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Climate policy beyond 2012

A survey of long-term targets and future frameworks

Asbjørn Torvanger

Michelle Twena

Jonas Vevatne

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CICERO
Center for International Climate
and Environmental Research
P.O. Box 1129 Blindern
N-0318 Oslo, Norway
Phone: +47 22 85 87 50
Fax: +47 22 85 87 51
E-mail: admin@cicero.uio.no
Web: www.cicero.uio.no

CICERO Senter for klimaforskning
P.B. 1129 Blindern, 0318 Oslo
Telefon: 22 85 87 50
Faks: 22 85 87 51
E-post: admin@cicero.uio.no
Nett: www.cicero.uio.no

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Forfatter(e): Asbjørn Torvanger, Michelle Twena og Jonas Vevatne

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Sammendrag:
Denne rapporten er basert på ein omfattande og strukturert litteraturgjennomgang av viktige spørsmål knytt til langsiktige mål for klimapolitikken, og til rammene for gjennomføring av klimapolitikken.
Studien gjev eit grunnlag for arbeidet med global klimapolitikk etter 2012, enten Kyotoprotokollen trer i kraft eller ikkje. Den store utfordringa er å få til breiare deltaking i framtidige klimaavtaler enn det ein har klart i Kyotoprotokollen, spesielt frå USA og utviklingslanda si side, samt å få til omfattande reduksjonar av globale klimagassutslepp for å unngå at den menneskeskapte klimaendringa kjem ut av kontroll. Drøftinga av klimamål er delt inn i fordelar og utfordringar med langsiktige globale klimamål, mål knytt til konsentrasjonen av klimagassar i atmosfæren, mål knytt til konsekvensar av klimaendringar, og spørsmål knytt til fastsetjinga av kortsiktige utsleppsmål som ledd i oppfyllinga av eit langsiktig mål. Drøftinga av gjennomføring av klimapolitikken er inndelt i arkitektur for framtidig klimapolitikk, ulike typar nasjonale forpliktingar under ein globale avtale, og differensiering av innsatsen mellom land for å redusere klimagassutsleppa.

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Abstract: This report is based on a comprehensive and structured literature review of key issues associated with long-term goals for climate policy, and to the framework for implementing climate policy. The study provides a basis for working with global climate policy after 2012, whether the Kyoto Protocol enters into force or not. The main challenges are to achieve broader participation in future climate agreements than has been the case with the Kyoto Protocol, especially with respect to the USA and developing countries, and to achieve deep emissions reductions to prevent human-induced climate change from getting out of control. The discussion of climate goals is divided into advantages and challenges presented by long-term climate goals, goals connected to the concentration of greenhouse gases in the atmosphere, goals connected to the impacts of climate change, and the issue of setting short-term emissions targets as a step in meeting long-term goals. The discussion of implementing climate policy is divided into architecture of future climate policy, different types of national commitments under a global agreement, and differentiation of national emissions reductions targets.

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CICERO Senter for klimaforskning
P.B. 1129 Blindern
0318 Oslo

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CICERO (Center for International Climate and Environmental Research – Oslo)
PO Box 1129 Blindern
0318 Oslo, NORWAY

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Foreword

This report was funded by the Norwegian Ministry of Environment, with some additional funding from the Ministry of Foreign Affairs. The project was carried out between January and May 2004. We would like to thank our colleagues at CICERO for their valuable contributions, in particular: Guri Bang, Camilla Bretteville, Gunnar Eskeland, Jan S. Fuglestvedt, Jon Hovi, Lynn Nygaard, Lars Otto Næss, Pål Prestrud and Kristin Rypdal.

Abbreviations

AOSIS	Alliance of Small Island States
CICERO	Center for International Climate and Environmental Research - Oslo
CO_2	Carbon dioxide
COOL	Climate OptiOns for the Long-term
COP	Conference of the Parties
COP/MOP1	First Conference of the Parties, where Kyoto Protocol was ratified
EU	European Union
G-77	Group of 77 developing countries
GDP	Gross Domestic Product
GHG	Greenhouse gases
HIDC	High-Income Developing Countries
IIASA	International Institute of Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
LDCs	Least-Developed Countries
LRTAP	Convention on Long-Range Transboundary Air Pollution
MIC	Middle-Income Developing Countries
OECD	Organization for Economic Co-operation and Development
PAMs	Policies and Measures
R&D	Research and Development
SBSTA	Subsidiary Body for Scientific and Technological Advice
SIDS	Small Island Developing States
SLR	Sea Level Rise
SRES	Special Report on Emissions Scenarios
UN	United Nations
UNAGGG	United Nations Advisory Group on Greenhouse Gases
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States of America
THC	Thermohaline Circulation
WAIS	West Antarctic Ice Sheet
WBGU	German Advisory Council on Global Change (Der Wissenschaftliche Beirat der Bundesregierung Globale Umweltveränderungen)
WG1	IPCC Working Group 1
WMO	World Meteorological Organisation
WTO	World Trade Organisation

Executive summary

New creativity is needed for the further development of global climate policy. The future of the Kyoto Protocol is uncertain due to Russian hesitation to ratify. According to the Kyoto Protocol, negotiations on commitments for the period after 2012 should at latest commence by 2005 and be finalized by the end of 2007. If the protocol should not enter into force, more fundamental issues on the design and negotiation of international cooperation modes must be raised.

The aim of this study is to provide an underpinning for this thinking and the formulation of future climate policy through a comprehensive survey of the literature. An increased understanding of the main issues, challenges, questions, solutions suggested so far, and the inter-linkages between these issues is a fundamental prerequisite for the process. Major challenges are first to induce broader participation in climate policy, foremost the involvement of the USA and developing countries, and second to induce depth in mitigation efforts, which refers to the necessity to achieve substantial reductions in global greenhouse gas emissions over the next decades to avoid a sizeable man-made climate change.

