations on next steps after 2012 was prevented by the fact that the Protocol has not yet entered into force. Without a clear signal that developed countries are taking the lead, developing countries are not willing to enter any discussion on future steps, which evidently might result in additional commitments for them. Consequently, the agenda item on the revision of the Convention ("second review of adequacy" Article 4.2 (d) of the Convention) was initiated in 1998, as required by the Convention, but deferred without decision for six years in a row. Only unofficial discussions and dialogues on future actions are now going on.

The Kyoto Protocol also demands a review of commitments in two Articles. According to Article 3.9 on the quantified commitments for Annex I Parties, the review of commitments for

Annex I Parties included in Annex B shall be initiated in 2005. Article 9.2 of the Kyoto Protocol calls for a general review of the Protocol coordinated with the review of the Convention, starting at the second meeting of the Parties to the Protocol. This so-called COP/MOP-2 would take place in November 2006. The Kyoto Protocol does not include a requirement on when to finalise negotiations for a second commitment period.

Future negotiations could therefore be initiated under the Convention or under the Kyoto Protocol. A process under the Convention would involve the 189 countries that accepted it, including USA and Australia and oil producing countries. It would be inclusive and start from the principle that developed countries take the lead and that all countries have certain commitments according to their common but differentiated responsibilities and capabilities. A process under the Kyoto Protocol would involve only the countries that ratified the Protocol, for the time being, 128 countries including all major developing countries but excluding e.g. USA, Australia and major oil producing countries. It can be assumed that oil producing countries would ratify the Protocol once it is in force to be able to influence its further development. A process under the Protocol would therefore essentially only exclude the USA and Australia. A Kyoto Protocol process could also be seen as a pure extension of Annex I commitments under the Kyoto Protocol.

Official negotiations on a future climate regime under the UNFCCC/Kyoto Protocol would have to be initiated by agreeing on a mandate, similar to the Berlin Mandate agreed at COP1. The first opportunity for a new mandate would be COP10 in Buenos Aires, December 2004 (see also Figure 35). However, given the uncertainty surrounding the entry-into-force of the Kyoto Protocol, this is a very unlikely outcome of COP10. The next, more realistic, opportunity would be COP11 in November 2005.

If a continuation under the UNFCCC and the Kyoto Protocol is negotiated, negotiations should best be finalized by end of 2007 (see Figure 35) as to have agreed on targets for the second commitment period prior to the start of the first commitment period. The earlier future targets are defined the better since the implementation of mitigation measures requires time before emission reductions are realised. In addition, an early agreement creates a more certain political future for companies, stimulating decisions on emission reduction investments.

If, however, additional time is needed, negotiations may be finalised during the first commitment period. But the later the targets are agreed, the more difficult it might become to achieve them. Uncertainty about the future would provide wrong signals to industry.

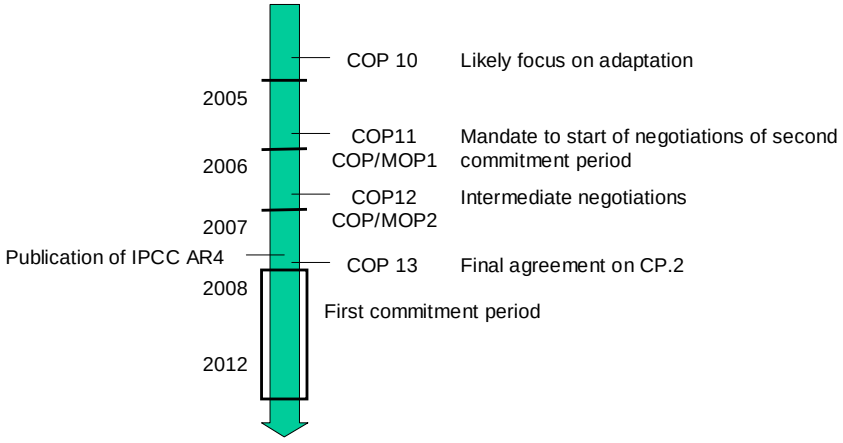

Figure 35. Possible timeline for negotiations on a second commitment period of the Kyoto Protocol

If the EU and other parties would aim for finalising negotiations prior to the start of the first commitment period, the resulting time schedule is very ambitious. Future commitments would have to be finalized in three years from now, including only two years of official negotiation time.

To accelerate the process, a mandate at COP 11 could already include some guiding decisions, such as Annex I countries would receive binding commitments and a substantial part of the Non-Annex I would receive concrete but non-quantified targets.

The assessment reports of the Intergovernmental Panel on Climate Change (IPCC) have the potential to serve as a constructive push for the negotiations. In the scenario depicted in Figure 35, the fourth assessment report of the IPCC will unfortunately be published relatively late (planned for the end of 2007) to have a substantial impact on the negotiations. If negotiations are extended, the new scientific insights could influence the negotiations.

A sequence of decisions could be envisaged:

- First, the long-term ambition level is defined. The choice of the stabilization level (e.g. 400, 450 or 550 ppmvCO_2) significantly influences the required reductions and the entry of countries into the regime (see Chapter 10). Defining a (preliminary) ambition level at an early stage would be very useful for the further design of the system. It may be difficult to reach an agreement on a long-term temperature or concentration level due to uncertainties and the long time horizon. But already the desired global emission level by e.g. 2020 and the direction thereafter would be a useful indication.
- Next, the types of commitments could be agreed (e.g. binding emission targets or policies and measures), including an indication when they should be assumed and by whom.
- Once the types are defined, the accounting or monitoring rules have to be defined unambiguously. For the first commitment period of the Kyoto Protocol, reduction percentages were agreed without a clear agreement how to account for land use change and forestry (LUCF). The then following negotiations on the accounting rules for LUCF were therefore very cumbersome. In addition, it needs to be defined whether and if so how emissions from international transportation and other greenhouse gas agents should be included.
- Finally the target values (reduction percentages or specific policies) have to be agreed.

An alternative framework to that of the UNFCCC and the Kyoto Protocol would be the decomposition into several treaties on a bilateral or sub-global multilateral basis (see also Sugiyama and Sinton, 2003 or Berk & den Elzen, 2004). Such a system may be easier to implement, as like-minded countries would join efforts on clearly defined issues of their concern. It could include a scenario, where the Kyoto Protocol is in force, not supported by the federal government of the USA, but with several US states being linked through the emission trading system.

As an example, the USA is starting a “methane to markets” initiative, gathering several interested countries to jointly make efforts to reduce CH_4 emissions from landfills, underground coalmines, and natural gas and oil systems. [24]

As climate change is a global problem, such a decomposed system may not be able to ensure the stringency necessary on the global level to keep the 2°C target within reach.

Even if the Kyoto Protocol enters into force, the participation of the USA would be crucial for the overall success of the global emission reduction effort. One alternative could be to organize consultations of the major emitters, e.g. only the USA, China and the EU.

Such an approach would be attractive to the participating countries. China could represent the concerns of the developing nations, USA would be given a prominent role as the leading economic power and the EU could act as an intermediary.

Such an approach would have to have the acceptance of all other countries that are not directly involved. Consequently, any results of such a process should be brought back to the global forum of the UNFCCC. But any proposal that has the backing of China, the USA and

[24] See http://www.methanetomarkets.org/ or http://www.epa.gov/methane/international.html

the EU has a high chance of being acceptable on a global level. This process would therefore be a supplement to the global process.

The advantage of a limited group would be that finding an agreement between three parties may be easier than between 189, but with a view to broader agreement to the outcome afterwards they will have to tackle a wide range of issues important to others. Although only three countries participate, they represent a large share of the global variation in national circumstances. On the other hand it is not guaranteed that these three parties would be able to reach a common position at all, due to the very divergent views and interests of these countries.

11.2.3 Links to international activities in other fora

In addition to the climate negotiations, activities in other international fora are relevant for international action on climate change. This chapter covers other frameworks such as renewable energy, sustainable development and trade.

Activities on renewable energy could be very important for the negotiations on climate change. While renewable energy started to become important on the political agenda during the oil crisis in the mid 70s, it took almost three decades until renewable energy targets were discussed globally for the first time (IISD 2004). In 2002, renewable energy targets were raised at the WSSD (World Summit on Sustainable development) in Johannesburg, where it was considered as an important means to address different goals such as contributing to securing energy access in particular in developing countries, contributing to sustainable development and poverty alleviation and eventually addressing the climate challenge (see also section 11.3.4 on side benefits).

One of the major outcomes of the WSSD was the adoption of the Johannesburg Plan of Implementation, which addresses renewable energy in several chapters. Regarding sustainable development and production patterns, governments agreed to increase the global share of renewable energy sources substantially and emphasised the role and importance of national and voluntary targets and initiatives.

During the final WSSD Plenary, Denmark, on behalf of the EU, announced the formation of a like-minded group of countries on renewable energy, now known as the Johannesburg Renewable Energy Coalition (JREC). The EU, with the Alliance of Small Island States, Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Iceland, Latvia, Lithuania, Malta, New Zealand, Norway, Poland, Romania, Slovakia, Slovenia, Switzerland and Turkey, issued a statement entitled "The Way Forward on Renewable Energy." The statement indicates participating countries have adopted, or will adopt, targets for the increased implementation of renewable energy, and will encourage others to do likewise. The first international JREC conference was held in June 2003, and focused on the regional status and potential for renewable energy use. By June 2004, JREC had 87 members and was being serviced by a Secretariat hosted by the European Commission (EC).

To advance on the renewable energy commitments and report on actions taken to foster renewables following the WSSD, the German government invited the international community in June 2004 to the international conference on renewable energy *'renewables 2004'.*

During preparation of the *renewables 2004,* the European Conference for Renewable Energy - Intelligent Policy Options, was held in January 2004, in Berlin, Germany. The meeting adopted the "Berlin Conclusions" urging, *inter alia*, EU institutions to start a political process of setting ambitious, time-bound targets for increasing the share of renewable energy in final energy consumption for the medium (2020) and long term. The Berlin Conclusions note that a 20% renewable energy target for gross inland energy consumption is achievable in the EU by 2020.

The *renewables 2004* conference itself resulted in a political declaration where “Ministers and governments of the participating countries commit to work towards these objectives, individually or jointly, by undertaking actions they have submitted for inclusion in the ‘International Action Programme’ and through other voluntary measures. They agree that

these measurable steps should be reported to the UN Commission on Sustainable Development (CSD) and that progress should be reviewed as foreseen in the Johannesburg Plan of Implementation. An appropriate arrangement for follow-up should be identified in a further meeting in preparation for CSD 14/15."

In addition, an International Action Programme (IAP) was presented. It includes concrete actions and commitments towards developing renewable energies, which were put forward by a large number of governments, international organisations and stakeholders from civil society, the private sector and other stakeholder groups. All conference participants were invited to contribute to the IAP with voluntary commitments to goals, targets and actions within their own spheres of responsibility.

International discussions on renewable energy are an important complementary element, but they are not to be seen as alternative to international efforts to address climate change. The climate agenda is so broad that it has proven useful to consider the specific issue of renewable energy separate and only with the countries really interested in the issue. Possibly other such complementary efforts can be supported.

Activities on Sustainable development: The Millennium Summit held in September 2000 concluded with the Millennium Declaration incorporating the Millennium Development Goals. These goals commit the international community to an expanded vision of development that vigorously promotes human development as the key to sustaining social and economic progress in all countries, and recognizes the importance of creating a global partnership for development. The goals have been commonly accepted as a framework for measuring development progress. In total eight goals and eighteen targets were defined.

Goal seven "Ensuring Environmental Sustainability" addresses among other indicators, energy use and carbon dioxide emissions (per capita) and consumption of ozone depleting substances. These indicators relate to target nine "Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources".

