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Graduation and Deepening: An Ambitious Post-2012 Climate Policy Scenario

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Abstract. In the second commitment period 2013–2017, the Kyoto Protocol structure is strengthened considerably. The current Annex B countries agree to reduction targets averaging 23% reductions from 1990 level. This induces non-Annex B countries to take up emissions targets according to a multi-tiered graduation system. Graduation is undertaken according to thresholds defined by per capita GDP and emissions. Compared to the current Annex B, coverage of emissions by absolute caps would increase by about 25%; large low-income countries such as India and China do not graduate. Therefore, large emitters above 50 million t. p.a. can utilise a policy-based Clean Development Mechanism. Sinks of all types – terrestrial, marine and geological can be used. To achieve this policy scenario, voter pressure due to extreme meteorological events and a coordination of all progressive forces in the international climate negotiations are necessary. Moreover, a judicious combination of carrots and sticks has to be developed to entice Non-Annex B countries to graduate.

Key words: developing countries, emission budgets, graduation, Kyoto Protocol

1. Introduction

Anthropogenic emissions of greenhouse gases have been increasing since industrialisation started about 150 years ago. Due to the long residence time of many greenhouse gases and the ubiquity of emissions sources in an industrialised economy, international climate policy is a task for many generations. Thus the international climate negotiation process has started with a general framework that is specified in more detail as time passes. Each step achieved serves as stepping stone to the subsequent step. So far we have defined the UN Framework Convention on Climate Change (UNFCCC) in 1992, the Kyoto Protocol in 1997 and the Marrakech Accords to the Kyoto Protocol in 2001. The UNFCCC defined the general outline of the regime while the Kyoto Protocol set a structure of emissions commitments and policy instruments. In the Marrakech Accords detailed rules for the operation of the Kyoto Protocol's instruments are given. Given that climate policy started only about 15 years ago the progress made so far is relatively good compared to other international regimes such as the Law of the Sea that took almost three decades to negotiate. The climate policy regime is having annual meetings of its Conference of the Parties, has two subsidiary bodies and a permanent secretariat. So it has the character of a stable regime with a long institutional lifetime. However, it must be noted that negotiators have only been able to forge the regime by foregoing a number of intractable issues instead of directly facing them, such as future global commitments and integration of some of the world's largest greenhouse gas emitters in its system of reduction commitments.

While many observers criticise the regime for its short-term orientation, it has always been open to further development. The institutional setting is geared towards a regular updating. Currently, the target date of 2005 is set to define the rules for the regime after 2012. As the regime becomes more mature, there is certainly a degree of path dependency. For example, a change from a target-based to a policy-based regime would become difficult. However, there is still a high level of freedom for future development.

This article will develop a scenario for the second commitment period of the Kyoto Protocol that leads to strong emission reductions and a rapid integration of developing countries into the commitment regime. We will first discuss the assumptions underlying the scenario and then try to quantify its emission targets as well the use of different instruments. Moreover we give recommendations how the scenario can be achieved and what barriers exist. Suggestions will be made for removal of these barriers. A timetable for policy steps will form the final section. The analysis is based both on economics and political science. It builds on the efficiency properties of market mechanisms and the cost reduction potential of addressing a wide range of greenhouse gases and mitigation options. Moreover, it draws on the experiences accumulated in the first 15 years of the international climate policy process.

2. Elements of the Projected Second Commitment Period Climate Regime

Our scenario that is elaborated in detail for the period 2013–2017 and forms the backbone for future commitment periods beyond that date contains the following major building blocks based on specific assumptions that will be assessed in detail in each section:

- The architecture of the Kyoto Protocol remains valid. Quantified emissions budgets are the basis of the regime. Increased political salience of the climate problem due to a series of extreme weather events with major losses means that willingness to embark on emission reductions compared to business-as-usual will be stronger than in the period 2008–2012. There is political consensus to orient the global emission path towards a stabilisation at a concentration of 550 ppm CO_2 equivalent. To achieve this, the country group that accepts quantified emission budgets expands. Thresholds that define the capacity to act are defined. Sub-scenarios will look at different types of thresholds.
- The process of defining emission budgets for countries surpassing the thresholds will become somewhat less 'bazaar-like' than in the Kyoto negotiations. It will be

oriented on capacity to pay and current emissions per capita and contain elements of contraction and convergence.

- International transport will be covered with the intergovernmental agencies International Air Transport Association (IATA) and International Maritime Organisation (IMO) becoming parties in their own right with an absolute emissions target.
- Due to an overall success of the Kyoto Mechanisms in the first commitment period, their basic structures will remain valid. Rules will be streamlined.
- Least developed countries (LDCs) receive targeted funds for adaptation to negative economical, social and ecological impacts of climate change.
- The sequestration of carbon dioxide by biospheric sinks and technical storage in geological formations plays an increasing role.

3. Derivation of a Concentration Target

The emphasis of current climate policy lies in reduction of greenhouse gases. In the early days of the climate policy regime, a decision was made to introduce quantitative commitments instead of policy commitments.

If economists cannot use a cost-benefit approach,[1] they use the standard-price approach as a second best (Baumol and Oates 1971). The standard has to be set by the political process (which obviously generates an opportunity for lobbies to influence the standard level) and then instruments are introduced to equalise marginal costs of reaching the standard. For a global pollutant, equalisation of marginal costs means that mitigation cost is minimised. This does not mean that the burden for everybody is the same, as an action to mitigate greenhouse gas emissions can be implemented by one actor but its costs covered by another one.