The survey is divided into two main sections based on a top-down climate policy development design. The first part is on defining long-term targets for climate policy, whereas the second part investigates climate policy frameworks. Climate policy should meet criteria such as environmental integrity (achieving deep global GHG emission reductions), cost-effectiveness, political feasibility (broad participation), and technical feasibility (in negotiations and implementation).

According to the United Nations Framework Convention on Climate Change (UNFCCC) the ultimate objective for climate policy is, “stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system” (Article 2). However, developing policies requires a specific interpretation of this general principle. Even if adopting a specific long-term target at least at present seems infeasible, and it is difficult for politicians to commit to a long-term global target, there are a number of attached potential benefits. A long-term target can present a point of departure for setting short-term targets and assessing progress, induce technological change, and promote awareness and mobilize society. Such targets can be defined in terms of concentration of greenhouse gases in the atmosphere, which is closely related to radiative forcing, or to temperature rise. They could alternatively be defined in terms of allowable impacts from climate change on ecosystems and society. Because our major climate concerns are linked to impacts from climate change, basing a long-term target on climate impacts has intuitive appeal. On the other hand, it raises difficulties in terms of what indicators to choose and how to compare impacts across indicators and countries/regions. Meeting a long-term target implies choosing a consistent global emission path, where one aspect is the choice between early or delayed mitigation efforts.

Future climate action can build on different frameworks. The discussion in this report is structured around three levels organized in a hierarchical manner, where the first relates to the architecture of future actions. Architecture refers to fundamental decisions in the design of global climate policy, such as whether or not it fully or partly builds on United Nations institutions such as the climate agreements. Other fundamental decisions relate to whether or not the policy aims at specific short-term emission targets or rather at moving us in the right direction; the coordination level of the policy (global, regional, national, or sectoral); grouping of countries; and the choice of allowing only one or more commitment types for each nation and between nations. Additional issues for global climate policy design include

how to integrate development and climate policy in poor countries, and how to combine mitigation and adaptation policies.

The second level is represented by climate policy commitment types. We present different types of commitments that all could contribute to reduced emissions. Finally, the third level relates to various ways of differentiating such commitments, given that one or more commitment types have been selected. Lastly, we discuss criteria that are useful for assessing these schemes.

The major conclusions of this survey are summarized in six points:

1. A flexible approach is needed to ensure broad participation and significant emission reductions. The flexibility could be along four dimensions: choice of commitment type(s), methods of differentiating across countries, timing with regard to when certain groups (foremost poor countries) take on commitments, and inclusion of substances that indirectly affect climate.

2. Progress in negotiations will be best served by more focus on moving in the right long-term direction in order to keep future options open than on meeting specific short-term global emission caps.

3. Mitigation costs and participation attractiveness should be given sufficient attention when evaluating different emission paths meeting the same temperature increase ceiling.

4. All things considered, concentration and temperature targets are a better choice than impacts-based targets. However, better information on the distribution in time and space of impacts given a climate change scenario is a valuable input to decisions on emission, concentrations and temperature based targets.

5. A coalition of most willing nations could be an interesting supplement to a global UN-based process (building on UNFCCC and the Kyoto Protocol), and in particular if the Kyoto Protocol should fail.

6. Some type of international coordination of climate policy is required because of both cost-effectiveness concerns (to employ flexibility mechanisms) and attractiveness for broad participation. Increased cost-effectiveness could make more ambitious policies attainable. Nations' willingness and efforts to manage the climate system given its nature as a global common property resource will be conditional on the efforts by other nations.

Norway's contributions in particular can include the following:

1. Norway can contribute to bridging countries across the Atlantic and the North-South climate policy cleavage. In this regard Norway can take advantage of its good relations with developing countries and its large official development aid contributions. There is a potential for better integration of sustainability and climate policies in development policies and assistance. Furthermore, Norway could contribute to better integration of climate change impacts and adaptation, and emission abatement policies.

2. As a country with a strong climate research tradition, Norway could invest in conducting more research to explore essential post-2012 issues.

3. From a national perspective, Norway should consider its interest in future negotiations. For instance, does Norway prefer to build on the global Kyoto structure or on a more regional approach involving the most willing nations?

Samandrag

Ny kreativitet er nødvendig for å vidareutvikle global klimapolitikk. Framtida til Kyotoprotokollen er usikker på grunn av den russiske nølinga med å ratifisere. Ifølgje Kyotoprotokollen skal forhandlingar om mål for perioden etter 2012 seinast starte opp i 2005, og vere ferdige innan utgangen av 2007. Dersom protokollen ikkje skulle tre i kraft vil det reise meir fundamentale spørsmål om utforming av internasjonale forhandlingar og former for internasjonalt klimapolitisk samarbeid.

Denne studien gjev eit grunnlag for arbeidet med global klimapolitikk etter 2012 basert på eit omfattande gjennomgang av litteratur. Ei auka forståing for dei viktigaste spørsmåla, utfordringane, spørsmåla, løysingar foreslått så langt, og koplingar mellom desse spørsmåla er ein viktig føresetnad for denne prosessen. Den fyrste store utfordringa er å få til breiare deltaking i klimapolitikken, fyrst og fremst at utviklingslanda og USA blir med. Den andre store utfordringa er å få til omfattande reduksjonar i globale klimagassutslepp over dei neste tiåra for å unngå ei større menneskeskapt klimaendring.