The Commission on Sustainable Development (CSD) emerged from Agenda 21 in June 1992 as a programme to be adopted by the United Nations Conference on Environment and Development (UNCED). The CSD was created to ensure effective follow-up of UNCED, enhance international cooperation, and examine progress in the implementation of Agenda 21 at the local, national, regional and international levels. In 1997, at Rio+5, the implementation of Agenda 21 was reviewed and a five-year CSD work programme defined, which identified sectoral, cross-sectoral and economic sector/Major Group themes for the subsequent four sessions of the CSD.

CSD 12, held in April 2004, was - since the WSSD - the first session that took a critical and comprehensive look on how the world is implementing sustainable development. The idea was put forward at that meeting that the CSD should be challenged to become the "watchdog" of progress aimed at implementing the Johannesburg goals and targets.

Another key element that emerged during the session was the clear link between the Millennium Development Goals (MDGs) and the Johannesburg Plan of Implementation (JPOI). While this relationship had its detractors in Johannesburg, two years later the rationale behind linking the two sets of international targets and goals has found a new home, with many delegates calling on the CSD to become an effective mechanism for monitoring progress. CSD-12 reaffirmed the WSSD's agreement of placing the issue of poverty eradication at the center of the sustainable development agenda (IISD coverage CSD-12, 2004)

These international efforts on sustainable development are an important supplement to the climate negotiations. Development plays a crucial role in developing countries in mitigation (keeping GHG emissions low) as well as adaptation (strengthening adaptive capacity being able to cope with the occurring or expected changes).

Trade

The EU and its Member States generally do not have a strong history of linking different political issues to obtain a better negotiating result. Such linking might, however, provide an incentive for certain countries to take a more progressive stance in the climate negotiations. A recent example of such a linking is the negotiations with Russia on its WTO membership, which played a role in Russia's ratification process of the Kyoto Protocol.

The US has more substantial experience in this area. In the field of trade relations, the US can award the most-favoured-nation (MFN) trading status to countries. In many cases[25], this status is awarded permanently, but for certain countries such as China this status is reviewed on an annual basis (World Council on International Trade, 2004).

It should be noted that the preferred trade partner status does not necessarily apply to all goods of a certain country. It can also be valid for certain goods or products, e.g. if there is a shortage of a certain product in the importing country. Advantages that may be awarded to preferred trade partners are e.g. (International Trade Data system, 2004):

- The right to be paid before other creditors of the same debtor
- The use of lower duty rates on goods imported from some countries
- Admissibility of goods in quantities over and above those normally permitted

In the context of certain disputes, e.g. on human rights, the preferred trade partner status can be changed. The threat of removing this status can be an instrument in achieving certain negotiation objectives. An example where this may have played a role is the debate on the removal of China's MFN status after the spy plane incident in April 2001 (Americans and the world, 2004).

In the context of the climate negotiations it might be worthwhile for the EU to review its trade/foreign relations and current and/or potential future preferred partner provisions. An analytical step that might be useful in this perspective is to prepare a matrix in which for major parties in the climate negotiations (in terms of negotiation bottlenecks) the major trade/foreign relation partners in the EU and its Member States are identified. These can than be matched against existing preferred partner provisions to identify areas in which these relations can be used to further the negotiations.

One important bottleneck in this approach may be the strength of the position of the minister responsible for climate issues in relation to the other ministers. It depends whether the responsible minister has sufficient influence to make e.g. trade and foreign relations subject to this link. This will also be influenced by the relative importance the public attaches to the climate issue compared to other issues on the political agenda.

Other possibilities of linking, that may not have this drawback, can be the provision of financial or other support in certain areas as an award, e.g. related to capacity building in certain areas, technology transfer, etc.

Furthermore, tax adjustments at the border for energy intensive goods could be applied. The rationale would be that industries in a country with high energy taxes have a competitive disadvantage when selling their goods on the international market. Biermann and Brohm (2003) analysed whether certain border adjustments for energy taxes would be permissible under world trade law, in particular the General Agreement on Tariffs and Trade and the Agreement on Subsidies and Countervailing Measures. They conclude "that despite remaining ambiguity in both the legal provisions and the pertinent case law, border tax adjustments are under certain circumstances compatible with world trade law. Yet given persisting degrees of legal uncertainty, it seems likely that such energy tax adjustments at the border would be challenged by affected members of the World Trade Organisation before its dispute settlement mechanism."

[25] In total the MFN status is awarded to about 170 countries.

11.3 ELEMENTS OF A STRATEGY

11.3.1 EU leadership

Any environmental treaty needs a driving force to stimulate its implementation, which can be a single country or a country group. With regard to climate change, the EU is the Annex I Party that is politically most committed to act against climate change and thus would represent the only entity capable to act as a global leader today to further encourage and push international efforts (Gupta & Grubb, 1999, Obertür & Ott 1999, Ott et al. 2004). If the EU takes the 2°C target seriously, it needs to show leadership.

The report of the South-North Dialog on Equity in the Greenhouse (Ott et al. 2004) mentions three different aspects of leadership:

- *Structural leadership*, referring to making use of general political and economic weight
- *Instrumental leadership*, referring to building coalitions and alliances
- *Directional leadership*, referring to demonstrating solutions to others

Concrete implementation actions *(directional leadership)* provide positive signals to other Parties to follow since Parties will acknowledge that the leader is taking the issue seriously (see also Sections 11.3.2 and 11.3.4).

The EU for instance demonstrates such aspect of leadership already today by implementing measures to combat climate change through the implementation of the EU wide emissions trading system as of 1 January 2005, three years prior to the start of the first commitment period of the Kyoto Protocol. Additional climate change measures are implemented such as the renewable energy directive and the energy efficiency directive. Individual Member States pursue strategies at different levels, such as renewable energy support programmes that stimulate market penetration of low to zero emission technologies. These measures are a first step, but not yet sufficient and need to be extended further to close the gaps for a few EU members between current emission trends and the Kyoto targets.

In addition, the EU could show leadership in climate change specifically at the *structural level*. Here, this would mean to continue to commit to the Kyoto Protocol. It is important that the Parties that ratified the Protocol emphasize adherence to the emission reduction targets agreed under the Kyoto Protocol. The EU has officially stated that it would adhere to the Kyoto targets even if the Kyoto Protocol should not come into force and thus has set another signal to other Parties taking the climate change issue seriously. Thus, the EU acts as a driving force for other Parties stimulating comparable statements. However, there are some individual Member States that attempt to weaken this resolve.

In addition, The EU could put in its weight linking climate change to other processes, including the preferred trading status discussed in Section 11.2.3. The support of the EU to the membership of Russia in the WTO would be an example.

Finally, leadership can be demonstrated by playing an active role in bringing countries together through informal discussions and dialog processes prior to negotiations thus representing *instrumental leadership* (see also chapter 11.3.3, 11.3.4). The EU and its member states are funding the informal process to foster information exchange (such as this project, FIACC), but it has not implemented official initiatives to bring countries together under the issue of climate change – apart from its initiative to collaborate with the G77 by forming the ‘Green Group’ in Berlin in 1995. The EU could seek to strengthen its leadership position in this regard, as it has done for the coalition on renewable energy (JREC).

Advantages of the EU taking leadership are manifold: a) the EU would strengthen its international recognition as a motor to combat climate change, b) the EU would enhance trust among Parties to further talk, negotiate and undertake joint efforts no matter what the potential obstacles might be and c) the EU would become preferred partner for developing countries, partly with strongly growing economies and large domestic markets.

Being the first to act could also provide a ''competitive advantage'' (Höhne 2003). It seems certain that measures to curb greenhouse gas emissions will have to be taken in the long term, there is only a serious debate about when and which measures should be taken. New technologies will play an important role. Industry within the EU could protest against the EU taking the lead in reducing emissions, arguing it would distort the international competitiveness. But reducing energy costs and increasing productivity is always an advantage. In addition, early developed and adopted new technology can later be sold on the world market. And finally, policies could be designed in a way that does not lead to substantial cost increases for those energy-intensive industries that are internationally competing. And the best performing industries would have new economic opportunities for selling excess emission allowances. This advantage could be further enhanced by further technology R&D funding by the EU, but also implementation support to bring existing technologies to markets.

Consequently, a major part of any successful negotiating strategy should be the leadership by the EU.

11.3.2 Contents

The strategy would entail to consider in particular the critical issues with Parties that have opposite viewpoints.[26] Building on the analysis provided in Chapter 3.2, Figure 1, we identify the following critical issues.

Urgency to act (environmental effectiveness vs. economic efficiency): There is a different perception of 'urgency' between the USA and EU politicians and scientists. The US has the viewpoint that immediate emission reductions are not necessary and that it is sufficient to foster technology development so that emissions can decrease in the future. The EU rather believes that urgent action is necessary, as otherwise ambitious long-term targets (such as a maximum 2°C temperature increase) may be out of reach within a few decades.

This fundamental difference cannot only be observed in the negotiations but also in the scientific literature comparing US authors and European researchers, e.g. on the timing of action: Wigley et al. (1996; WRE profiles) argued that postponing abatement action is always a more cost-effective strategy, mainly because reduction options will become cheaper in the future. On the other hand, mostly Europeans (e.g. Azar, 1998; Van Vuuren and De Vries, 2001) argued that early abatement can significantly accelerate technology development and therefore reduce costs. The difference is also apparent on the future design of an international climate regime (compare e.g. Aldy et al. 2003 and Criqui et al. 2004).

The EU should seek an active dialogue with the USA on their views on what level of emissions is necessary to prevent dangerous interference with the climate system in the short term. As the economic argument has high value in the USA, economists of both sides could be brought together to openly discuss the economics of acting early versus acting late (see also section 11.3.4 on side benefits).

Developing country involvement: There is a major conflict, mainly between advanced developing countries and the USA, on whether and how advanced developing countries should be included in the mitigation efforts. Developing countries are only willing to act *after* the USA has acted, the USA will only act *together with* the developing countries.

On this controversial point, the EU could enable the dialogue between the USA and the advanced developing countries, as this issue can ultimately be solved only between the USA and the advanced developing countries. The EU could promote approaches that facilitate the participation of developing countries, such as a multistage setting with first targets for developing countries that avoid capping economic growth or the Triptych approach.

In addition, one could aim to combine the actions already occurring in developing countries with the concept of "meaningful participation" of developing countries requested by the USA. Advanced developing countries have a clear desire to develop in an efficient way and already

[26] On the importance of focal issues see also Hasenclever et al. (2000)

implement actions towards low emissions. But by no means they want to be bound by international obligations. Possibly, least developed countries (with the aim to have USA included in the reduction effort to reduce the impacts of climate change) could convince advanced developing countries to adopt some kind of targets for the already occurring activities that could move the USA to also adopt measures. These targets would also have to include a little extra effort and would have to be quantified but on a voluntary basis.

Adaptation: A still unresolved and difficult topic in the international climate negotiations is that of adaptation (see also Chapter 6). Here, the dialogue between the Annex I countries and the developing countries has to be intensified.

It has to be clarified whether "adaptation" is used to refer to *damage repair* (as is the case with insurance) or to *damage prevention* (increasing adaptive capacity). As a first step a clear definition of adaptation should be agreed upon, or at least constituencies should always make clear, which kind of adaptation they refer to.

Many of the issues considered under adaptation are beyond the coverage of the UNFCCC regime. Promising options for further action on adaptation are the inclusion of adaptation considerations into development and disaster relief (mainstreaming). But effective implementation of these options would occur outside of the UNFCCC regime. As a consequence, a separate adaptation protocol under the UNFCCC may not seem adequate. The issues are too broad to be covered only under the UNFCCC. In addition, it could distract attention from the urgent need to address mitigation.

On the other hand, the issue of damage repair and restoration is clearly a matter related to climate change and the UNFCCC. Within the UNFCCC regime, narrowly defined adaptation projects could be implemented through the available funds (GEF, least developed country fund and later the special climate change fund and the adaptation fund). Here, a clear commitment of developed countries could be voiced to support adaptation activities also outside of the UNFCCC.