The Kyoto Protocol has many features of a standard-price approach. The emission targets define the standard and the Kyoto mechanisms allow marginal cost equalisation. However, the targets only cover a part of global emissions and are uncertain beyond 2012 making long-term marginal cost equalisation impossible. For a long-term target path, a concentration target has to be defined (see Michaelowa, Tangen and Hasserknippe this volume). In the political debate, concentration targets so far have taken a back seat. The only exception is the 1997 EU proposal of a stabilisation at 550 ppm CO_2.[2] This might be due to a fear of stringent future emission targets: once a concentration target and the target path has been defined, the maximum level of global GHG emissions in a given period is quantified setting the base for negotiations concerning the allocation of emission targets to all countries. One might imagine the political explosiveness of resulting negotiations as the only option to reduce the stringency of one nation's reduction target would then be to shift burdens to other nations.

We assume that a 450 ppm target will not be acceptable in the international negotiations but that a 550 ppm target will be agreed as an *indicative* concentration target.[3] This will be supported by major weather-related disasters in the next decade. Indeed, in recent years weather extremes have multiplied and people's awareness of them is increasing. However, it is still politically not possible to negotiate a detailed, legally binding path. Nevertheless, consensus is achieved that global emissions should not peak later than 2030.

4 Which Emissions Count and How do They Relate to Each Pther?

4.1. Extending Coverage of Gases and Other Substances

The Kyoto basket of six greenhouse gases does not cover all known greenhouse gases or substances that influence the global climate. The Kyoto gases are estimated to account for about 92% of the total radiative forcing by substances with a 'high' to 'medium' level of scientific understanding (IPCC 2001, p. 8).[4] Tropospheric ozone has a forcing of almost 15%, while stratospheric ozone depletion reduces the forcing by 6%. Inclusion of tropospheric ozone would be a realistic option and politically interesting as it acts as a major local pollutant with negative effects on health and agricultural production. Targets would have to be expressed in units of the precursors, NO_x, CO and VOC as the concentration of ozone is difficult to measure. These precursors cannot be directly included in the Kyoto basket as they do not generate radiative forcing and thus GWPs are not applicable to them. A rough and easy way to take them into account would be to translate the overall Kyoto basket target on NO_x, CO and VOC, i.e. if a country has a reduction target of 5% for the Kyoto basket, NO_x, CO and VOC have to be reduced by the same amount. As these gases are local pollutants, they are well-monitored. CO has been regulated in industrialised countries for decades. Two NOx emissions trading systems have been implemented in the US and are functioning well.

Aerosols such as dust and SO_2 lead to regional cooling effects which counteract greenhouse gas warming. The order of magnitude of the direct effect is 30% of the Kyoto basket but the indirect effect could be almost as large (IPCC 2001, p. 8). It is likely that the cooling phase from 1940 to 1975 was due to the strong increase in aerosol loads during that period and that measures to reduce SO_2 emissions in industrialised countries have contributed to the strong warming push since the mid-1980s as global sulphate forcing stabilised (IPCC 2001, p. 402). As aerosols are linked to local and regional pollution there is a strong incentive for countries to reduce these emissions; in fact newly industrialised countries are embarking on this path which will mean a further 'unmasking' of the greenhouse effect.

Theoretically, countries with a high production of aerosols could receive a 'bonus' for their greenhouse gas target. The quantification of this bonus is difficult due to the regional character of the cooling effect and the transboundary pollutant effects. Moreover, it would give a perverse incentive not to reduce the aerosol load. Thus no bonus will be given in our scenario.

Many observers (see e.g. Sato et al. 2003) from the US have argued for an inclusion of black carbon, i.e. soot, the only aerosol with a warming contribution whose radiative forcing is about 8% of the cumulative radiative forcing of the Kyoto basket. Due to measurement uncertainties and the unknown impacts of the different size of soot particles, black carbon is not covered in our scenario.

4.2. Change of GWPs for conversioninto CO_2 equivalent

In Art. 5,3, the Kyoto Protocol fixed the use of 100 year Global Warming Potentials (GWPs) as specified by the IPCC Second Assessment Report (SAR) for the first commitment period. Accordingly, the 2001 update of GWPs by the Third Assessment Report (TAR) has not been followed by the Kyoto Protocol. A procedure has to be developed how updates are done. Also, the 100 year timeframe may not be seen as adequate. Choosing a different time horizon might lead to significant differences in the GWP of a given greenhouse gas (see Table I).

Moreover, indirect effects (due to the atmospheric chemistry properties, for example) should be taken into account. In the case of methane they increase the GWP by over 35% (IPCC 2001, p. 387).

In our scenario we assume that GWPs are updated for the second commitment period to the values derived in the IPCC's Fourth Assessment Report due in 2007. In our view, methane GWP will reflect the indirect effects and thus be raised strongly.

5. Expanding the Circle of Countries with Obligations under the UNFCCC Through Thresholds

The principle of common but differentiated responsibilities that has been adopted in Article 3 of the UNFCCC can be interpreted in the sense that countries should take

Table I. GWP changes over time.