Denne oversiktsrapporten er inndelt i to hovuddelar basert på ei utvikling av klimapolitikken som startar med det langsiktige målet. Den fyrste delen drøftar langsiktige klimamål, medan den andre delen undersøkjer rammene for å gjennomføre klimapolitikken. Klimapolitikk bør nå miljømåla som er fastsett for den (oppnå større reduksjonar i globale utslepp av klimagassar), vere kostnadseffektiv, mogeleg å gjennomføre politisk (brei global deltaking), og mogeleg å forhandle om og gjennomføre.

Ifølgje Klimakonvensjonen er det langsiktige målet for klimapolitikken å stabilisere konsentrasjonen av klimagassar i atmosfæren på eit nivå som hindrar ei farleg menneskeskapt forstyrring av klimasystemet (Artikkel 2). For å formulere ein praktisk klimapolitikk må dette generelle målet tolkast og spesifiserast. Sjølv om det kan sjå umogeleg ut å bli samde om eit langsiktig klimamål, og det er vanskeleg i vårt politiske system å binde seg til slike langsiktige mål, er det mange fordelar knytt til eit klårt mål. Eit langsiktig mål er eit utgangspunkt for kortsiktige mål og for vurdering av om ein er på veg til å oppnå målet, fremme teknologisk utvikling, og fremme merksemd om klimautfordringa og mobilisere samfunnet. Slike mål kan uttrykkjast som ein skranke på konsentrasjonen av klimagassar i atmosfæren, som er nært kopla til strålingspådrivet (’radiative forcing’), eller dei kan uttrykkjast i form av temperaturstigning. Alternativt kan dei uttrykkjast som skrankar på konsekvensar av klimaendring for økosystem og samfunn. Vi er mest opptekne av dei konkrete konsekvensane av klimaendring så dette alternativet ser ut til å vere det beste valet. På den andre sida er det mange vanskar knytt til dette alternativet, i form av kva indikatorar for klimaeffektar ein skal velje og korleis ein kan samanlikne effekten på ulike indikatorar og mellom land og regionar. Eit langsiktig klimamål må nåast gjennom ein utsleppsbane for klimagassar som svarar til målet, der eit val er om ein skal starte tidleg med omfattande reduksjonar av klimagassutsleppa eller vente med omfattande tiltak.

Framtidige klimatiltak kan byggje på ulike rammeverk. Drøftinga i denne rapporten er strukturert rundt tre hierarkiske nivå. Det øvste nivået, arkitektur, viser til grunnleggjande

spørsmål i utforminga av global klimapolitikk, som om rammene heilt eller delvis skal vere FN-institusjonar som Klimakonvensjonen og Kyotoprotokollen. Andre grunnleggjande spørsmål er om ein skal sikte mot spesifikke kortsiktige utsleppsmål eller nøye seg med at utviklinga går i rett retning; om koordineringsnivået er globalt, regionalt, nasjonalt, eller sektorbasert; gruppering av land; og om ein skal opne for eit eller fleire klimapolitiske mål for eit og mellom land. Andre viktige spørsmål knytt til utforming av klimapolitiske rammer er samvirke mellom utvikling og klimapolitikk i utviklingsland, og korleis ein kan kombinere tiltak for klimagasskutt med tiltak for tilpassing til klimaendring.

Det andre nivået gjeld ulike typar klimamål som land kan ta på seg. Vi drøftar ulike nasjonale klimamål som fører til reduserte klimagassutslepp. Det tredje og siste nivået ser på metodar for fordele utsleppskutta mellom land, på bakgrunn av eit eller fleire typar klimamål. Til slutt diskuterer vi kriterium som kan brukast til å evaluere metodar for fordeling av utsleppskutt mellom land.

Dei viktigaste konklusjonane frå prosjektet er:

1. Ei fleksibel tilnærming er nødvendig for å få til brei deltaking og omfattande reduksjonar i utsleppa av klimagassar. Fleksibiliteten bør gjelde på fire plan: val av type(ar) klimamål, metodar for fordeling av utsleppskutt mellom land, tidspunktet for når land (fyrst og fremst utviklingsland) skal ta på seg klimamål, og med omsyn på å ta med utslepp av substansar som har ein indirekte klimaeffekt.

2. Framdrift i globale forhandlingar blir best sikra ved å fokusere på å gå in rett retning enn å oppnå kortsiktige globale utsleppsmål.

3. Kostnader ved klimagasskutt og at det er attraktivt for land å delta må gjevast nok merksemd når ein skal samanlikna ulike utsleppsbaner som fører til det same globale målet uttrykt som ein skranke på temperaturstigninga i atmosfæren.

4. Etter ei samla vurdering ser vi langsiktige mål basert på konsentrasjon og temperatur som betre eigna enn mål basert på effektar av klimaendringar. Men betre kunnskapar om fordelinga av effektar frå eit klimascenario over tid og rom vil vere eit verdifullt tilskot til utforming av utslepps-, konsentrasjons, og temperaturbaserte mål.

5. Ein koalisjon av dei mest villige nasjonane kan vere eit interessant supplement til globale FN-baserte prosessar (som byggjer på Klimakonvensjonen og Kyotoprotokollen), og spesielt dersom Kyotoprotokollen skulle feile.

6. Ein eller anna internasjonal koordinering av klimapolitikken er nødvendig for å sikre kostnadseffektivitet (og bruke fleksibilitetsmekanismane) og å gjere eit slikt samarbeid meir attraktivt gjennom brei internasjonal deltaking. Blir klimapolitikken meir kostnadseffektiv kan det bli mogeleg å nå meir ambisiøse mål. Nasjonane sin vilje og innsats for å forvalte klimasystemet som ein felles global ressurs avheng av innsatsen til alle nasjonar.