In addition, the EU should work towards de-linking adverse effects of climate change and the effects of "response measures" (actions by Annex I Parties to reduce emissions and therefore, e.g., lowering the revenues from oil exports) on developing countries. This explicit link in Article 4.8 of the Convention prevented fast progress on adaptation.

Kyoto or not Kyoto: Another major conflict between the USA and the EU is the rejection or continuation of the Kyoto Protocol. The USA is rejecting it, although US negotiators have shaped it significantly. It is unclear, which elements of the Protocol are really unacceptable and which could be kept. One could assume that the nature of an absolute cap, the level of that absolute cap and the missing developing country "involvement" are the major obstacles for the USA as voiced several times. The flexibility over gases, sectors and national boundaries introduced through emission trading is likely to be supported by the USA. As emission trading works best with absolute caps, it could well be, that in the future the USA will also support absolute caps, see speech by Senator Byrd (2003). It would be useful to get a clearer view of which elements are acceptable and which not would be a step forward.

Technology: Another topic of particular interest to the USA and Japan is that of "technology". It seems clear that technology will have an important role to play in reducing greenhouse gas emissions, but it is unclear how "technology" can be incorporated within an international agreement on climate change. The current consideration of technology under the UNFCCC is related to technology *transfer* and less to technology *development*. Further dialogue has to be sought with the USA and also Japan on how technology development can be supported and integrated in an international agreement.

Certain areas of technological cooperation could also provide an incentive for Parties that either depend heavily on fossil fuels or whose GDP is strongly determined by the export of fossil fuels (e.g. OPEC countries). Relevant technologies could include CO_2 removal and storage.

11.3.3 Partners

In addition to the topics discussed above, the strategy also includes the dialogue with respective partners, the formation of coalitions and strategic considerations to split up existing coalitions that hinder progress on future commitments. This section discusses a few possibilities, building upon Chapter 4.

USA: The extension of the EU ETS to include other countries was discussed as a possible complementary measure to the UNFCCC/Kyoto Protocol (see Section 11.2.1). However, the EU ETS may also be used as an instrument to involve the USA. Several US states are becoming active in the area of (GHG) emissions trading and are planning to set up state systems. If the EU ETS would allow individual states to link their systems, this would increase the flexibility of the participating US companies to achieve their targets by having access to the larger EU market. Care must be taken, on the other hand, to not jeopardize the overall effectiveness of the EU ETS by lowering price levels due to generous US State allocations. It may also lead to a turn in the US position on economic risks of climate policies. In addition, it may lead to a call for harmonisation of legislation between US states to level the playing field between companies from different states. Similar harmonisation efforts have in the past led to the US-wide adoption of progressive legislation first adopted in e.g. California, at the request of companies active in several states.

The United Kingdom could play an important role in bridging the gap between the EU and the USA. UK Prime Minister Blair has announced that climate change would be a priority for his G8 presidency in 2005. It seems likely that the UK will start an initiative to join also the USA on climate change.

The USA is initiating various activities that are within their interests, such as the initiative on carbon sequestration technologies or the programme “methane to markets”. As multiple efforts are needed to reduce emissions, these activities could well be support by the EU, but they should not distract from a comprehensive international approach.

Dialogue with the individual groups within the G77: Non-Annex I countries with their diverse national circumstances, and therefore sometimes opposite interests, are joined in the ‘Group of 77 and China’ or ‘G77’. This group represents the interests of all developing countries, most of which have the common difficulty of having scarce resources available for the international negotiations. Within the G77, small island states (e.g. Marshall Islands, Tuvalu) fear loss of their territory due to sea level rise and have formed the Alliance of Small Island States, AOSIS. Oil producing countries (e.g. Saudi Arabia, Qatar) fear loss of their income and act accordingly. Rapid developing countries like China fear a constraint to development. The group of the least developed countries can receive special benefits under the Convention and more and more act as a group.

The EU could seek a dialogue with the separate groups of countries within the G77:

Strengthening least developed countries is important, since these countries have similar interest as the EU. They are favouring immediate global mitigation action. Being most threatened by the impacts of climate change, these countries could opt within the G77 for an opening of a discussion on next steps after 2012. But LDCs would have to be actively supported with capacity building measures to be able to effectively negotiate within the G77.

Concentrate on selected advanced developing countries: Engage in a direct dialogue with the major emitting and advanced developing countries to understand their concerns and opportunities. These countries could include Brazil, China, India, Mexico, South Africa and South Korea. Such direct dialogue could benefit from analytical work on the individual countries.

Oil exporting countries: Oil exporting countries are a very influential group within the G77. Their negotiators are often selected to represent the G77 as a whole. Due to their often

unconstructive behaviour in the negotiations, they are often excluded from the considerations. Any concept should also include a solution for those countries.[27]

Building coalitions with countries having renewable energy targets: The EU could strengthen coalitions with those developing countries that have formulated clear national or voluntary targets to increase the share of renewables. Several country governments have voluntarily committed to take on renewable energy targets and a compilation of those national commitments was provided at the Bonn renewables 2004. A list of national targets (not inclusive but indicative) is provided below to indicate the available range of commitments.

- Egypt committed to meeting 14% of the Egyptian electricity demand with Renewables in 2020 subject to appropriate financing schemes to render renewable energy project competitive
- Argentina wants to promote renewables with the aim of achieving 8% of power consumption from renewable energies in the country (JREC commitment)
- Philippines aims at doubling the generation capacity from renewable energy sources by 2013
- China announced formulating a renewable energy act (or law) and a national renewable energy development strategy. The expected result is an annual use of renewable energy up to a 17% share in China's projected energy consumption in 2020.

Those countries that are willing to move forward on the issue of renewable energy may also be good partners in the general climate change negotiations. The EU could seek partnerships with advanced DCs to promote mitigation measures, such as renewables targets or power sector modernisation.

11.3.4 Supporting activities

In addition to the activities described above, the EU could play an active role in bringing countries together on climate change. The following activities could be envisaged:

Capacity building is an important and critical issue needed to a) ensure future negotiations are perceived fair by all negotiating Parties (no Party should have the impression of being treated unfair due to lack of information and knowledge on future commitment schemes) and to b) future negotiations can be handled in a time and cost effective manner. It is important to note that today many developing countries do not have the personnel and financial resources to be well represented at the negotiations and often have to miss important sessions.

The EU has recognised the need for supporting developing countries by enhancing their capacity to become well-informed and confident negotiating counterparts. The EU Commission thus has initiated a new 3-year programme that will address building capacity in developing countries on future international action on climate change. The project is expected to start in January 2005.

Individual countries within the EU could supplement these efforts by supporting similar activities.

Encourage scientific dialogue: To bridge the divide in views on the urgency to act, the EU could engage scientists to discuss the question of urgency of the action, with negotiators as observers. This could even be of the form of organizing a global scientific conference on future climate policy. Such conference does not exist yet and would be a very useful addition to the scientific conference landscape.

Work on quantification of (monetary) benefits of climate policy: The costs of climate change policies have received much attention in the climate debate. The topic of ancillary

[27] For most oil exporting countries, oil exports are responsible for around half of the national GDP. For coal exporting countries, the revenues are usually only a few percent of GDP.

benefits associated with climate change mitigation has received much less attention. It should be noted that we refer here to side benefits of (net) emission reduction policies, not the avoided costs of adaptation to a changing climate. Such benefits may include aspects such as the reduction of other environmental concerns, e.g. acidification, eutrophication, local air pollution of fine particles. This will lead to reduced health damage and reduced damage to buildings and natural ecosystems and any productive functions of e.g. forests, agricultural lands and surface and ground water. There are many other side benefits, which may especially be relevant for developing countries.

- Increasing supply efficiency and the implementation of renewable energy will lead to an improved quality of life and increased productivity through an increased access to electricity, direct job creation from realisation and operation of projects, increased security of supply and a decreased dependency on imported fuels, thereby improving political stability as well as the national trade balance. In addition, improving energy efficiency on the demand-side will reduce energy cost, increase productivity and decrease or delay the need for new power plants. For rural electrification projects these benefits are more localised and therefore stronger. Because often no viable alternatives for electrification exist, more expansive technologies (e.g. PV) can be used. Additional benefits are improved health because of improved indoor air quality (decreased use of e.g. kerosene lamps), less costly transport of diesel to remote areas and reduced migration to urban areas.
- Policies aiming to reduce transport emissions can positively influence the mobility of poor people e.g. through increased access to public transport, reduce traffic jams and traffic accidents, and as mentioned before improve air quality and decrease dependency on imported oil.
- Sustainable forestry activities lead to the recovery of degraded soils and watershed restoration, permanent job creation, the introduction of sustainable production systems and a better quality of life;
- Waste management projects may lead to energy generation from waste (landfill gas, manure management, etc), decreased photochemical smog formation from NMVOC, improved leach ate control (i.e. better protection for ground and surface water), reduced risks of fires and explosions, reduced odour problems and better control of pathogens, all leading to improved health of the local population

Considering these benefits can decrease the reluctance to climate mitigation policies. However, this would require a systematic approach to quantifying (and possibly monetarising) these effects in a way that is transparent and acceptable to many countries. A first step in this direction has been made in e.g. Criqui et al. 2004.

Communication strategy: To help the strategy to become a success and to avoid any misunderstandings, the EU should explicitly address how it will communicate to other industrialised countries, developing countries and to the public.

Especially public communication can be enhanced. Climate change “sceptics” receive large attention in the media, while the mainstream scientific opinion of e.g. the IPCC is less heard. An awareness campaign in the EU could raise local support.

11.4 CONCLUSIONS

To meet the EU’s long-term goal that “global average temperatures should not exceed 2 degrees Celsius above pre-industrial levels”, serious efforts are required on multiple levels. Negotiations within the UNFCCC have to be supplemented by agreements on renewable energy, technology in general and development cooperation. In addition, capacity building for developing countries and support for the scientific community is needed.

In this effort, EU leadership is crucial. Directional leadership (meeting the Kyoto targets, predominantly domestically), instrumental leadership (actively building coalitions) and structural leadership (making use of the general and economic weight of the EU) are needed.

The EU could be more aware of the weight it can have as a major trading or political block, and not hesitate to link the climate change issue to other issues, such as trade relations and foreign relations.

The USA needs to be in the focus of EU efforts. An expanding EU emission trading system can be complementary to the UNFCCC / Kyoto Protocol. This expanding system may include US States, providing a lever to future involvement of the US at a federal level after harmonisation.

Further, the dialogue with developing countries should be intensified. The EU should concentrate on those countries within the G77 and China that have shown first actions and would be eager to further extend actions provided the framework is acceptable. The goal must be to find ways to formulate targets that are acceptable for active developing countries to date. The EU could promote approaches that facilitate the participation of developing countries, such as a multistage setting with first targets for developing countries that avoid capping economic growth or the Triptych approach.

Within the UNFCCC process, the following sequence of decisions could be aimed at:

- Further definition of the long-term ambition level, as it is crucial for the stringency of short-term reductions and the timing of participation of further countries
- Agreement on types of commitments (e.g. binding emission targets or policies and measures), including an indication when they should be assumed and by whom
- Definition of the accounting or monitoring rules for these types of commitment (for emission reductions e.g. the question on the inclusion of emissions from land use change and forestry, international aviation and shipping as well as other greenhouse gas agents.)
- Agreement on target values (reduction percentages or specific policies)

A key to break the deadlock could be to agree already in a mandate for the negotiations on future commitments at COP 11 in November 2005, which types of commitments will be taken by various groups of countries and when, e.g. binding emission limitation and reduction targets for all developed countries together with sustainable development oriented or non-binding targets for most developed countries for 2020 but binding targets in 2030. Giving it a long-term but defined perspective may increase the acceptability for all countries.

In addition, the efforts complementary to the UNFCCC, such as the coalition and the targets on renewable energy, should be further enhanced.