Gas	Average lifetime (years)	20 years TAR	*Kyoto SAR*	100 years TAR	500 years TAR	Scenario 4AR
CO_2	Variable, about 150	1	1	1	1	1
CH_4	12	62	21	23	7	40
N_2O	114	290	310	296	156	300
HFCs	0.3–260 (majority double-digit)	40–9400	140–11,700	12–12,000	4–10,000	Similar to TAR
PFCs	2600–50,000	3900–8000	6500–9200	5700–11,900	8900–18,000	Similar to TAR
SF_6	3200	15,100	23,900	22,200	32,400	Similar to TAR

Data source: IPCC (2001), pp. 388–389.

up emission targets once reach, for example, a level of wealth or of emissions comparable to the current Annex B countries. Such a threshold approach might help to ensure that countries contribute to fight global warming in a 'fair' way. Since the exact definition of 'fairness' or 'equal contribution' not only is a very complex task but also a very sensitive one in political terms, there is no concrete definition so far. It will, however, become a core element of future negotiations. Major elements (see also Pichs et al. 2000), might include:

- historical responsibility
- the need for (sustainable) development
- capability in terms of finance (Jansen et al. 2001)
- capacity in terms of (cheap) mitigation potential (Claussen and McNeilly 1998).

Consequently, there are several options as to how thresholds may be defined triggering target negotiations for Parties, e.g. GDP/GNP per capita, cumulative past emissions ('historical responsibility for climate change'), emissions per capita, etc. In order to reach a global emissions path, the level of the threshold and the stringency of targets for countries that have passed the threshold are two distinct variables that can be set. The data source used for the following calculations is IEA (2002) and is limited to fossil fuel CO_2 as reliable emissions data for the Kyoto basket do not exist for many countries. Micro states of less than 100,000 inhabitants such as San Marino and dependent territories (e.g. Bermuda) are not analysed. The latter should in any case be taken into account as part of their respective Annex B 'mother' country.

If thresholds are to be based on financial indicators, one can – to a certain extent – take into account the capacity of a country to contribute to global GHG-emission reduction or limitation. Financial indicators can be expressed in GDP per capita or in purchasing power parities of a reference period or averages of past periods per capita. This idea was first developed by Claussen and McNeilly (1998) but only applied in a fairly superficial manner. Gupta (1999), Gupta et al. (2001) and Gupta (2003) developed a far more detailed version with a 'graduation profile' matrix comprising per capita emissions and per capita income. There are nine possible entries in their matrix, each leading to a different target and policy package. They however do not quantify the thresholds. Based on the same idea but a simpler application, we develop a graduation index complemented by overall emissions and institutional thresholds for our scenario.

5.1. Combined Financial and Emission Thresholds: Graduation Index

A combination of GDP and per capita emissions thresholds would be promising as it captures both ability to pay and the 'polluter pays' principle. If a 'graduation index' is calculated where both figures are weighted with 50%, we get the results shown in Table II. For the underlying per capita GDP and emissions data see Appendix A. Each 10,000$ GDP per capita and each 10 t CO_2 per capita give the graduation index value 1. For example, Qatar has a GDP of 26,051$ per capita (Graduation

Table II. Combined GDP and emissions per capita thresholds (2000 data).

	Graduation index[a]	Emissions (million t CO_2)	Share of current Annex B (%)	Emissions change 1990–2000 (%)
Qatar	4.3	35.1		+150.4
Kuwait	2.3	62.6		+213.1[b]
United Arab Emirates	2.1	68.7		+68.0
Bahrain	1.7	14.1		+20.7
Singapore	1.7	42.0		+46.0
Brunei	1.6	5.1		+57.8
Average Annex B	1.6	227.6	1.7	+92.0
Israel	1.4	62.4		+85.8
Taiwan	1.4	215.3	1.6	+88.9
Cyprus	1.4	6.3		+63.1
Oman	1.4	23.5		+120.1
Bahamas	1.3	1.9		NA
Saudi Arabia	1.2	260.6	1.9	+54.1
Korea	1.2	433.6	3.2	+91.7
Lowest Annex II	1.2[c]	1231.2	9.0	+81.9
Barbados	1.1	2.2		NA
Trinidad and Tobago	1.0	15.1		+38.7
Malta	1.0	2.3		−0.9
South Africa	0.8	295.8	2.2	+16.2
Argentina	0.7	130.2		+33.1
Kazakhstan	0.7	122.8		−50.7[d]
Libya	0.6	38.9		+46.5
Malaysia	0.6	106.1		+123.9
Mexico	0.6	359.6	2.6	+23.1
Mauritius	0.6	1.8		NA
Turkmenistan	0.5	34.3		+17.6[4]
Venezuela	0.5	128.6		+25.4
Iran	0.5	292.1	2.1	+83.7
Uruguay	0.5	5.3		+25.4
Turkey	0.5	204.1	1.5	+58.4
Botswana	0.5	3.0		NA
North Korea	>0.4	167.3	1.2	−16.7
Lowest Annex B	0.5	3139.7	22.9	+37.7

[a] 10,000$ and 10 t CO_2 give the graduation index value 1.
[b] Very low 1990 level due to Iraqi occupation; compared to 1989 level, the increase is only 22.7%.
[c] Switzerland.
[d] Compared to 1992.

index = 2.6) and annual per capita emissions of 60 t CO_2 (Graduation index = 6). The graduation index of Qatar is shown in the first line of the table.

$$GI_{Qatar} = \frac{2.6 + 6}{2} = 4.3$$

5.2. Absolute Emission Thresholds

Table III provides data for all non-Annex B countries emitting more than 50 million t CO_2 in 2000.