I eit norsk perspektiv kunne den viktigaste medverknaden komme i tre kategoriar:

1. Noreg kan prøve å minske den transatlantiske avstanden (mellom Europa og USA) og avstanden mellom fattige og rike land. I denne samanhengen kan Noreg byggje på gode relasjonar med mange utviklingsland gjennom utviklingsprosjekt. Det finst eit potensiale for betre integrasjon av berekraftig utvikling og klimapolitikk i utviklingspolitikken i fattige land og gjennom utviklingsprosjekt finansiert av rike land. Noreg kunne også hjelpe til med ein

betre integrasjon av tilpassing til klimaendringar og tiltak for å redusere utslepp av klimagassar.

2. På bakgrunn av vår sterke tradisjon for klimaforsking kunne Noreg satse på meir forsking om post-2012 spørsmål.

3. Ut frå eit nasjonalt perspektiv bør Noreg vurdere sin interesse i dei klimapolitiske forhandlingane som vil komme. For eksempel, vil Noreg helst byggje på den globale Kyoto-strukturen eller ynskje ei meir regional tilnærming som involverer dei mest interesserte nasjonane?

Contents

1 Introduction

Now is the time to think creatively about the future of global climate policy. The future of the Kyoto Protocol is uncertain due to Russian hesitation to ratify, which to a large degree is a consequence of American withdrawal in March 2001. Even if the Kyoto Protocol should be ratified by Russia and thus enter into force, negotiations on commitments for the next target period (after 2012) should, according to the protocol, at latest commence by 2005 and be finalized by end of 2007.

The aim of this study is to provide an underpinning for this thinking and the formulation of future climate policy through a comprehensive survey of the literature. The paper is structured in a way that contributes to increased understanding of the main issues, challenges and questions, and examines how these issues are interlinked, and the solutions suggested so far. One major challenge is to induce broader participation in climate policy, foremost the involvement of developing countries and the USA. Another major challenge is depth in mitigation efforts, which refers to the necessity to achieve substantial reductions in global greenhouse gas emissions over the next decades to avoid a sizeable, and potentially dangerous, man-made climate change over this century.

Figure 1.1 provides a schematic overview of the main stages and issues in the development of a global climate policy based on a well-defined long-term target. This structure is reflected in the main structure of this survey, but not necessarily in the treatment of the issues belonging to each box of the diagram. We find this top-down approach useful, but this does not imply that one must start with e.g. a long-term target before deciding on a future action architecture. Taking the Kyoto Protocol as an example, a short-term emission target was negotiated and differentiated across industrialized countries without any reference to a long-term target. This issue relates to a third major issue as part of designing global climate policy: Should the aim be to meet specific short-term emission or concentration targets, e.g. by 2030, or is a better way forward to focus on moving in the right direction (towards a long-term target)?

The survey is divided into four main sections. It includes contributions from recent and ongoing projects at CICERO. A number of related issues are beyond the scope of the study and therefore not touched upon.[1] Section 2 investigates long-term climate policy targets. Section 3 examines climate policy frameworks, and is divided into different approaches to future climate regimes (architectures), commitment types, and differentiation of commitments. Section 4 considers some related issues, and is followed by a discussion of the most interesting findings with regard to post-2012 issues in Section 5. Throughout the survey we have emphasized the inclusion of references to an extensive literature list, where the interested reader can seek out more detailed studies for further reading.

[1] Examples of such issues include integration of other gases and particles (indirect climate gases and air pollutants) in climate policy, biotic sinks and underground storage of carbon dioxide, emissions from international ship freight and aviation, the relation between the trade regime (WTO) and the climate regime, and learning in terms of conveying new insights from research to applied policy design.