Finally, the EU should be instrumental in bringing scientists together on the future climate policy. An international scientific conference on the future climate policy would be an opportunity for the exchange of the divergent views on the most effective and efficient long-term climate policy. In addition, the elaboration and quantification of side benefits of emission reduction measures could be an important tool to reduce the reluctance against climate policies in the international negotiations.

Meeting the 2°C target is a major challenge. We would hope that the array of activities presented in this strategy will help the EU in meeting this challenge.

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APPENDIX A KICK OFF PAPER NO.1

Converging per-capita emissions

Kick off contribution for the on-line discussion on www.fiacc.net from 27 January to 3 February 2004

A future international climate regime based on converging per-capita emissions in conjunction with a gradual decrease in global emissions towards stabilization of greenhouse gas concentrations has been proposed by many institutions, most prominent by the Global Commons Institute as the main component of the "Contraction and Convergence" approach[28].

Converging per-capita emission is traditionally considered an approach supported by many developing countries. It is based on the principle to share the common good of the atmosphere equally between citizens. Many developed countries, led by the US, have very strongly opposed such an approach - even to the concept of using per-capita emissions as an indicator. As a result, Annex I Parties are not required to report per-capita emissions in their National Communications.

Recently, the German Advisory Council on Global Environmental Change has slightly changed this "black and white picture" by recommending the contraction and convergence approach as the most suitable one for a comprehensive solution of the problem.[29] This most elaborate advocacy was preceded by some more general endorsements for the principle idea of C&C.

Per-capita convergence is a simple approach and easy to understand: All countries participate and per capita emission allowances converge to the same level until a predefined date, e.g. 2030 or 2050, so that global emissions lead to a predefined stabilization level. But maybe per-capita convergence is too simple to adequately take into account the great variety of national circumstances, to which individual country parties often refer. Therefore, quite a few proponents of an equal per capita concept in general think of possible ways to accommodate these circumstances by differentiating between groups of countries, e.g., by allowing for delayed entry into the scheme, differing types of targets in the beginning, or tolerance clauses, which could allow opting out for least developed countries triggered by predefined thresholds for participation.

It is the general perception that under per-capita convergence large resource transfers will take place through emission trading from the developed countries (which drastically need to reduce emissions) to developing countries (which will receive more emission allowances than they would need to cover their emissions).

However, several recent studies (RIVM[30]/ECOFYS[31]) providing detailed calculations show that for relatively strict long-term targets (e.g. 450 ppmvCO_2) and convergence by, e.g., 2050, not all developing countries would benefit from this approach. As the per-capita emissions have to converge to a level below current average of developing countries, those developing countries above or close to the average (e.g. Argentina, Brazil, Venezuela, Mexico, South Africa, North Korea, Namibia, Thailand, China) will soon (e.g. 2020) be constrained and will not receive excess allowances. More excess allowances would be available under a higher concentration target, e.g. 550 ppmvCO_2, or under earlier convergence, e.g. by 2030.

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[28] See http://www.gci.org.uk/images/CC_Demo(pc).exe

[29] WBGU, 2003 "Climate Protection Strategies for the 21st Century. Kyoto and Beyond", http://www.wbgu.de/wbgu_sn2003_engl.html

[30] Den Elzen, M.G.J., Berk, M.M., Lucas, P., Eickhout, B. and Van Vuuren, D.P., 2003. Exploring climate regimes for differentiation of commitments to achieve the EU climate target. RIVM Report no. 728001023, National Institute of Public Health and the Environment, Bilthoven, the Netherlands, page 53, http://arch.rivm.nl/ieweb/ieweb/Reports/728%20001%20023_final_V1.pdf

[31] Höhne, N.; C. Galleguillos, K. Blok, J. Harnisch, G.J.M Phylipsen (2003): Evolution of commitments under the UNFCCC: Involving newly industrialized economies and developing countries. Research Report 201 41 255. UBA-FB 000412, page 41, http://www.umweltbundesamt.org/fpdf-l/2246.pdf

On the other hand, it becomes apparent in many studies, that reaching a fixed global emission level is easier for Annex I countries, if all Non-Annex I countries participate immediately (converging per capita emissions), compared to a gradual phase-in of developing countries receiving commitments (a “multistage” approach), because only then relatively cost effective mitigation options in some developing countries can be accredited and traded within the system.

Following questions would also be interesting to discuss in the on-line forum:

- Have developing countries (especially those with relatively high per-capita emissions) recently voiced their positions on converging per capita emissions or in particular “contraction and convergence”? What about developed countries?

- Is the advantage of per-capita convergence, that all countries participate in the reduction effort immediately, sufficient to convince opposing developed countries of the merits of this approach?

- Which modifications to per-capita convergence might be appropriate to accommodate different national circumstances in developing and developed countries to facilitate acceptance? E.g. how can developing countries with relatively high per capita emissions be accommodated in a per-capita convergence approach? How to operationalise, e.g. a “per capita plus” concept (EcoEquity), a “tolerance clause” (German WBGU) or “regional bubbles” (GCI) etc.?

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APPENDIX B KICK OFF PAPER NO.2

Prospects for the role of the US in the international climate protection process

Kick off contribution for the on-line discussion on www.fiacc.net from 26 February to 5 March 2004

The International climate protection architecture is coined by two agreements, which are each the result of many years of tough negotiations: The UN Framework Convention on Climate Change and its Kyoto Protocol. In both negotiation processes the USA, crucially influenced the philosophy and design of this treaty system. As the worlds largest emitter of greenhouse gases (about one quarter of the global CO_2 emissions in 2000, one fifth of all six "Kyoto Gases") the inclusion of the USA is indispensable for any effective climate protection regime. USA participation is even more so necessary politically, since developing countries will only follow Annex I countries in curbing their emission trends, if real efforts of the latter and "demonstrable progress", esp. by the USA, can be shown.

How to re-engage the USA in the multilateral process?

Already in the run-up to the negotiations of the Kyoto Protocol the USA made clear, prominently in form of a senate resolution from July 1997 (Byrd-Hagel Resolution, S.Res.98), that they would only commit to reduce their greenhouse gas emissions, if also important developing countries engage in considerable efforts of climate protection ("meaningful participation"). This claim, however, ran counter to the AGBM mandate to negotiate a protocol that recognizes the industrialized nations historical responsibility for climate change and should as first step reverse the trend of industrialized countries greenhouse gas emissions.

Hope for ratification of the Kyoto Protocol by the USA expired finally, when the president of the USA, George W. Bush in March 2001 publicly denounced the treaty as economically ruinous for the USA and unfair, since major developing countries, esp. China and India, are not included. In the follow-up the US government presented a national climate protection goal, which plans a reduction of greenhouse gas emissions relative to its GDP. Between 2002 and 2012 this measure should be lowered by around 18%, which according to many experts' view essentially resembles business as usual. Any consideration of further action was thereby postponed to 2012, when reviewing the effect and adequacy of this (voluntary) goal.

In the recent past, esp. during COP 8 in Delhi 2002 a strategy change of the USA could be observed. Instead of demanding meaningful participation of developing countries, it expressly supported developing countries in their strict rejection of any discussion of climate protection obligations for them. This was seen by many observers as an efficient method to help to maintain the present impasse of the international climate protection negotiations.

COP 9 in Milan 2003, however, has seen the USA heavily promoting its hydrogen and climate science research programmes as the way forward in climate protection, many would say as an actionist disguise for postponing real action. At home, the US administration has recently been blamed by Senator Byrd for hiding behind the Byrd/Hagel resolution to justify a "know nothing, do nothing" policy vis-à-vis climate change. He made clear, that quantified emission reduction targets (also for the USA) are at the heart of emissions trading, a mechanism, which is key to any cost-effective international treaty.

What can be done at the multilateral stage to meaningfully re-engage the USA? Is the US technology approach just a dead end street to a fossil fuelled "hydrogen" economy or does it provide for effective links to new international cooperation and action? Can we expect the US to take on binding emission reduction targets in the future or shall we rather search for other types of commitments to engage the USA?

Signs of hope from the federal states?

Looking beyond the federal administration, however, reveals a proactive role of more and more federal states in climate protection in recent years. The northeast states, e.g., together with five east Canadian provinces are aiming at cutting their greenhouse gas emissions until

2010 to the level of 1990 and again 10% lower by 2017. The state New York was first to establish a regional certificate market for power plants and won the interest of nine neighbouring states to join. Renewable energy targets (shares in energy portfolio) exist in 14 states (incl. Texas).

Many more facets could be mentioned, but this all comes down to the conclusion, that state level could be a lever to pressure the federal government towards action. Opinion polls show, that 75% of the population regard climate change as a real problem demanding real action. In November 2003, 60% assented to the statement, that "we know, what to do against climate change" and that "it is time to start action". Consequently, even in a Senate dominated by Republicans, a bill introduced by Senators McCain (REP) and Liberman (DEM), which essentially covers 80% of US CO_2 emissions and requires those to fall to 1990 levels by 2012, got 43 out of 100 votes in late 2003. Although defeated in its first attempt, it succeeded in breaking the Byrd/Hagel myth, i.e. its 95 to 0 vote back in 1997.

Can action of federal states in the USA move the federal government to reengage in international climate negotiations? If state action contributes to a more constructive engagement of the USA in international climate protection, how can Europe or international agents in general support federal states in their efforts? Would linking the EU emissions trading system to a similar scheme in the Northeast of the USA be a feasible option? What would be the preconditions regarding the design of federal state emission trading systems? Or could Border Tax Adjustments be applied for companies who are neither part of the EU-ETS nor a comparable US scheme? Since US ENGOs are crucial for public opinion and domestic political will, how can they be supported?

Are Business and Finance getting the point ?

Emerging emissions trading systems, high potential costs of weather extremes, the risk of law suits because of climate related damages, and geopolitical risk (oil dependence) are all increasing stakeholder activism and are pointing business and especially finance markets to incorporating "carbon risks" into their balances. WestLB Panmure, a major finance services company, estimates Market Value at Risk in the order of 210 to 915 billion US$. To attribute those risks to individual companies and make them transparent to investors and shareholders, the so-called "Carbon Disclosure Project" (35 investors worth 4.5 trillion US$) started in 2002 to request emissions data from the 500 largest corporations globally. A few other investors and agents like US state and city treasurers have also begun to request disclosure of financial risks or to assess long term risks to major investments posed by climate change.

For these attempts to be successful, it is, however, essential to maintain momentum in the international or regional (EU, Japan, Canada ...) climate process , e.g. by setting clear near term targets as signals to the markets. A successful "Renewables" conference in June in Bonn, Germany could be an important driver for business to come in.

What will be the likely role of business in the next round of negotiations (on action post 2012)? Can and will businesses put pressures on the USA to be more proactive on climate change? Is it after the start of an EU emission trading system in the direct business interest of European and transnational businesses, that the US will rejoin an international climate regime? Is business already doing what governments seem to be unable to: think beyond the next decade? If so, which part of business? Which type of regulation can increase the ability to do so? How can one conceive of a BINGO/ENGO alliance to press for a new effort in multilateral process? What alliances of this kind already exist? What is an adequate risk management of business regarding the mounting climate risks? Would it make sense, to initiate negotiations restricted to the car and airplane producer countries, to initiate joint technological action?

[Questions in italics are meant to constitute the initial threads of the online debate, any other threads can, however, be introduced as well.]

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APPENDIX C KICK OFF PAPER NO.3

Dangerous Anthropogenic Interference

Kick off contribution for the on-line discussion on www.fiacc.net from Tuesday, 30 March until Tuesday 6 April 2004

Introduction

The steadily growing debate over short and long term climate policy and the accelerating scientific awareness of the scale of projected climate impacts, including the increasing risk of abrupt climate change, has focused increasing attention on Article 2 of the UNFCCC. This calls for the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". Such a level "should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

Defining the meaning of Article 2 and operationalizing it entails a broad set of very complex scientific, political and ethical issues. As Anand Patwardhan, Stephen Schneider and Serguei M. Semenov point out in a concept paper for the IPCC in mid 2003: [32]

Thus, the term "dangerous anthropogenic interference" may be defined or characterized in terms of the consequences (or impacts) of climate change outcomes, which can be related to the levels and rates of change of climate parameters. These parameters will, in turn, be determined by the evolution of emissions and consequent atmospheric greenhouse gas concentrations. Evaluating the consequences of climate change outcomes to determine those that may be considered "dangerous" is a complex undertaking, involving substantial uncertainties as well as value judgments."