The countries in italics do not pass the lowest threshold under the graduation index. They account for a combined 38% of current Annex B emissions and thus combine more emissions than the entire set of graduating countries. In our scenario, they are parties to a special Annex which allows them to choose between an ex-ante intensity target with emissions trading, or allows use of countrywide CDM (see discussion in the policy section). Countries could give a commitment to implement all macroeconomically sensible policies with greenhouse gas benefits. A narrow approach would be to address all projects that are pure monetary no regrets. Krause (2000, p. 30f) estimates the potential at 1.7 to 6.7 billion t CO_2 for the first commitment period. A wider perspective would be to take positive local pollution externalities into account ('ancillary benefits', OECD 2000). In severely polluted

Table III. Emitters above 50 million t CO_2.

	Emissions (million t CO_2)	Share of current Annex B (> 1%)	Emissions change 1990–2000 (%)	t CO_2/ capita
China	3035.5	22.1	+ 32.6	2.4
India	937.3	6.8	+ 60.7	0.9
Korea	433.6	3.2	+ 91.7	9.2
Mexico	359.6	2.6	+ 23.1	3.7
Brazil	303.3	2.2	+ 57.0	1.8
South Africa	295.8	2.2	+ 16.2	6.9
Iran	292.1	2.1	+ 83.7	4.6
Indonesia	269.3	2.0	+ 100.1	1.3
Saudi Arabia	260.6	1.9	+ 54.1	12.6
Taiwan	215.3	1.6	+ 88.9	9.7
Turkey	204.1	1.5	+ 58.4	3.1
North Korea	167.3	1.2	−15.7	9.5
Argentina	130.2		+ 33.1	3.5
Venezuela	128.6		+ 25.4	5.3
Kazakhstan	122.8		−50.7[2]	8.3
Uzbekistan	114.9		+ 2.3[4]	4.6
Egypt	108.5		+ 48.0	1.7
Malaysia	106.1		+ 123.9	4.6
Pakistan	98.0		+ 66.1	0.7
Iraq	77.2		+ 35.4	3.3
Philippines	68.9		+ 91.4	0.9
United Arab Emirates	68.7		+ 68.0	23.7
Algeria	66.6		+ 21.8	2.2
Kuwait	62.6		+ 213.1[1]	31.5
Israel	62.4		+ 85.8	10.0
Colombia	57.2		+ 27.8	1.4
Syria	52.3		+ 68.9	3.2

areas, the externalities can be higher than the costs for greenhouse gas abatement and reach values of above 10 \$/t CO_2 equiv.

5.3. Organisational Thresholds

Other than being derived from quantitative thresholds graduation has to be linked to organisational parameters, i.e. on a country's membership in certain intergovernmental organisations. This is based on the observation that some organisations only admit countries that have reached a certain degree of economic development. In fact, OECD membership originally defined Annex II membership in the UNFCCC. Likewise, being a recipient of IDA funds or food aid is a clear signal that a country is still a low-income, developing country. We therefore assume the following simple institutional graduation scheme (Table IV).

5.4. Definition of Emission Targets According to Graduation Status

We assume that current Annex B countries take up absolute targets that lead to a intensification of the emission reduction trends initiated in the first commitment period. For countries in transition targets would be considerably stricter taking into account the hot air availability. As policymakers tend to use simple numbers,[5] target differentiation could be made in multiples of 3. As many countries have found that the base year 1990 is inequitable, targets should be based on a simple reduction from 'business-as-usual' (BAU). BAU would be proposed by review teams for Annex B countries with hot air in a similar process as adjustments to Assigned Amounts are made under the Kyoto Protocol. However, the final BAU figure would have to be agreed by the government of the respective country. For all countries without 'hot air', BAU would be defined by first commitment period target levels. This would create the following target allocation (see Table V):

5.5. The Concentric Circles of Target Stringency

We assume that all countries achieving the lowest graduation index threshold take up absolute targets, but with a base year of 2012 instead of 1990. There will be a decreasing degree of target stringency according to the level of the graduation index:

- Countries whose graduation index is above Annex B average take the unweighted average reduction rate applied for current Annex B members with the exception of hot air countries, i.e. −6%;

Table IV. Institutional graduation.

Institutional characteristics	Graduation
EU, OECD, IEA membership	Automatic inclusion in Annex B
LDC, IDA and food aid recipients	Exemption from any target

Table V. Current Annex B target allocation for the second commitment period.

	Second commitment period target (% change from 1st Commitment Period)	Emissions gap 2000 (%)
Ukraine	−47	−7.1
Russia	−42	10.3
Australia	−12	18.8
EU-28		16.8
Canada	−6	25.6
New Zealand		10.2
US		23.8
Iceland	−3	0
Japan		18.2
Norway		8.0
Switzerland		10.1
Sum (compared to 1990)	−23.3	17.9

- Countries whose graduation index is above the lowest Annex II country value take the lowest Annex B reduction rate, i.e. −3%:
- Countries whose graduation index is above the lowest Annex B country value stabilise emissions at 2012 levels;
- Countries on the large emitters list that lie below the graduation index threshold can use a country-wide CDM (see below).

5.6. Overall Target Allocation

Making a linear trend extrapolation of emissions growth from the 1990s to 2015, emission budgets and reduction needs for the graduating countries can be derived (see Table VI). This must be seen as a pessimistic variant, not taking into account saturation tendencies in countries at the top of the graduation index list. However, we cap emissions at 20 t CO_2 per capita (the current US level) for countries without indigenous fossil fuel sources. These are denoted by an asterisk.

One clearly sees that the reduction burdens of most countries in most cases amount to less than 10% of 2015 emissions.