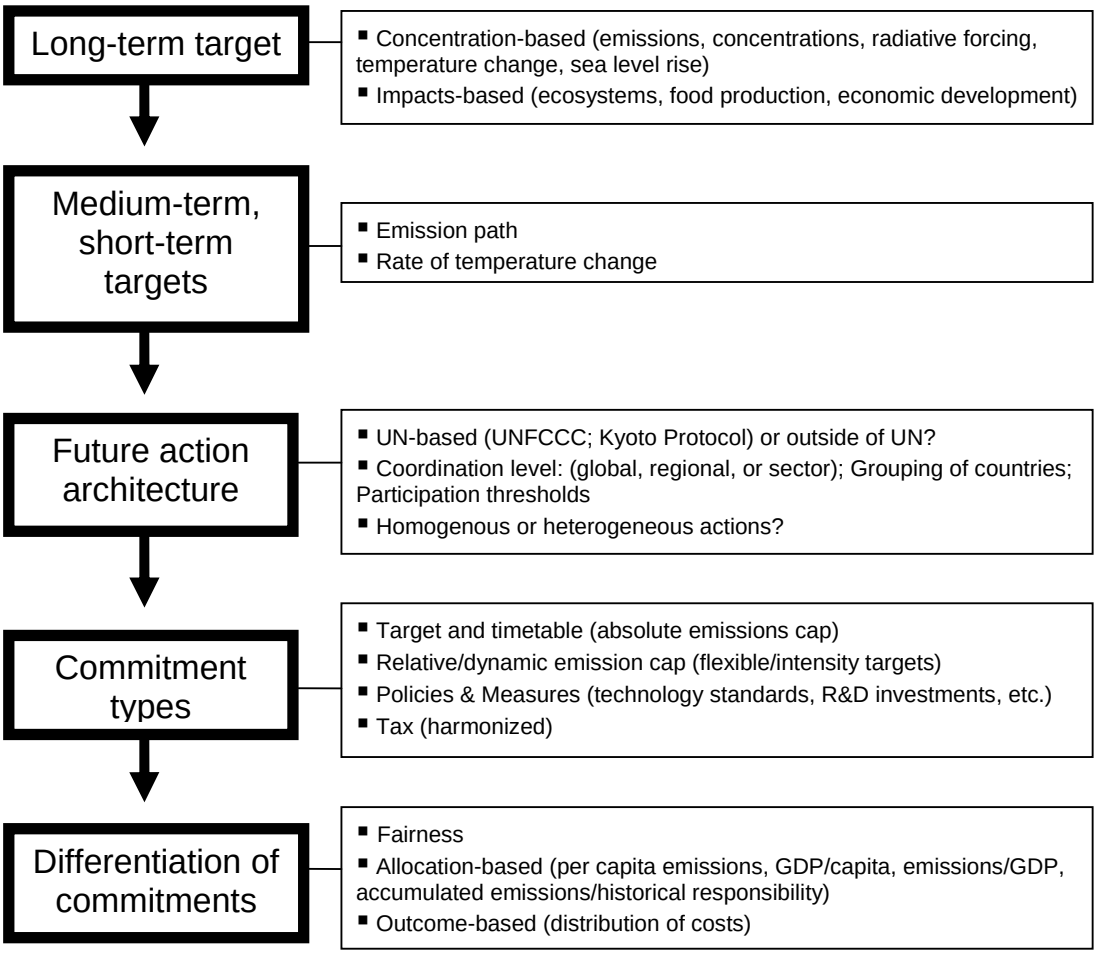

Figure 1.1 Main stages and issues in the development of global climate policy

2 Climate Policy Targets

The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (Article 2). However, there is no international consensus over the stabilisation level that may be required to avoid such damage, despite more than a decade of discussion in international negotiations and earlier scientific consideration of this issue. The difficulties are essentially twofold: impacts remain uncertain, and the concept of dangerous interference inevitably invokes value judgements. It is therefore hardly surprising that the Intergovernmental Panel on Climate Change (IPCC) has to date left discussion of the issue to the political rather than the scientific arena.

Soon after the Kyoto Protocol was adopted in 1997, discussion of short-term issues, such as how its rules and structures might be revised, began to feature heavily in the international climate negotiations. Attempts to launch a formal review of commitments were initiated in 1998, and then again at the Eighth Conference of the Parties (COP-8) in December 2002; however, they were met with little success. The most recent initiative at COP-8 was tabled by the European Union (EU) with the support of several Annex I countries,[2] but was rejected by the Group of 77 (G-77) and the United States (US).[3]

Traditionally, concentration levels of atmospheric CO_2 (or greenhouse gases) have gained most attention when discussing avoiding "dangerous anthropogenic interference."[4] However, there are other factors that might be more appropriate indicators of climate change and thus more suitable as a basis for setting a long-term target (see Section 2.2).

Drawing upon the latter part of the objective of the Convention (Article 2), attention has more recently focused on maximum acceptable or tolerable climate change based on impacts to ecology, the economy and society (see Hare 2003; WBGU 2003). This impacts-dimension is also mentioned in the objective of the Convention (Article 2) and could be a way of approaching the issue of a long-term target (see Section 2.2.1). As early as the late 1980s, such tolerable rates and thresholds as a driver for climate policies were discussed by the UNEP and WMO advisor to the UN Advisory Group on Greenhouse Gases (UNAGGG) (Agrawala 1999; Corfee-Morlot and Höhne 2003:280), but they have only more recently been reintroduced in the context of a post-2012 climate regime.

Another approach to setting long-term targets is founded on economic modelling, whereby GHG abatement and climate change damage functions are explicitly formulated to determine optimal mitigation in a cost-benefit setting. Nordhaus and Boyer (2000) carry out such an analysis at the global regional level employing the RICE model. Obviously there are intrinsic uncertainties in such studies related to long-term scenarios for economic development, energy use and available energy sources, damage costs, and future mitigation costs, but over time these will be reduced as new knowledge on climate change impacts and other issues is gained.

[2] Annex I is a list established under the UNFCCC of industrialised countries, including economies in transition, taking on specific emissions commitments.
http://europa.eu.int/comm/environment/climat/glossary.htm

[3] The Group of 77 is the main negotiating group of developing countries within the UN system and represents more than 130 countries. http://europa.eu.int/comm/environment/climat/glossary.htm

[4] The Kyoto Protocol deals with the greenhouse gases carbon dioxide, nitrous oxide, methane, sulphur hexafluoride, hydrofluorocarbons and perfluorocarbons (IPCC 2001a).

In this section we first examine whether it is necessary to have an explicit long-term target, and what benefits and drawbacks a "top-down" approach involving a specified long-term target would provide. We then go on to review potential indicators for climate change, target levels and short-term emission paths consistent with a long-term target.

2.1 A long-term target

In this section we discuss whether a long-term target is necessary before we explore in more detail the rationale for developing and agreeing to a long-term target.

2.1.1 Is a long-term target necessary?

Even if Article 2 of the Framework Convention states that the ultimate objective is stabilization of CO_2 concentration levels, the Kyoto Protocol negotiations did not consider, let alone agree upon, a long-term target. The Kyoto process has instead focused on setting short-term targets (for Annex I parties), on the understanding that these will be subject to review and revision as time proceeds. As a result, some have described the current system as being characterized by "ad-hoc incrementalism" (Corfee-Morlot and Höhne 2003:280). Critics believe that setting a long-term target may help bring the negotiation process back on track.