The debate as to what is dangerous anthropogenic interference

It is beyond the scope of this paper to review the current scientific literature regarding potential impacts of climate change. There have been numerous contributions to the debate on dangerous climate change in the last year or two. We mention four here, in addition to the reports of the IPCC, that we judge particularly important, and which we suggest as further background for this discussion. In roughly chronological order, they are:

1) An editorial in 2002 by O'Neill and Oppenheimer in Science Magazine,[33] in which they recommended a limit of 1ºC beyond 1990 temperatures to protect coral reefs,. 2ºC to protect the Greenland and West Antarctic Ice sheets; and 3º to protect the thermohaline circulation;

2) A position paper issued at COP-8 by the International Climate Action Network[34] calling for global temperature increase to be held below two degrees above pre-industrial levels and then to drop, based on a wide range of concerns for equity, human health, and ecosystems;

3) A report by the German Advisory Council on Global Change (WBGU) and its supporting documentation calling for stabilization not higher than 2ºC above pre-industrial,[35]

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[32] This paper is available for reference at http://www.fiacc.net/data/cct3_Art_2_key_vulnerabilities.pdf

[33] O'Neill, B. C. and M. Oppenheimer (2002). "Climate change - Dangerous climate impacts and the Kyoto protocol." Science **296**(5575): 1971-1972.

[34] Climate Action Network (2002). Preventing Dangerous Climate Change, available at http://www.climatenetwork.org/docs/CAN-adequacy30102002.pdf

[35] Grassl, H., J. Kokott, et al. (2003). Climate Protection for the 21st Century: Kyoto and beyond. Berlin, German Advisory Council on Global Change (WBGU). Available at http://www.wbgu.de/wbgu_sn2003_engl.pdf. Also Hare, W. (2003). Assessment of Knowledge on Impacts of Climate Change – Contribution to the Specification of Art. 2 of the UNFCCC. Berlin, German Advisory Council on Global Change (WBGU),. Available at http://www.wbgu.de/wbgu_sn2003_ex01.pdf

4) A recent article in Scientific American by James Hansen of NASA's Goddard Institute for Space Science in the US, identifies sea level as a key indicator of dangerous anthropogenic interference and advocates a limit to further temperature increase of 1ºC (corresponding to an increase in his calculation of 1 W/m² for radiative forcing) as prudent with regard to preventing sea-level rise from the break up of the Greenland ice sheet.[36]

There is already evidence of what some may consider "dangerous" climate change, if one considers victims of last year's heat waves, or recent exceptional flooding and drought events. Additional temperature increases of one to two degrees C will likely put millions to tens or hundreds of millions of people at additional risk from water shortages, food insecurity, increases in vector borne diseases, and storm-related damages.[37] Coral reefs and other ecosystems and many species are also at risk of extinction with changes in that range. Beyond a total global warming of 1-1.5°C increase above pre-industrial (compared to about 0.6 ºC today), we will be in a global environment warmer than any we have seen in more than 400,000 years. As the global mean temperatures increase approaches and exceeds 2ºC, the risk non-linear and abrupt events including abrupt changes climate regimes (El Nino, drought patterns), in ocean circulation, melting of Greenland or collapse of the West Antarctic Ice sheet, or release of methane bound beneath oceans or permafrost become increasingly likely possibilities.

Key question:

- *What level of global temperature change is associated with unacceptable risks of dangerous impacts?*

Categorizing critical limits that could be used in establishing limits under Article 2

Patwardhan, Schneider and Semenov categorise issues relevant to Article 2 into three categories of critical limits. Their categorization is summarized in the table below with some examples given from their paper and elsewhere. There are clearly different implications for the placement of "critical limits" into different categories for discussion about what may or may not constitute dangerous anthropogenic interference. For example, if an issue is in Category 1 (Widespread negative consequences) then all or most might consider this dangerous. Issues that fit into Category 3 (Mixture of gains and losses) would most likely not obtain such widespread agreement, yet still be very important. In each case the basis for evaluation and specific value judgment have to be supported by both impact information and ethics (rights, cultural).

Critical limits	**Socio-economic and human systems**	**Ecosystems**
Category 1 Widespread negative consequences at any time or over any spatial scale.	No winners only losers.	Loss or near total loss of ecosystems and a large fraction of endemic species.
	Examples: Consequence of THC collapse or West Antarctic Ice Sheet disintegration.	**Examples:** Succulent Karoo, Fynbos, montane wet tropical forests of north Queensland, many coral reef systems, Amazon collapse.

[36] Hansen, J. (2004). "Defusing the global warming time bomb." Scientific American **290**(3): 68-77. A similar article is available online at http://pubs.giss.nasa.gov/docs/2003/2003_Hansen.pdf

[37] Parry, M., N. Arnell, et al. (2001). "Millions at risk: defining critical climate change threats and targets." Global Environmental Change-Human and Policy Dimensions **11**(3): 181-183.

Category 2 Unambiguously negative for specific systems.	Reverse Pareto criterion where some regions or sectors are worse, and others are not likely to benefit.	Substantial negative effects on specific systems with significant increases in vulnerability and/or risk of extinction.
	Examples: Agricultural impacts for warming of more than a few degrees. Sea level rise impacts on small island states and deltaic regions.	**Examples:** Arctic tundra ecosystems, European mountain ecosystems.
Category 3 Mixture of gains and losses.	Some sectors or populations gain and some lose.	Some ecosystems gain and others lose.

Key questions:

- *What issues do you see fitting into each of these categories (and for what level of global mean temperature increase) and why?*
- *What relevance are Category 1, 2 and 3 issues to defining a global limit to acceptable climate change? What mixture if any of gains and losses in Category 3 could constitute DAI in the view of respondents?*

Ethics and Dangerous Anthropogenic Interference

It's well recognized that the problem of defining dangerous climate change cannot be narrowly addressed by natural (or economic) science. Fundamentally, it requires us to determine what we consider to be acceptable and unacceptable risks and/or damages. This raises inescapable ethical questions concerning rights to be protected from climate harm, whether or not these harms can be compensated (loss of life or property), the problem of representation for people most likely to be affected (including those not yet born), and questions about the weight given to damages to species and ecosystems. These questions have to be answered with the help of ethical principles.

Key questions:

- *What weight should be given to rights to be protected from climate harm? What rights could that be in detail? What weight should be given to different vulnerable populations in setting DAI? What arguments are these judgments based on? For example, does the fact that small island states have low populations mean that their interests should be discounted in setting acceptable upper levels to sea level rise, and why?*
- *What weight should be given to ecosystem impacts in setting levels of DAI and how can this be justified?*
- *For any given impact, what level of risk is unacceptable?*

Why should a long-term target be set? Should it be a global limit to warming?

All of the articles and reports mentioned above accept the argument for a target of some kind, and make a case for a particular definition or target. Pershing and Tudela[38], by contrast, systematically address the arguments for and against setting a target of any kind, as well as for setting a target at a particular stage in the cause-and-effect chain. While we refer you to

[38] Pershing, J. and F. Tudela (2003). A Long-term target: Framing the climate effort. Washington, D.C., Pew Center on Global Climate Change. Available at http://www.pewclimate.org/document.cfm?documentID=276

their article for the arguments concerning the different stages, their overall reasons for having or not having an internationally negotiated target are worth repeating (note that the items on the right and left are not paired).

PRO	**CON**
Providing a concrete goal for current and future climate efforts	It will be difficult to agree on a measure of "acceptable risk"
Increasing awareness of the long-term consequences of our actions	Target setting requires that we apportion effort
Calibrating short-term measures and measuring progress	Too stringent a target may produce backlash
Inducing technological change	Too weak a target may be worse than none
Limiting future risks derived from climate change	Difficult negotiations may delay short-term action
Mobilizing society	Negotiation failure may impede overall efforts
Promoting global participation	

These considerations remind us that this discussion is taking place in the real world of conflicting national interests and economic and political inequality. They further highlight the point that these issues are not separable from questions of timing, and from issues of political strategy. Put bluntly, we care about the results (preventing climate change), not the target, and as Pershing and Tudela note, it is not necessarily the case that establishing a more stringent target, or any target at all, will produce better results.

Two critical political facts need to inform this discussion. The first is that the US has rejected even the modest reductions associated with the Kyoto Protocol, and is unlikely to move rapidly from this opposition all the way to a global accord embracing a stringent target. Similarly, most developing countries remain adamantly opposed to any limits on their emissions, and many have opposed discussions of "adequacy of commitments" (an implicit confrontation with the demands of Article 2) because developing country commitments are unavoidable with stringent climate targets. In spite of this, however, several important actors, including the Climate Action Network and the WBGU, as well as the EU Environmental Council decision in 1996[39], have argued that establishment of a formal target is an important step.

Key questions:

- *Will attempting to negotiate a globally agreed limit to climate change produce better results than countries or regions using their own view of this to pressure international negotiations on climate change?*

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[39] European Community (1996). Climate Change - Council conclusions 8518/96. Available at http://ue.eu.int/newsroom/LoadDoc.asp?BID=89&DID=43617&from=&LANG=6

APPENDIX D KICK OFF PAPER NO.4

Why Do many Integrated Assessment Models Overestimate the Costs of Mitigation ?

Ottmar Edenhofer, Marian Leimbach[40]

1. Introduction

How much economic growth does it cost in order to stabilise CO_2 concentration below 450 ppm? In general, this question is answered by Cost-Benefit-Models (CBM) or Cost-Effectiveness-Models (CEM) which are the dominant type of Integrated Assessment Models (IAM) supplied by many scientists and demanded by most decision makers.

Over the last decade, technological change has been an important issue in Integrated Assessment modeling. On the one hand, technological change may have a great opportunity to reduce the costs. On the other hand, most economists would agree that the potential of cost reduction cannot be realised by decentralised markets alone. Because of, technically speaking, overall non-convexities, technological change is the main source of market failure. Techno-logical change can only be the solution if it is embedded in an appropriate institutional framework. We describe three aspects of technological change :

1. Learning-by-doing
2. Biased technological change and investments
3. Path dependencies.

First we will show to what extent the mitigation costs are affected by technological change and second why this potential of cost reduction can probably not be realized by real-world markets.

2. Technological Change

Learning-by-doing

Learning-by-doing denotes the decrease of investment costs when cumulated capacity and operational technological knowledge increase. For example, a learning rate of 10% decreases the investment costs per kW (or production cost per kWh) by 10% if the cumulative capacity (or cumulative production) is doubled.