6. Future Role of the Flexible Mechanisms

6.1. Attractiveness of IET Compared to CDM

Non-Annex B countries can participate in IET once they have joined Annex B and thus could avoid the higher transaction costs of the project based mechanisms:[6]

Table VI. Emission targets for non-Annex B countries.

	Estimated emissions 2015 (million t CO_2)	Emission target (compared to 2012)	Absolute emission reduction need	Costs (mill. $) at market price of 10 $/t CO_2
Qatar	79	68	11	110
Kuwait	84	76	8	80
United Arab Emirates	139	119	20	200
Bahrain	18	16	2	20
Singapore	71	61	10	100
Brunei	10	8	2	20
Israel	125*	109	16	160
Taiwan	440*	382	58	580
Cyprus	12	11	1	10
Oman	66	55	11	110
Bahamas	3	3	0	0
Saudi Arabia	471	414	57	570
Korea	946*	816	130	1300
Barbados	3	3	0	0
Trinidad and Tobago	24	22	2	20
Malta	2	2	0	0
South Africa	367	358	9	90
Argentina	195	183	12	120
Kazakhstan	150	149	1	10
Libya	66	60	6	60
Malaysia	303	264	39	390
Mexico	484	460	24	240
Mauritius	2	2	0	0
Turkmenistan	43	34	9	90
Venezuela	178	163	15	150
Iran	659	587	72	720
Uruguay	7	7	0	0
Turkey	383	347	36	360
Botswana	6	6	0	0
Sum	5336	4997	339	3390
% of 2000 world emissions	22.8	21.4	1.4	

- Project identification and baseline selection;
- Project approval;
- Monitoring and verification of project performances;
- Certification of GHG emission credits obtained as a result of CDM activities
- Negotiating sharing of achieved credits.

It is quite obvious that for most developing countries and countries in transition climate change does not belong to the priority tasks and they do not intend to implement measures exclusively aimed at GHG emission reduction. For such countries, CDM is the instrument of choice as it helps to introduce new environmentally sound technologies in key economic sectors. That will promote both GHG emission reduction and sustainable development. In addition to these benefits, the participation in the CDM will further help to create national institutions to address climate change issues (Michaelowa 2003), and promote markets.

If a non-Annex B country joins Annex B, the CDM projects it hosts automatically lose their CDM status. There are the following possibilities:

- No compensation for loss of Certified Emission Reductions (CERs) is given;
- Projects are converted into JI and instead of CERs generate the same amount of Emission Reduction Units (ERUs);
- The investors receive Assigned Amount Units (AAUs) equal to the CERs; The investors are bought out.

6.2. The CDM Market – Real Participation of Developing Countries?

Even if there is no expansion of Annex B, the CDM could already now lead to a considerable involvement of developing countries in mitigation activities. However, the Kyoto Mechanisms are competing against each other due to the decision taken at Marrakech that all types of emission rights are fully fungible. While CERs and ERUs formally can only be banked up to a limit of 2.5% of a country's emissions budget and Removal Units (RMUs) from sinks projects are not bankable, countries will just use up RMUs, CERs and ERUs first, and bank AAUs. Moreover, there is no formal supplementarity threshold; in principle countries can buy as many emission rights abroad as they like.

The shares and revenues of the different mechanisms are strongly dependent on demand and supply. If one takes the targets for the first commitment period only and assumes the US and Australia stay at the sidelines, the market is very lopsided. The withdrawal of the US has reduced demand by over two thirds. Russian hot air covers the residual demand alone; Ukrainian and Eastern European hot air add about the same amount. Thus the CDM and JI market depends on voluntary export restrictions of the hot air countries; an alternative would be voluntary import restrictions for hot air as already defined in the EU 'linking directive'. Under a rational behaviour, only one third of hot air would be exported and the price reaches about 4 Euro/t CO_2. If the CDM involves a strict additionality test and high transaction costs, its share would be minor while if profitable projects are registered by the Executive Board low-priced CERs could compete with hot air. JI supply depends on the willingness of hot air countries to embark on positive cost measures whereas JI demand depends on the willingness to buy hot air.

The situation changes substantially if the targets of the second commitment period are known well in advance of the first period, involve more countries and are relatively tough as in our scenario. Then banking of hot air as well as CDM (and to a lesser extent JI demand) will increase.

6.3 Policy and Measures CDM

A recurrent theme in CDM negotiations has been the question whether CDM only includes concrete projects where a technology is installed or whether it could be interpreted in a broader sense as covering policies. Especially under a unilateral CDM policies would be an attractive option. Here, a tough determination of additionality becomes crucial to avoid 'CDM-isation' of business-as-usual behaviour and thus to avoid a reward of past sub-optimal policies. Samaniego and Figueres (2002) even suggest extending CDM to national policies which exacerbates the additionality problem. However, in the context of a scheme to involve countries with high absolute but with low per capita emissions and low GDP, a national CDM may be able to mobilise a high amount of reductions.

7. Coverage of International Transport

The Kyoto Protocol exempted international air and sea travel from the emission reductions commitment of Annex B targets. This exemption should be lifted. Emissions could be allocated to the countries where trips originate and end or the IMO and the IATA would be allocated a distinct target (see Bode et al. 2002). Emissions from air travel should use a special conversion factor that includes the indirect effects due to the specific chemistry of aircraft emissions in the high troposphere. Using IPCC results, this factor amounts to 2 to 4 (IPCC 1999). Contrail effects are not included in this estimate but should enhance this factor further as recent findings have reconfirmed their significance (Travis, Carleton and Lauritsen 2002). Our scenario assumes that IMO and IATA become parties to the Kyoto Protocol and get an absolute stabilisation target on 2000 levels.