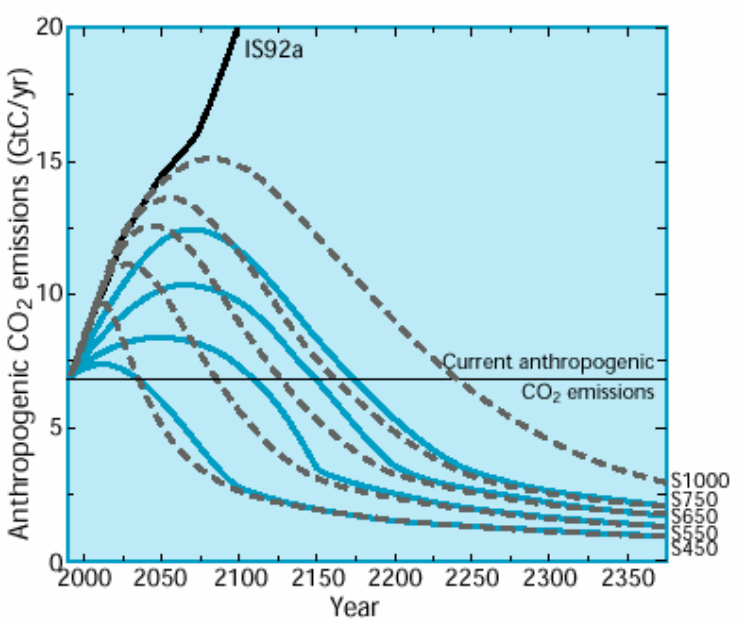

Figure 2.1: To stabilise concentrations at any level, emissions must ultimately fall to virtually zero. IS92a indicates the business-as-usual path, while the others indicate alternative paths to a future level of CO_2-stabilization. Source: IPCC 2001b.

Corfee-Morlot and Höhne (2003) propose that four major issues should be addressed when assessing the need for a long-term target. First, stabilisation of atmospheric concentrations in the 21st Century at any level would require a significant departure from current emission levels. Global emissions would need to drop radically compared to today, to well below 1990 levels and decline to close to zero over time (see Figure 2.1). For example, to reach a certain stabilisation target of 450 ppmv,[5] global greenhouse gas (GHG) emissions would have to fall

[5] For very small concentrations of gases, atmospheric scientists use the unit ppmv, which stands for parts per million by volume and represents the fraction of volume of gas occupied by a component multiplied by 1,000,000. If there is 3 ppm of CO_2 in a bottle filled with gas, then for every 1,000,000 molecules in the bottle, 3 of those molecules are CO_2.

below 1990 by 2040 and peak by 2015 – perhaps even earlier (see Table 2.1). "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" (Corfee-Morlot and Höhne 2003:278).

Table 2.1 Level and timing of required global emission reductions. Source: IPCC 2001b, Table 6-1

WRE* CO_2 stabilization profiles	Accumulated CO_2 emissions 2001 to 2100 (GtC)	Year in which global emissions peak	Year in which global emissions fall below 1990 level
450	365-735	2005-2015	<2000-2040
550	590-1135	2020-2030	2030-2100
650	735-1370	2030-2045	2055-2145
750	820-1500	2040-2060	2080-2180
1000	905-1620	2065-2090	2135-2270

* WRE= Wigley, Richels and Edmonds. (1996).

Second, they underline that there may be many different paths to a future stabilisation level of GHGs, and that there is a risk that if, in the short term, emissions rise above a certain level, low long-term stabilisation levels may be out of reach. Third, due to the inertia and delays in the climate system, even with stabilised concentrations, the world will still be committed to some significant climate changes for centuries to come. The longer mitigation is delayed, the longer the time period over which there will need to be a "commitment to climate change". Finally, they emphasise the *rate* of warming, which is important as it drives ecosystem impacts and possibly other effects such as non-linear, abrupt climate changes.

2.1.2 The case for a long-term target

This section discusses the arguments in favor of a long-term target that have been forwarded.

Reviving the international climate negotiations

Given the ease with which an incremental Kyoto-type process can be delayed and obstructed, a concerted international effort to achieve a consensus around an explicit long-term target might stimulate the international climate negotiations. The process of setting a long-term target could help the parties to lift their views and set focus on their common task in hand – to preserve a global public good for generations to come. It could also help the parties to shift their attentions away from individual near-term relative gains or costs, and instead put more emphasis on planning for a common future.

A point of reference for determining short-term targets and assessing progress

Pershing and Tudela argue that an explicit target for current and future actions would be valuable since, "it makes sense to know where you are going when starting a journey" (2003:13). A long-term commitment could also be more easily used as a basis for calibrating short-term measures and measuring progress (see Section 2.2.3). This standpoint is taken by the COOL-project (Climate OptiOns for the Long-term) at the National Institute for Public Health and the Environment (RIVM) in the Netherlands, which argues that a long-term target "would provide a clear reference for evaluating the adequacy of short-term climate policies" (Berk et al. 2001a:21). After all, "'being on track' can only be determined if the destination is known" (Pershing and Tudela 2003:14). Storey suggests that a long-term target is useful from both a research and a policy-making perspective, not only because a long-term target would provide a reference point from which to define short- and medium-term targets, but it might also improve the potential for cost-effective and fair implementation (since mitigation

http://calspace.ucsd.edu/virtualmuseum/Glossary_Climate/gloss_a-f.shtml

measures and projects need to be assessed over a longer time scale). Regular review of a tentative long-term concentration target could take place, which would provide the opportunity for later adjustments in light of the most recent scientific evidence and changes in social and political priorities (Berk et al. 2001a:21; Evans 2002:5; Storey 2002:20). A regular revision process would also be a way of ensuring that the parties are regularly committing to the long-term target.

Learning about the limits of man-made interaction with the climate system
Setting a long-term target can be a useful learning experience for researchers and decision makers involved since more insights in the climate effects of man-made emissions and the implications of various mitigation scenarios can be gained. Thus one can learn more about the limits put on human activities by the climate system.

Addressing the risks of climate change
Implicit in the process of setting a long-term target is that a decision is made regarding the 'acceptable' level of risk. Establishing this level can help the international community come to terms with how to cope with the risks they face (Pershing and Tudela 2003) and consider how best to address the key issues of vulnerability and adaptation.