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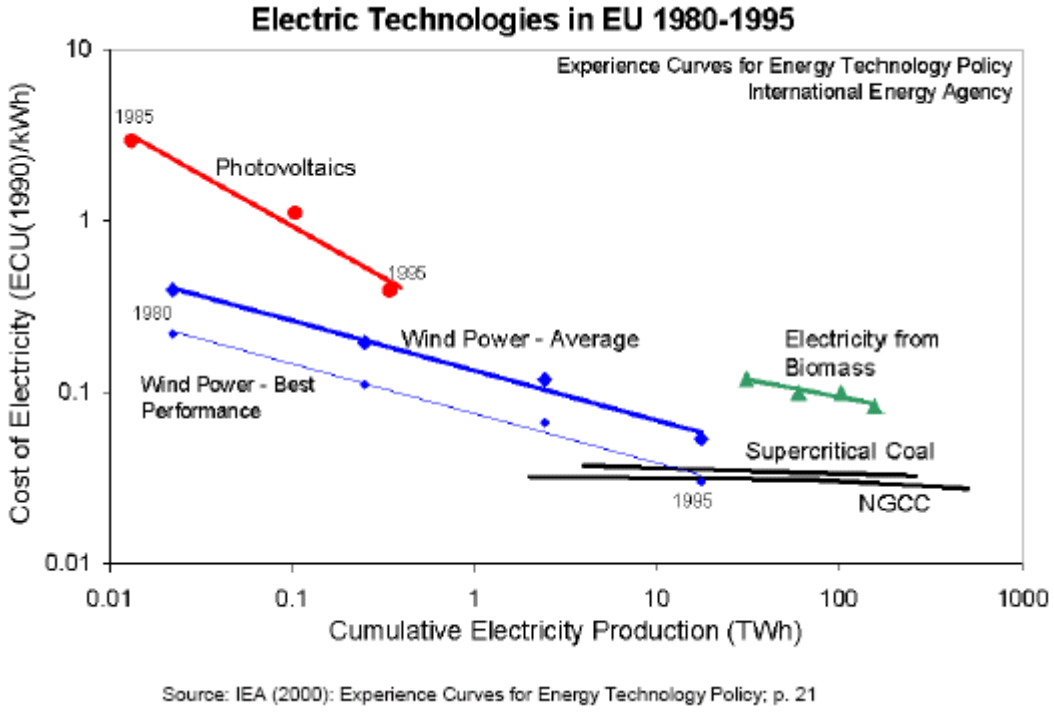

Source: IEA (2000): Experience Curves for Energy Technology Policy; p. 21

Figure 1. *Learning-by-doing within the renewable energy sector*

IA models, in which technological progress comes through learning-by-doing, find large welfare gains from induced technological change (Chakravorty/Roumasset/Tse 1997, Goulder/ Mathai 2002, 210 – 250, van der Zwaan et al. 2002, Gerlagh/van der Zwaan 2003, Manne/Richels 2004). This result is confirmed by many bottom-up energy system models – learning-by-doing within the renewable energy sector reduces the costs of meeting specific concentration targets (Grübler/Messner 1998, Kypreos/Bareto 2000).

Technological progress through learning-by-doing needs investments. Investments in learning-by-doing, however, may crowd out investments in economic sectors with higher productivity. Therefore, it is argued that models incorporating learning-by-doing overestimate its potential for reducing the mitigation costs.

Biased Technological Change and Investments

Investments in learning-by-doing, in research and development (R&D), in carbon-free technologies or in improving energy efficiency can reduce economic growth, if they exhibit a lower return on investment than investments in improving labour efficiency. This argument is emphasized by Nordhaus (2002). He introduces the R&DICE model to enhance the global DICE model with induced technological change. Nordhaus assumes that there is a fixed amount of total R&D spending in the economy. Therefore, increasing the R&D expenditures within the energy sector in order to reduce the carbon intensity of the economy reduces the amount of R&D investments aiming at increasing the overall total productivity. As a result, in R&DICE improving the energy efficiency through R&D investments is less important for reducing greenhouse gas emissions and welfare losses than the substitution of energy by capital. In the model of Buonanno et al. (2003), the accumulated stock of R&D has two effects: it increases total factor productivity and decreases the carbon intensity of the economy. In contrast to R&DICE, R&D investments in the energy sector create an external effect for the whole economy. Because of this feature, economic growth and emissions cannot be decoupled in a sustainable way. In his model ENTICE, Popp (2003a) includes a representative energy technology whose efficiency parameter can be improved by R&D investments. In a re-fined version – called ENTICE-BR – Popp (2003b) has also included a backstop technology. He argues that introducing a backstop technology shows a greater potential in reducing the costs of climate protection than the improvement of energy

efficiency. Nevertheless, the improvement of labor efficiency (or total factor productivity) is set as an exogenous time path. Therefore, this model like the others, does not allow us to assess the total amount of opportunity costs of climate protection.

It is a striking fact that over the last two centuries technological change was biased (see Figure 2): Labor productivity grows faster than the overall energy productivity. Primary energy consumption increases as an input factor, whereas labor and capital-productivity remain constant. This bias of technological change is a well-known stylized fact of economic growth, but is not very well explained within economic models.

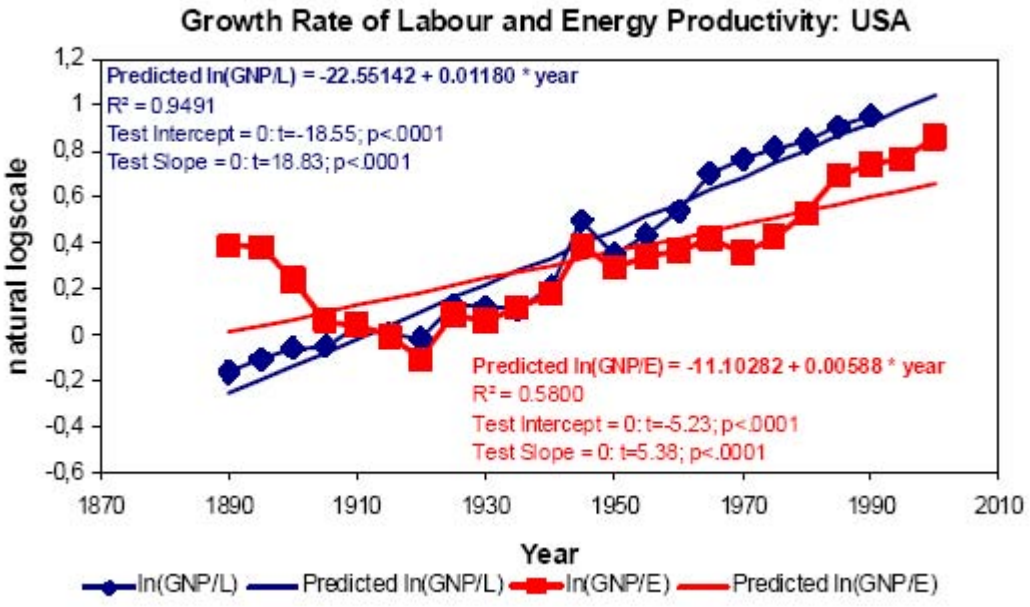

Figure 2. *Biased technological change*

Over the last two hundred years, exhaustible resources like oil, coal and gas were abundant and cheap because technological progress in exploration reduced the marginal costs of using fossil fuels remarkable. For the foreseeable future, fossil fuels are plentiful and the return of investments in improving energy efficiency or using renewable energy sources will be too low for attracting new capital. These developments are accountable for the carbon problem of humankind – there is enough carbon available to destabilize the climate system. Historical experience clearly shows, that technological change is not manna from the heaven but driven by investment decisions trying to deal with emerging scarcities in different markets like the energy and labor market.

Technological change can be triggered either by R&D investments or by gross investments. R&D represents learning-by-searching in order to improve the overall efficiency of the input factors. Technological change can be seen as embodied in gross investments and therefore embodied in capital goods. In this perspective, investments do not only enhance the over-all capital stock of the economy, but also improve the efficiency of factors used in production. As it was shown by Scott (1989) gross investments are not only able to explain the different levels of GDP but also the different growth rates of GDP.

Both aspects are widely neglected by Integrated Assessment models. Neither the R&D investments are determined endogenously nor the externalities of investment decisions. The costs of mitigation are overestimated because the economy lacks of flexibility – entrepreneurs and investors are not able to react flexibly if faced with new scarcities induced by climate policy.

Path Dependencies and Lock-out Options

Industrial economics explains why learning-by-doing, increasing returns to scale and network externalities create path dependency of technological change which means that, if locked in an equilibrium, the costs of moving to a new equilibrium are prohibitive. The world-

energy system is locked in a fossil fuel equilibrium. However, it seems reasonable not only to consider lock-in phenomena but also to look for lock-out options. Lock-out options are options which allow for a transition from a high-emission, high-economic-growth equilibrium to a low-emission, high-economic-growth equilibrium. Good candidates for lock-out options are:

1. Improving energy efficiency of fossil fuels
2. Substituting renewable energy resources for fossil fuels
3. Capturing CO_2 at large power stations and storing it in geological formations (CCS).

A prudent timing of these options may allow a transition to a new equilibrium at bearable opportunity costs.

3. Modeling Technological Change in a Cost-Effectiveness Framework

If all three technological options are incorporated within a CEM, it turns out that the mitigation costs can be reduced substantially (Edenhofer et al., 2004). Our modeling exercises with the model MIND showed that the renewable energy option has the largest potential for a lock-out. It can be supplemented by CCS as a joker if the renewable energy sources are not able to realize the expected learning rates.

In contrast to our results, mitigation costs in models with exogenous technological change are relatively high. In Figure 3 results of the IA models MiniCAM, AIM and MARIA are shown which either assume exogenous energy and labor efficiency, constant macroeconomic investment rates or given price paths for backstop technologies. Admittedly, there is a broad range of estimations. However, nearly all models agree that achieving an ambitious climate protection targets increases the GDP losses substantially.

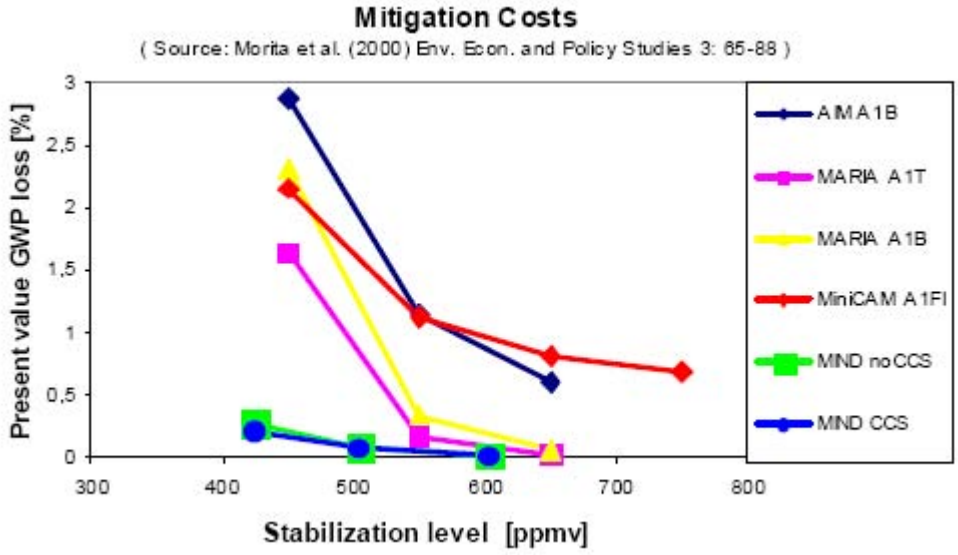

Figure 3. *Mitigation costs can be reduced by endogenising technological change*

As we have argued, endogenous technological change is driven by investment decisions. If ambitious climate protection goals shall be achieved, the long-term investments within the energy sector must be reallocated from a pure fossil-fuel based energy portfolio to a renewable energy path, including CCS. The crucial question is: Are real-world markets able to channel long-term financial flows in this direction?

4. Technological Change and Market Failure

Capital markets are perhaps the most complicated and least understood source of market failure. Unfortunately, all discussed aspects of technological change depend on investment

decisions and on the well-functioning of capital markets: Changing the bias of technological change, realising learning-by-doing and spillover effects, and implementing lock-out options are hindered by long-term market failure. The conventional economic wisdom to cure market failures recommends imposing taxes (e.g. on CO_2) or R&D subsidies. While having a correcting impact, they, however, do not address the most fundamental reason for market failure – the inability of capital markets to ensure intertemporal efficiency and justice. Agents endowed with imperfect information take decisions within incomplete future markets: There are no good reasons to believe that the investment portfolio will be re-allocated according to our CEM analysis if capital markets are incomplete, investors and firms do not have perfect fore-sight about the future or act myopic.