8. Carbon Sequestration by Biospherical Sinks

Biospherical sinks can be classified as terrestrial sinks or marine sinks. Many stakeholders see terrestrial sinks as a cheap option to comply with emission targets while supposedly contributing to 'save the world's large forests'. At the same time, the inclusion of terrestrial sinks is a chance for many developing countries to participate at the global market for emission certificates.

However, the decision about which sink types would be eligible almost scuppered the subsequent negotiations and still leaves many questions open. The main 'technical' problems of sinks are the issue of permanence and monitoring. The very point about permanence is the following: while any non-emissions of greenhouse gases for energy use are assumed to be of permanent benefit, carbon uptake in soils and vegetation will be reverted at some time in the future. This can happen 'early' due, for example, to non-sustainable forest management, cessation of replanting after harvesting, or natural fires and pests.

The resulting question then is: What is the benefit of temporal carbon storage for the global climate system? The Marrakech Accord has defined a jumbled forest sinks accounting including unsystematic caps; it still leaves many questions open. Overall, the regime is relatively unbalanced. Afforestation and reforestation can be accounted for in full whereas forest management is capped at ad hoc levels. It is also not clear how a natural increase in forest carbon stocks is to be distinguished from planned or human-induced increase. This task becomes even more complicated if indirect effects of human action – e.g. atmospheric carbon fertilisation or increased temperatures due to global warming – are to be taken into account. Sinks in the CDM have been capped and limited to afforestation and deforestation. COP 9 in Milan agreed to issue 'temporary CERs' (tCERs) for afforestation and reforestation CDM projects. These credits are only created for a certain period of time, i.e. 5 years, after which they expire and need to be replaced by other emission rights. If the project still subsists after this period, the same amount of new credits can be re-issued until the end of the crediting period of the underlying sinks project.

Due to the focus of negotiators' interest on forest sinks, soil sinks in Annex B were not capped in the Marrakech Accords. Potentially, soil sinks can become highly important but monitoring and introduction of policies addressing many dispersed actors remains problematic. Generally speaking, soil sequestration and general sustainable development practices in agriculture are a much easier 'fit' than forest sinks and sustainable development.

Marine sinks can encompass artificial fertilisation and disposal of liquid CO_2 in the deep sea (see Michaelowa et al. this issue).

We assume that sinks can be used without limit if they can be monitored. CDM sinks credits are temporary (expiry at the end of each commitment period but re-issuance if the sink continues to exist). We assume that countries can use marine sinks in their exclusive economic zone.

8.1. Geological Storage

Carbon dioxide could be separated from the effluent gas of fossil fuel fired plants, collected and stored in aquifers, coal seams and empty oil and gas reservoirs (see Michaelowa et al. this issue). In our scenario, countries can use geological sinks on their territory.

9. Political Barriers that May Remain and How to Overcome Them

When developing this scenario many colleagues have commented that it was too optimistic. Definitely, there are high barriers that remain. But as in other policy fields that were initially believed to be unmanageable, an aggressive strategy on climate policy can become a mainstream position. Even OPEC countries may realise that phasing out coal production is in their interest and that keeping oil reserves in the long-term for high-value-added chemical industry uses is better than shelling out oil in the short term.

9.1. 'Short-termism'

A huge barrier to the scenario is the possibility that policymakers follow just very short-term interests. The prime example is of course President Bush and the US oil industry. Climate policy essentially as a long-term issue will then have a hard time. But the same short-termism may then lead to a hard change in course if voters suddenly feel strongly about climate change, maybe due to a sudden perception that it is a problem that requires immediate action. Such an abrupt change will be much more costly than a continuous policy path as the one suggested here. The aftermath of September 11 has shown what deleterious effects can be created by policymakers who just concentrate on one issue.

9.2. Wild West

Another barrier could be called 'high noon syndrome'. Every negotiator in international negotiations will flinch only at the last minute – and then inefficient and inequitable solutions are likely to come out or negotiations fail completely. Russia is a particularly good example of such a strategy. It can be alleviated by increasing transparency of and access to the negotiations. If media and non-governmental organisations scrutinise the actions of negotiators, the search for compromise will be rewarded.

10. Policy Strategies to Make Graduation and Deepening Happen

The graduation and deepening scenario is much more ambitious than the current mainstream gloom in climate negotiator circles. Obviously, it will not be an easily selling item. We will set out strategic elements that improve its chances.

10.1. Weather Catastrophes as Political Windows of Opportunity

Extreme weather events make the common man think about the impacts of unfettered climate change. They are thus an excellent opportunity to push policymakers to commit themselves to ambitious mitigation efforts. But people quickly forget so the chance passes. An example of a chance grasped is the drought in the US Midwest in 1988 that led to the US support of developing an international climate policy regime. Likewise the German flood of 2002 which fell in the general election campaign was used by the Green Party to quickly put up posters announcing "We fight climate change". The Green result improved markedly compared to earlier polls and they were able to put an indicative −40% emission reduction target in the coalition treaty. Of course, initial political gains after a catastrophe can be eroded by stubborn lobbies of which France is a good example. The big storms of late 1999 led to the announcement of an ambitious climate policy strategy with a carbon tax as its cornerstone. However, within 2 years of debate, the tax had been successfully prevented by the emitter lobbies.