Inducing technological change

An explicit long-term target could induce technological change by providing a clear and stable signal to markets and, in doing so, encourage long-term investment in climate-friendly technologies (Pershing and Tudela 2003). For example, a clear target might have an impact on long-term investment planning. Would coal-based power plants still be a viable option if the Chinese knew that adjustment to a post-carbon economy was only a few decades away? Hasselman et al. underlines this argument, "although binding long-term commitments cannot be expected from governments, declarations of long-term policy goals and visible actions to achieve these goals are essential for the investment plans of businesses, particularly for energy technologies characterised by long capital lifetimes" (Hasselman et al. 2003:1924). Furthermore, they argue that while it is a natural response to uncertainty to take a step-by-step approach, the large reductions necessary to combat climate change require a long-term strategy and a broader spectrum of instruments.

Promoting awareness and mobilizing society

The process of setting a long-term target might improve awareness of climate change as an issue and strengthen the link in people's minds between their actions today and their consequences tomorrow (Pershing and Tudela 2003). It may also broaden the support for near-term commitments and actions. In addition, the process of setting a long-term target could be a way of mobilizing society as a whole (business, industry, public sector, NGOs and individuals) to a much larger extent than the situation at present, where commitments are to a certain extent "taken care of" through more "abstract" means such as the flexibility mechanisms. A long-term target would provide legitimacy for climate mitigation action here and now – and not at some time and place in the future.

Promoting global participation

Pershing and Tudela (2003) claim that promoting global participation might be another rationale for a long-term target, because a stringent long-term target will require a *global* effort towards a climate goal. Watson also argues that a series of intermediate targets could be a way of involving developing countries *in an equitable manner* (Watson 2003:1926).

2.1.3 Potential problems with a long-term target

While few would disagree that there is a strong case for setting a long-term target *in principle*, various commentators have voiced their concern over the practical feasibility of agreeing on a long-term target in practice. We go on to discuss their reservations below.

From a theoretical point of view, it should be easier to agree upon a long-term than a short-term target, as governments making far-sighted commitments today won't be the ones held accountable if they are not fulfilled at some point in the distant future. According to the Roman principle of Justice, *rebus sic stantibus*, states have the right to break international agreements if their circumstances change (Hovi 1991, 1992, personal communication). A long-term climate target set for the next century would be subject to such uncertainties, and even if adopted might not be regarded as strictly binding.

Even though Storey points at the usefulness of a long-term target, he underlines that:

> Achieving an international consensus on long-term stabilisation targets, however, will be very difficult to achieve at any point in the near future...what is considered to be a 'safe' level of climate change will vary widely between countries and regions. *The more immediate and realistic task should instead be to develop some degree of international consensus around short and medium-term targets that keep future options open*. Such short and medium-term targets will probably be expressed in terms of emissions rather than global concentrations of greenhouse gases. (Storey 2002:21, our emphasis).

Pershing and Tudela (2003) also indicate some technical and political obstacles associated with setting a long-term target. They argue that the process will inevitably be confounded by scientific uncertainty, and as such, defining *acceptable risk* will be based on value judgment, rather than hard evidence. This could make an agreement complicated to negotiate. Moreover, such a process may divert what limited political will already exists away from mitigating climate change and meeting short-term targets, and play into the hands of those who are happy to stall the political process. The danger is therefore that rather than serving as a lever for action, a focus on the long term might end up "as an excuse for inaction."

Corfee-Morlot and Höhne also advocate a middle-way. They claim that it could be easier for the parties to agree upon "threshold levels for certain categories of impacts or of risks posed by climate change [which] could be translated into acceptable levels of atmospheric concentrations" (2003:277). Establishing a range of upper limits for global emissions in the medium term could help the parties set the ambition level for negotiations on stronger and broader GHG mitigation commitments in the near term.

2.1.4 Alternatives to internationally negotiated targets

Two alternative approaches to a global target have been suggested that could provide at least some of the benefits of a long-term climate target without requiring a formal goal to be negotiated at the international level: a *hedging strategy*, and the emergence of *an informal target* as a guide for action (Pershing and Tudela 2003:30-33).

A hedging strategy

This approach promotes near-term actions that leave open a range of future "targets" without necessarily requiring a commitment to any of them. It has been advocated by a variety of studies, most notably, the COOL dialogue and the German Advisory Council on Global Change (Berk 2001c; WBGU 2003; also see Section 2.2.3). A hedging strategy has the advantage of side-stepping the need to make any formal agreement on a specific long-term target, but poses a difficult political challenge because it requires more stringent long-term targets to be kept within reach, which is likely to require a considerable mitigation effort.

An informal target

It is conceivable that in the absence of an international consensus on the matter, an informal long-term target emerges that gradually becomes a guide for future climate change action. This could be the result of a regional initiative (e.g. by the EU) that spreads outwards to other countries as the need to meet the regional market's stricter internal standards takes hold. Alternatively, one could envisage that the IPCC's use of 550 ppmv as a standard value in its first report of 1991 implicitly becomes the basis for analysis and policymaking, without ever

forming the basis of an internationally negotiated agreement (even though this was not the original intention of the IPCC).

2.2 Long-term climate target options

In this section, we explore the potential forms that a global climate change target can take. Determining a long-term target ultimately poses three key challenges: (1) identifying an appropriate indicator of climate change; (2) selecting a suitable level for that indicator and timing for meeting this level, thereby selecting a target; and (3) choosing an emission path that is likely to lead to that designated target. This process is not only undermined by elements of uncertainty, but also invariably raises questions about costs, timing and political feasibility. We present a brief evaluation of the possible solutions to these problems, addressing each of these three central challenges in Sections 2.2.1, 2.2.2 and 2.2.3 respectively.