In one of our model experiments we have compared a social optimum solution with a market solution if learning-by-doing is a by-product of technology transfer. The outcome of the market solution differs substantially from the social desired solution in terms of efficiency and justice because decentralised agents do not take into account the welfare effects of spillovers for other agents.

Admittedly, there is an impressive body of literature to describe herd behaviour on short-term financial markets, but there is little research about long-term investment decisions of firms and investors. The existing literature confirms our simulation results that the outcomes of capital markets are not socially optimal. Beyond this general statement there is little knowledge how governments, investors and firms deal with incomplete and imperfect capital markets. This question, however, is not only of interest within the scientific community, since, if there is a market failure especially on the long-term capital market, the potential of cost reduction will never be realised without a reasonable policy intervention.

5. Implications for a Research Agenda

Therefore, three main research questions can be formulated which are highly relevant for Integrated Assessment:

1. Assessing the potential of technological change within a CBM and CEM framework.
2. Understanding long-term investment decisions, especially the role of investors and firms endowed with bounded rationality in trading expectations and risks on imperfect or incomplete capital markets.
3. Exploring the potential of policy instruments to overcome the distortions of capital markets in order to support the transition of crucial sectors (like the energy sector) towards socially desirable outcomes (like climate protection and sustainability).

It seems highly unrealistic to expect that this research program can improve IAM in such a way that in general a unique global optimum can be achieved by implementing optimal policy instruments. However, IAM with a more realistic representation of markets, especially with a more realistic representation of the role of capital markets, may enable scientists to identify local optima which can be achieved even by less rational agents within incomplete markets. Such IAM are no longer unrealistic mind maps for Leviathan but an instrument to structure and to participate in a discourse about the transition towards socially desirable outcomes in a dangerous landscape.

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APPENDIX E DESCRIPTION OF THE EVOC MODEL

Model description

This section describes the Evolution of commitments model (EVOC) that is used to quantify emission allowances under the various approaches in this report. It includes emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 for 192 individual countries. Historical emissions are based on national emission inventories submitted to the UNFCCC and, where not available, other sources such as the International Energy Agency. Future emissions are based on the IPCC Special Report on Emissions Scenarios (Nakicenovic et al. 2000).

The greenhouse gas emission data for 1990 to 2000 (or 2001) is derived by an algorithm that combines emission estimates from various sources.

We first collected historical emission estimates by country, by gas and by sector from the following sources and ordered them in the following hierarchy:

1. National submissions to the UNFCCC as collected by the UNFCCC secretariat and published in the GHG emission database available at their web site
2. CO_2 emissions from fuel combustion as published by the International Energy Agency (IEA 2002)
3. Emissions from Land-use change as published by Houghton in the WRI climate indicator analysis tool (Houghton 2003)
4. Emissions from CH_4 and N_2O as estimated by the US Environmental Protection Agency (USEPA 2002)
5. CO_2, CH_4, N_2O, HFC, PFC and SF_6 emissions from the EDGAR database version 3.2 (Olivier and Berdowski, 2001)[41]

Future emissions are derived from the RIVM IMAGE implementation of the SRES scenarios (IMAGE-Team 2001).

The datasets vary in their completeness and sectoral split. We first defined, which of the sectors provided in the datasets correspond to 7 sectors. This definition is provided in Table 35. Note that CO_2 emissions from the IEA do not include process emissions from cement production. Hence, if IEA data is chosen, process emissions from cement production are not included.

For each country, gas and sector, the algorithm completes the following steps

1. For all data sets, missing years in-between available years within a data set are linearly interpolated and the growth rate is calculated for each year step.
2. The data source is selected, which is highest in hierarchy and for which emission data are available. All available data points are chosen as the basis for absolute emissions.
3. Still missing years are filled by applying the growth rates from the highest data set in the hierarchy for which a growth rate is available.

As future emissions are only available on a regional basis and not country-by-country, the resulting set of emissions in then extended into the future by applying the growth rates of the respective sectors and gas of the region, to which the country belongs.

[41] For CH_4 and N_2O, the values of EPA are largely based from the EDGAR database (1990 and 1995), but extended to the year 2000.

Table 35. Data sources and definition of sectors

	UNFCCC		Edgar 3.2 database		USEPA		LUCF Houghton		IEA		IMAGE CD	
	Regional:	country by country	**Regional:**	country by country	**Regional:**	country-by country	**Regional:**	country-by country	**Regional:**	country by country	**Regional:**	17 regions
	Temporal:	1990 to 2002 (various)	**Temporal:**	1990 and 1995	**Temporal:**	1990-2020	**Temporal:**	1950-2000	**Temporal:**	1970-2000	**Temporal:**	1970 to 2100
	Gas:	CO2, CH4, N2O, HFCs, PFCs, SF6	**Gas:**	CO2, CH4, N2O; HFCs, PFCS, SF6	**Gas:**	CH4, N2O	**Gas:**	CO2	**Gas:**	CO2	**Gas:**	CO2, CH4, N2O, HFCs, PFCs, SF6
Industry												
	1A2	Manufacturing Industries and Construction	**F10**	Industry					3T Other Energy Industries		ENERGY 01 Industry	
	2A0	Mineral Products	**F30**	Other transformation sectors					401 Iron and Steel		ENERGY 07 Other energy transformation	
	2B0	Chemical Industry	**B10CH4N2O**	Biofuel industry CH4 N2O					402 Chemical and Petrochemical		INDUS 01 Feedstocks	
	2C0	Metal Production	**B30CH4N2O**	Biofuel charcoal production CH4 N2O					403 Non-Ferrous Metals		INDUS 02 Industrial activities	
	2D0	Other Production	**I10**	Iron and steel					404 Non-Metallic Minerals			
	2G0	Other (Industrial Processes)	**I20**	Non-ferrous metals					409 Paper, Pulp and Printing			
			I30	Chemicals					405 Transport Equipment			
			I40	Building materials					406 Machinery			
			I50	Pulp and paper					407 Mining and Quarrying			
			I60	Food					408 Food and Tobacco			
			I70	Solvent use/Miscellaneous					410Wood and Wood Products			
			I80	Transport evaporation					411 Construction			
			I90	Miscellaneous industry					412 Textile and Leather			
			F60	non-energy use and feedstocks					413 Non-specified Industry			
									414 Non-Energy Use Ind/Transf/Energy			
									If the IEA data set is chosen, process emissions from industry (e.g. from cement) are not covered			
Electricity												
	1A1	Energy Industries	**F20**	Power generation					11 Public Electricity Plants		ENERGY 06 Electric power generation	
			B20CH4N2O	Biofuel power generation CH4 N2O					12 Public CHP Plants			
									13 Public Heat Plants			
									14 Own Use in Electricity, CHP and heat plants			
									21 Autoproducer Electricity Plants			
									22 Autoproducer CHP Plants			
									23 Autoproducer Heat Plants			
Domestic												
	1A3	Transport	**F40**	Residential, commercial and other sectors					5T Transport		ENERGY 02 Transport	
	1A4	Other Sectors (Fuel Combustion)	**F51**	Transport road					6T Other Sectors		ENERGY 03 Residential (households)	
	1A5	Other (Fuel Combustion)	**F54**	Transport land non-road					*MB Memo: International Marine Bunkers*		ENERGY 04 Services (commercial and public)	
	2E0	Production of Halocarbons and Sulphur Hexafluoride	**F57**	Transport air (international and domestic)					*AB Memo: International Aviation Bunkers*		ENERGY 05 Agriculture and other enduse	
	2F0	Consumption of Halocarbons and Sulphur Hexafluoride	***F58***	*Transport international shipping*							*ENERGY 09 Marine bunkers*	
	3TT	TOTAL Solvent and Other Product Use	**B40CH4N2O**	Biofuel residential CH4 N2O							FGAS	
	9TT	*TOTAL International Bunkers*	**B51CH4N2O**	Biofuel transport road CH4 N2O								
			C10	HFC-byprod.								
			C20	HFC use								
			C30	PFC-byprod.								
			C40	PFC use								
			C50	SF6 use								
	Sectors in italics are excluded when the user chooses to exclude international transport											
Fossil fuel production												
	1BT	TOTAL Fugitive Emissions from Fuels	**F70**	Coal production	02 Coal production				7T Differences due to Losses and/or Transformation		ENERGY 08 Fossil fuel production	
			F80	Oil production, transmission and handling	03 Natural gas production							
			F90	Gas production and transmission	04 Oil production							
			F95	Fossil fuel fires								
Agriculture												
	4TT	TOTAL Agriculture	**L10**	Fertiliser use	06 Manure management						LAND 10 wetland rice	
			L15	Rice cultivation	07 Enteric fermentation						LAND 11 animals	
			L20	Enteric fermentation	08 Rice production						LAND 12 animal waste	
			L30	Animal waste management (confined N2O, all CH4)	09 Agricultural soils						LAND 14 fertilizer	
			L50	Crop production							LAND 15 indirect fertilizer	
			L60	Animal waste management (deposited on soil- N2O)							LAND 16 indirect animal waste	
			L71	Atmospheric deposition							LAND 17 crop residues	
			L75	Leaching and run-off							LAND 18 biological N-fixation	
LUCF												
	5TT	TOTAL Land-Use Change & Forestry	**L41**	BB-Deforestation	10 Biomass combustion		Land-use				LAND 01 biomass burning	
			L42	BB-Savanna burning							LAND 02 burning of traditional biomass / fuelwood burning	
			L43	BB-Agricultural waste burning							LAND 03 timber pool (short lifetime)	
			L44	BB-Vegetation fires							LAND 04 timber pool (long lifetime)	
			L45	BB-deforestation post burn effects							LAND 05 carbon release by regrowing vegetation (-NEP)	
											LAND 06 agricultural waste burning	
											LAND 07 savanna burning	
											LAND 13 land clearing	
Waste												
	6TT	TOTAL Waste	**W10**	Landfills	11 Landfills						LAND 08 landfills	
			W15	Humans/pets	12 Wastewater						LAND 09 (domestic) sewage	
			W20	Waste water treatment								
			W30	Human waste disposal								
			W40	Waste incineration								
			W50	Miscelaneous waste handling (hazardous waste)								
	CO2 emissions from Biomass buring (UNFCCC sector 1A8 and EGRAR sectors B10 to B51) are not included as they are not to be included in the national totals according to teh IPCC guidelines and the UNFCCC repoting guidelines)											

The user can specify to following:

- Whether the emissions are determined on the basis of the hierarchy or are based exclusively on the EDGAR database
- Whether to consider only CO_2, the group of CH_4 and N_2O or the group of CO_2, CH_4, N_2O, HFC, PFCs and SF_6
- Whether the analysis should
  - exclude emissions from land use change and forestry
  - include emissions from land use change and forestry from the hierarchy
  - include emissions from land use change and forestry from Houghton
  - include emissions from land use change and forestry from EDGAR
- Whether international aviation and marine transport is included or excluded

For population, GDP in purchase power parities and electricity demand, the country base year data was taken from UN 2002 and IEA 2002 and extended into the future applying the growth rates from the IMAGE model for the region, to which the country belongs.

Emissions until 2010 are estimated as follows: It is assumed that Annex I countries implement their Kyoto targets by 2010. It is assumed that the reductions necessary to meet the Kyoto target are achieved in the all sectors equally, except the domestic sector (which includes transport). In 2010, the level of the domestic sector is taken from the relevant reference scenario. The level of the other sectors are taken from the reference scenario and reduced, so that the Kyoto target is met. The years from the last available year to 2010 are linearly interpolated. All Non-Annex I countries follow their reference scenario until 2010.