An analogy from the past where the window of opportunity was used is the sharp and costly SO_2 reduction in the early 1980s in Germany after reports of widespread forest dieback ('Waldsterben'). Despite later news that forest dieback was not as severe as thought, the programme was continued.

The international negotiations would need a ratcheting structure of target offers that would allow countries to offer a target that could be strengthened at a subsequent negotiation session but not weakened. Then policymakers could ratchet up their offer after an extreme event.

10.2. Linking Carrots and Sticks

The graduation and deepening regime has carrots and sticks that shall cater to different critical groups.

The full inclusion of sinks allows countries with large geological reservoirs, vegetation and marine areas to cover a large part of their commitment. This should be attractive to the US and Australia that have already embarked on large scale sequestration R&D programmes. The 'hot air' countries will also be compensated to some extent by sinks on their large territories for their stronger target.

The full use of international flexibility is attractive for all parties under the regime. An effective stick could be the exclusion from the mechanisms if a country does not take up a target despite passing the graduation threshold. Graduation is also sweetened by the chance to exchange the relatively cumbersome project-based CDM for emissions trading and JI.

10.3. Grasping the Fruit of Past Effort

Due to the large-scale support of renewable energy, the situation could be reached when the cost gap to fossil fuels closes. For some technologies, there are clear indications that this is happening. For example, wind power in very good sites is only a hair's breadth away from being competitive with new coal-fired power plants. The increasing age of the fossil-power plant fleet makes it increasingly impossible to rely on fully depreciated Methuselah plants. Countries with a large renewable energy industry will become a lobby of strong climate policy efforts.

11. A Negotiation Strategy and Policy Timetable

A precondition of graduation and deepening is strong pressure on Russia to ratify the Kyoto Protocol without further delay. The EU could play a leading role in this effort which could then be used to consolidate its leadership in the initial stages of post-2012 negotiations.

As a first step in building trust, the EU showed developing countries that it takes them seriously by quickly deciding on the 'linking directive' for the immediate use of CDM credits in the EU emissions trading scheme. Fortunately, the idea of an import cap has been abandoned. It now remains to be assured that import of CDM credits should not be subject to complex government approval rules and EU member countries should bundle their current efforts towards a coordinated capacity building programme for CDM host countries. A successful CDM will also show emitters that emission reduction is much less expensive than currently thought.

Pro-climate policy groups within the EU should join forces and prepare proposals for unilateral targets for post-2012 that may be quickly brought into the debate once a meteorological extreme event occurs. EU targets going beyond business-as-usual are decisive to show the rest of the world that the EU is not just window-dressing.

The EU should reach out to other progressive countries to form a 'Beyond 2012 group'. Candidates are Norway, Switzerland and New Zealand, and links to progressive forces within Canada and Japan should also be forged. This group should develop a target proposal for the core of industrialised countries making clear that such targets can only be reached if non-Annex B countries graduate.

The US and Australia can be re-engaged by starting a debate on sinks definitions.

Negotiation of an indicative concentration target could be taken up once the IPCC Special Report on dangerous climate change is published. It should not face major hurdles and could be finalised in 2005. The negotiation of Annex B targets should start at COP 11 in 2005 and be finalised at COP 13 in 2007. Sinks rules and GWPs would be defined by COP 12 in 2006. Graduation thresholds as well as the extension of the CDM are negotiated at COP 13 in 2007. A IATA/IMO target would be set at COP 14 in 2008.

12. Conclusions

The scenario 'graduation and deepening' considerably strengthens Annex B emission targets. It introduced targets on the base of a concentric ring structure where a graduation index consisting of per capita emissions and per capita GDP is assessed for all non-Annex B countries. Countries whose index is above the Annex B average get Annex B average targets, albeit with a base year of 2012. Countries with an index above the lowest Annex II level get a target which corresponds to the lowest Annex B level, and those above the lowest Annex B level have to stabilise. Large emitters below this threshold can use a CDM including policies and measures. Countries can use all types of sinks, terrestrial, marine and geological, as long as they are capable of being monitored. CDM sink credits expire after each commitment period but can be renewed.

Notes

1. In climate policy, use of a cost–benefit approach is difficult due to the problem in setting a discount rate covering a period of centuries, due to the need to valuate non-market impacts and the assumption that distribution does not matter. For a good discussion of these points see Goulder (2003).
2. In the document specifying the target, the EU also aims to limit the temperature increase to 2 °C compared to the preindustrial level. This is unlikely to be achieved with a 550 ppm CO_2 target.
3. There is an increasing consensus that costs of reaching the 550 ppm target are much lower than of reaching 450 ppm (Edmonds and Sands 2003, p. 178).
4. The radiative forcing is proportional to the current concentrations of the respective greenhouse gases and thus not directly linked to current emissions.
5. For example, the Kyoto target negotiations circled around a stepwise differentiation of one percentage point between the EU, US and Japan. The small project thresholds of the CDM all use the number 15, leading to an inconsistent but seemingly easy and just outcome.
6. Transaction costs for emissions trading systems are about an order of magnitude lower than for project-based mechanisms (Michaelowa et al. 2002).

Appendix A

Table A1. Non-Annex B GDP data and comparison to Annex B (2000 data).