Additionally, the user can select the following:

- Whether the USA reaches in 2010
  - Its Kyoto target
  - It national target, which we interpreted as a 23% increase of total emissions from 1990 to 2010
  - Its reference emissions
- Whether all other Annex I countries reach in 2010
  - Their Kyoto targets
  - The lower of their Kyoto target and their reference scenario
  - Their reference emissions

Explanation of the regions

EVOC 01 USA: United States of America

EVOC 02 EU15, Old EU Member states: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom

EVOC 03 EU+10, New EU Member states: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia

EVOC 04 RWEU, Rest of Western Europe: Iceland, Liechtenstein, Monaco, Norway, San Marino, Switzerland

EVOC 05 RUS: Russian Federation

EVOC 06 REEU in Annex I, Rest of Eastern Europe in Annex I: Belarus, Bulgaria, Croatia, Romania, Ukraine

EVOC 07 JPN: Japan

EVOC 08 RAI, Rest of Annex I: Australia, Canada, New Zealand

EVOC 09 TUR: Turkey

EVOC 10 REEU, Rest of former soviet states: Albania, Armenia, Azerbaijan, Belarus, Bosnia & Herzegovina, Georgia, Kazakhstan, Kyrgyzstan, FYR Macedonia, Moldova, Serbia & Montenegro, Tajikistan, Turkmenistan, Uzbekistan

EVOC 11 ARG: Argentina

EVOC 12 BRZ: Brazil

EVOC 13 MEX: Mexico

EVOC 14 VEN: Venezuela

EVOC 15 RLA: Rest of Latin America: Bahamas, Barbados, Belize, Bolivia, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Saint Kitts & Nevis, Saint Lucia, Saint Vincent & Grenadines, Suriname, Trinidad & Tobago, Uruguay

EVOC 16 EGY: Egypt

EVOC 17 ZAF: South Africa

EVOC 18 NGA: Nigeria

EVOC 19 RNA, Rest of North Africa: Algeria, Libya, Morocco, Tunisia

EVOC 20 RAF, Rest of Africa: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Dem. Republic Congo, Côte d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Rwanda, Sao Tome & Principe, Senegal, Seychelles, Sierra Leone, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe

EVOC 21 SAU: Saudi Arabia

EVOC 22 ARE: United Arab Emirates

EVOC 23 RME, Rest of Middle East: Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Syria, Yemen

EVOC 24 CHN: China

EVOC 25 IND: India

EVOC 26 IDN: Indonesia

EVOC 27 KOR: Korea (South)

EVOC 28 MYS: Malaysia

EVOC 29 PHL: Philippines

EVOC 30 SGP: Singapore

EVOC 31 THA: Thailand

EVOC 32 RAA, Rest of Asia: Afghanistan, Bangladesh, Bhutan, Brunei, Cambodia, Cook Islands, Fiji, Kiribati, Korea (North), Laos, Maldives, Marshall Islands, Federated States of Micronesia, Mongolia, Myanmar, Nauru, Nepal, Niue, Pakistan, Palau, Papua New Guinea, Samoa, Solomon Islands, Sri Lanka, Taiwan, Timor-Leste (East Timor), Tonga, Tuvalu, Vanuatu, Vietnam

Figure 01 USA: United States of America

Figure 02 EU25: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom

Figure 03 FRA: France

Figure 04 GER: Germany

Figure 05 UK: United Kingdom

Figure 06 RUS+EEU: Belarus, Bulgaria, Croatia, Romania, Russian Federation, Ukraine

Figure 07 JPN: Japan

Figure 08 RAI, Rest of Annex I: Australia, Canada, Iceland, Liechtenstein, Monaco, New Zealand, Norway, San Marino, Switzerland

Figure 09 REEU, Rest of former soviet states: Albania, Armenia, Azerbaijan, Belarus, Bosnia & Herzegovina, Georgia, Kazakhstan, Kyrgyzstan, FYR Macedonia, Moldova, Serbia & Montenegro, Tajikistan, Turkey, Turkmenistan, Uzbekistan

Figure 10 LAM, Latin America: Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Kitts & Nevis, Saint Lucia, Saint Vincent & Grenadines, Suriname, Trinidad & Tobago, Uruguay, Venezuela

Figure 11 AFR, Africa: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Dem. Republic Congo, Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome & Principe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe

Figure 12 ME, Middle East: Saudi Arabia, United Arab Emirates, Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Syria, Yemen

Figure 13 SAsia, South Asia: India, Pakistan, Afghanistan, Bangladesh, Bhutan, Sri Lanka, Maldives, Nepal

Figure 14 CPAsia, Centrally planned Asia: China, Korea (North), Mongolia

Figure 15 EAsia, East Asia: Brunei, Cambodia, Cook Islands, Fiji, Indonesia, Kiribati, Korea (South), Laos, Malaysia, Marshall Islands, Federated States of Micronesia, Myanmar, Nauru, Niue, Palau, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Taiwan, Thailand, Timor-Leste (East Timor), Tonga, Tuvalu, Vanuatu, Vietnam

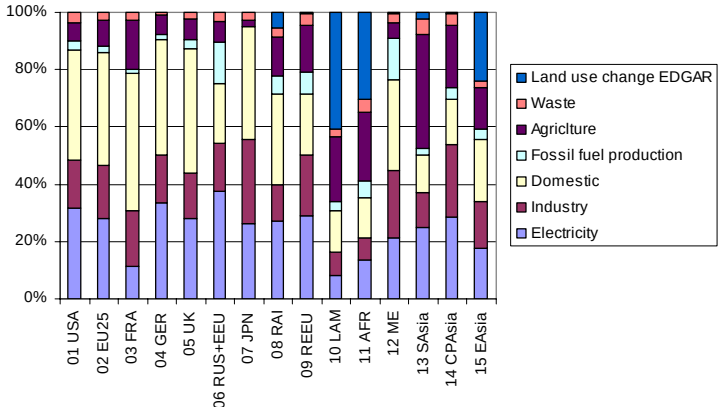
Example results

Table 36. GHG emissions in 2000

	Electricity	**Industry**	**Domestic**	**Fossil fuel production**	**Agriculture**	**Waste**	**Land use change EDGAR**	**LUCF Houghton**	**Total all gases excluding LUCF**	**Total CO_2 only excluding LUCF**	**CO_2 only excluding LUCF**	**ALL GHG excl LUCF EDGAR**	**ALL GHG incl LUCF EDGAR**	**ALL GHG incl LUCF Houghton**
	Mt CO_2 eq	Mt CO_2 eq	Mt CO_2 eq	Mt CO_2 eq	Mt CO_2 eq	Mt CO_2 eq	Mt CO_2	Mt CO_2	Mt CO_2 eq	Mt CO2	tCO_2/cap	tCO_2eq/cap	tCO_2eq/cap	tCO_2eq/cap
UNFCCC Annex I	5544	3218	6385	817	1384	558	99	-199	17907	14567	12.4	15.3	15.3	15.1
UNFCCC Non Annex I	3456	2879	3090	913	4045	647	3264	8031	15030	9364	2.0	3.2	3.9	4.9
World total	9208	6249	9654	1743	5518	1239	3395	7901	33611	24458	4.0	5.6	6.1	6.9
01 USA	2288	1189	2768	209	475	249	6	-403	7178	5982	20.8	25.0	25.0	23.6
02 EU15	1120	796	1822	74	407	105	5	-35	4323	3565	9.4	11.4	11.4	11.3
03 EU+10	303	157	171	28	54	34	1	11	746	608	8.1	10.0	10.0	10.1
04 RWEU	12	21	68	4	11	8	0	-4	123	96	8.0	10.2	10.2	9.9
05 RUS	861	271	445	295	138	43	1	82	2053	1543	10.6	14.1	14.1	14.7
06 REEU in Annex I	200	202	149	118	67	43	1	2	778	535	5.6	8.2	8.2	8.2
07 JPN	363	408	545	1	34	34	2	57	1386	1272	10.0	10.9	10.9	11.4

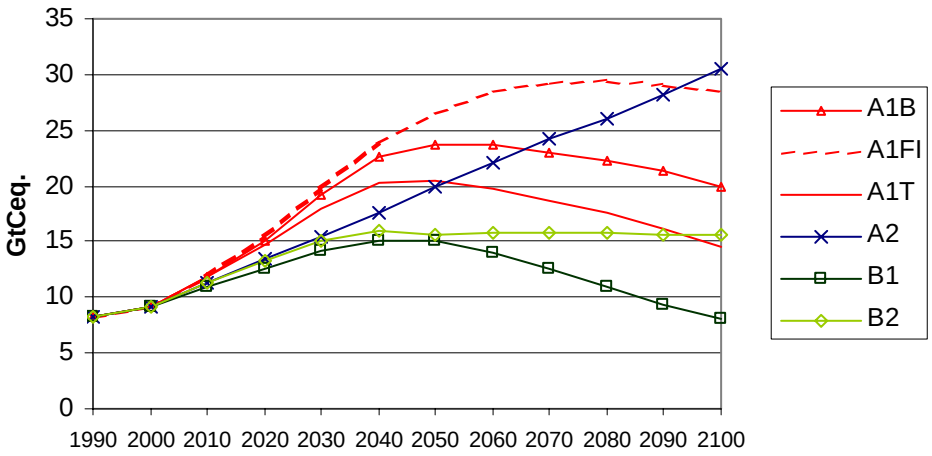
08 RAI	402	177	421	88	199	43	82	90	1332	976	18.2	24.8	26.3	26.5
09 TUR	75	65	73	4	70	18	2	21	306	207	3.1	4.6	4.6	4.9
10 REEU	213	147	139	72	94	22	1	7	687	494	4.6	6.4	6.4	6.4
11 ARG	44	26	73	22	120	17	37	55	302	145	3.9	8.2	9.2	9.7
12 BRZ	29	121	178	7	354	38	1016	1373	726	315	1.9	4.3	10.2	12.3
13 MEX	202	64	150	30	38	14	20	97	499	413	4.2	5.0	5.2	6.0
14 VEN	18	71	45	68	34	11	200	144	247	147	6.1	10.2	18.5	16.2
15 RLA	81	101	216	19	489	45	606	690	951	395	2.2	5.2	8.5	9.0
16 EGY	36	31	63	6	21	8	0	3	166	123	1.8	2.4	2.4	2.5
17 ZAF	186	64	62	7	33	18	8	2	371	307	7.1	8.6	8.7	8.6
18 NGA	6	15	27	65	66	16	18	195	195	105	0.9	1.7	1.9	3.4
19 RNA	64	43	70	46	37	11	0	10	270	196	2.6	3.6	3.6	3.7
20 RAF	20	27	101	15	404	45	680	1203	612	114	0.2	1.3	2.7	3.8
21 SAU	65	93	120	67	9	8	0	0	362	298	14.7	17.8	17.8	17.8
22 ARE	31	32	25	34	2	1	0	0	124	88	33.8	47.7	47.7	47.7
23 RME	223	226	326	119	67	40	9	9	1001	808	5.5	6.8	6.8	6.8
24 CHN	1354	1101	707	179	1026	179	20	136	4545	3072	2.4	3.6	3.6	3.7
25 IND	510	232	233	38	667	88	10	-40	1769	948	0.9	1.8	1.8	1.7
26 IDN	92	66	117	66	92	12	211	2565	445	271	1.3	2.1	3.1	14.2
27 KOR	119	160	192	4	12	12	2	3	499	457	9.8	10.7	10.7	10.7
28 MYS	30	41	42	14	10	3	102	699	139	117	5.3	6.3	10.9	37.8
29 PHL	22	19	34	0	36	8	58	95	120	72	1.0	1.6	2.3	2.8
30 SGP	15	10	16	0	0	2	0	0	43	39	9.8	10.8	10.8	10.8
31 THA	56	60	59	8	89	1	36	48	273	173	2.8	4.3	4.9	5.1
32 RAA	198	229	210	44	377	66	263	791	1125	630	1.2	2.1	2.6	3.5

Source: EVOC



Source: EVOC, including CO_2, CH_4, N_2O, HFCs, PFCs and SF_6

Figure 36. Sectoral split of emissions



Source: EVOC, including CO_2, CH_4, N_2O, HFCs, PFCs and SF_6

Figure 37. Global emissions under the reference scenarios

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