	GDP/capita	Emissions (million t CO_2)	Share of current Annex B (>1%)	Emissions change 1990–2000 (%)
Qatar	26,051	35.1		+150.4
Singapore	22,716	42.0		+46.0
Average Annex B	20,218	77.1	0.6	+80.2
Cyprus	19,197	6.3		+63.1
Taiwan	18,547	215.3	1.6	+88.9
Israel	18,454	62.4		+85.8
United Arab Emirates	18,182	68.7		+68.0
Oman	17,667	23.5		+120.1
Brunei	16,264	5.1		+57.8
Malta	15,333	2.3		−0.9
Lowest Annex II	15,019	460.7	3.4	+83.3

Table A1. Continued.

Bahamas[a]	15,000	1.9		NA
Kuwait	14,833	62.6		+213.1[b]
Barbados[a]	14,500	2.2		NA
Bahrain	14,203	14.1		+20.7
Korea	13,790	433.6	3.2	+91.7
Argentina	11,506	130.2		+33.1
Saudi Arabia	10,452	260.6	1.9	+54.1
Even number	10,000	1461.8	10.7	+88.4
Mauritius[c]	9940	1.8		NA
Chile	8898	48.1		+58.9
South Africa	8754	295.8	2.2	+16.2
Uruguay	8452	5.3		+25.4
Trinidad and Tobago	8446	15.1		+38.7
Mexico	8358	359.6	2.6	+23.1
Malaysia	8195	106.1		+123.9
Costa Rica	7630	4.6		+74.3
Botswana[3]	7170	3.1		NA
Brazil	6949	303.3	2.2	+57.0
Turkey	6299	204.1	1.5	+58.4
Thailand	6020	147.2	1.1	+89.0
Tunisia	5986	17.8		+45.4
Gabon	5878	1.4		+32.0
Colombia	5843	57.2		+27.8
Namibia	5744	1.9		+55.8[d]
Dominican Republic	5728	17.8		+132.6
Equatorial Guinea[c]	5600	NA		NA
Panama	5580	4.9		+98.8
Iran	5567	292.1	2.1	+83.7
Venezuela	5518	128.6		+25.4
Bosnia and Herzegovina	5452	15.4		−21.6[e]
Kazakhstan	5194	122.8		−50.75
Peru	4518	26.4		+37.7
Macedonia	4729	8.4		−8.1
El Salvador	4177	5.2		+141.7
Paraguay	4115	3.3		+70.6
Philippines	3845	68.9		+91.4
Guatemala	3577	8.8		+166.5
Turkmenistan	3548	34.3		+17.6[e]
Lowest Annex B	3528	3766.2	27.5	+49.6

[a]Data from national communication and World Bank.
[b]Very low 1990 level due to Iraqi occupation; compared to 1989 level, the increase is only 22.7%.
[c]Philibert and Pershing (2002) and respective national communications.
[d]Compared to 1991.
[e]Compared to 1992.
Source: IEA (2002).

Table A2. Per capita emissions thresholds.

	t CO_2/ capita	Emissions (million t CO_2)	Share of current Annex B (>1%)	Emissions change 1990-2000 (%)
Qatar	60.0	35.1		+150.4
Kuwait	31.5	62.6		+213.1[a]
United Arab Emirates	23.7	68.7		+68.0
Bahrain	20.4	14.1		+20.7
Brunei	15.0	5.1		+57.8
Saudi Arabia	12.6	260.6	1.9	+54.1
Trinidad and Tobago	11.6	15.1		+38.7
Average Annex B	11.2	461.3	3.4	+71.0
Singapore	10.5	42.0		+46.0
Israel	10.0	62.4		+85.8
Even number	10.0	565.7	4.1	+70.3
Taiwan	9.7	215.3	1.6	+88.9
North Korea	9.5	167.3	1.2	−15.7
Korea	9.2	433.6	3.2	+91.7
Cyprus	8.4	6.3		+63.1
Barbados[b]	8.2	2.2		NA
Oman	9.8	23.5		+120.1
Kazakhstan	8.3	122.8		−50.7[b]
Bahamas[c]	7.5	1.9		NA
Libya	7.3	38.9		+46.5
South Africa	6.9	295.8	2.2	+16.2
Turkmenistan	6.6	34.3		+17.6[b]
Malta	5.8	2.3		−0.9
Lowest Annex II	5.8	1909.9	13.9	+31.6
Venezuela	5.3	128.6		+25.4
Malaysia	4.6	106.1		+123.9
Iran	4.6	292.1	2.1	+83.7
Uzbekistan	4.6	114.9		+2.3[d]
Macedonia	4.1	8.4		−8.1
Yugoslavia	4.1	43.2		−22.8[e]
Bosnia and Herzegovina	3.9	15.4		−21.6[d]
Jamaica	3.7	9.8		+35.9
Mexico	3.7	359.6	2.6	+23.1
Azerbaijan	3.5	28.2		−37.4[d]
Argentina	3.5	130.2		+33.1
Iraq	3.3	77.2		+35.4
Lebanon	3.3	14.2		+121.8
Syria	3.2	52.3		+68.9
Chile	3.2	48.1		+58.9
Turkey	3.1	204.1	1.5	+58.4

Table A2. Continued.

Jordan	2.9	14.3		+55.4
Cuba	2.8	31.4		−1.1
Lowest Annex B	2.8	*3673.9*	26.9	+36.6

[a]Very low 1990 level due to Iraqi occupation; compared to 1989 level, the increase is only 22.7%.
[b]1997 data.
[c]1994 data.
[d]Compared to 1992.
[e]Compared to 1991.

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