2.2.1 Indicators of climate change

Figure 2.2 illustrates the way in which human activities interact with the climate system to cause climate change and its corresponding environmental, social and economic implications. Each step in the 'cause-effect chain' represents a stage at which a climate policy target could potentially be set. The benefit of using an indicator that is closer to the 'effect' end of the process is that it defines a target in the context of the damages it seeks to avoid ('increasing relevance' in the Figure 2.2).

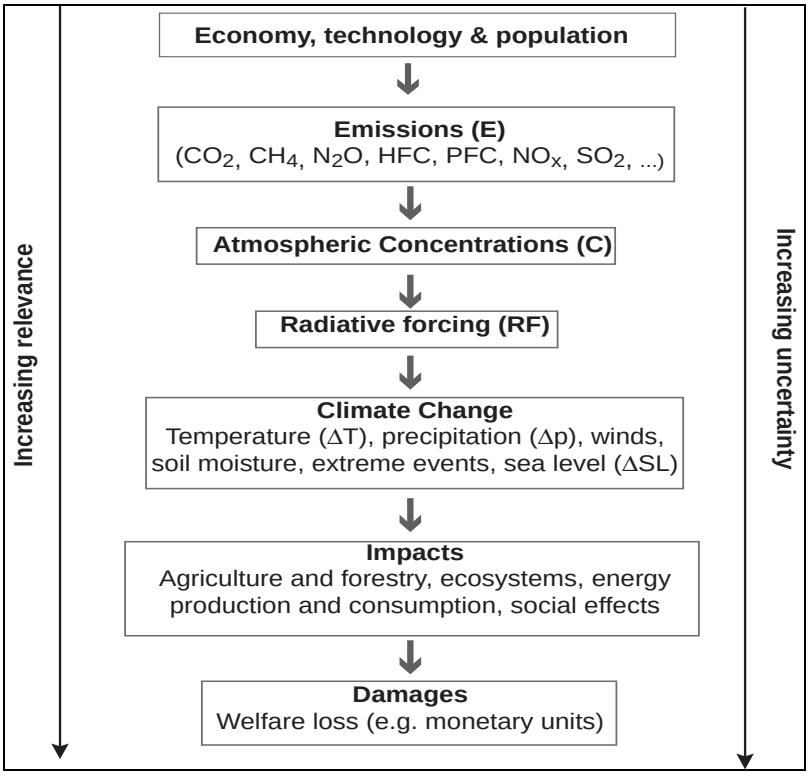

Figure 2.2: Cause-effect chain from emissions to climate change and damages
Source: Adapted from Fuglestvedt et al. 2003

The drawback, on the other hand, is that with every progressive step in the chain, there is an increasing amount of uncertainty resulting from an additional stage in the calculation - not to mention a longer time lag. In addition to the criteria of closeness to impacts and certainty, a

UNFCCC (2002) report proposes that a climate indicator should be understandable to both scientists *and* the public.[6]

We proceed with a brief examination of the relative merits of the main indicators.

Emissions

This is the short-term indicator currently employed by the Kyoto Protocol to the UNFCCC, which commits developed countries to reducing greenhouse gases outputs (measured in CO_2 equivalents) by an average of five per cent from 1990 levels between 2008 and 2012. In addition, the UK government has made a long-term commitment to reduce CO_2 emissions by 60 per cent by 2050, and the Swedish government has pledged to cut emissions by 46 per cent by 2050.[7] The case for setting emissions as a climate change indicator is, first, that it is understood to be the cause of climate change; second, that domestic emissions lie within the legal jurisdiction of national governments; third, and finally that the IPCC methodology for emission inventories is already in place. Furthermore, uncertainty is comparatively low because emissions sit high in the 'climate change chain' and emissions targets are easily understandable (UNFCCC 2002:10). On the downside, an emissions indicator is far removed from climate impacts.

Concentration

"Stabilisation of greenhouse gas concentrations in the atmosphere" is the ultimate objective of the UNFCCC. The choice of this indicator represents a political consensus reached at the end of an arduous negotiation process, which potentially makes this the most politically viable option (Pershing and Tudela 2003:22). Other advantages are that it is understandable, certainty is relatively high, it is closer to impacts than emissions (UNFCCC 2002:10), and it captures cumulative rather than simply marginal change (Pershing and Tudela 2003:22). This approach also leaves room for including substances in addition to those included among the six Kyoto gases – such as ozone precursors and aerosols – that also have a climate effect. The inclusion of these substances would increase mitigation flexibility and could enhance the cost-effectiveness of climate policy, but on the other hand the complexity in negotiations and implementation of mitigation measures would increase (Rypdal et al. 2004).

Radiative forcing[8]

Using radiative forcing as a metric of climate change has been explored in detail by studies such as Fuglestvedt et al. (2003). This approach is currently used in the Kyoto Protocol through the Global Warming Potential (GWP) metric, which compares the integrated radiative forcing of a pulse emission of a climate gas for a specific time horizon. CO_2 is taken as the reference gas, so that the effects of other GHGs are expressed in CO_2 equivalents. This makes the climate effects of various GHGs comparable and a comprehensive "basket" approach across the six Kyoto Protocol gases possible. Thus countries can choose to implement their Kyoto target as an abatement mix from a menu of gases.

Temperature change and sea level rise

Temperature increase and, to a greater extent, sea level rise (SLR) are indicators with added uncertainties compared to radiative forcing. As seen from Figure 2.3 they are characterised by very long time-lags. While their effects are felt globally, warming will have more severe effects on some regions than others, for example, temperature is predicted to rise faster in the Polar Regions, and low-lying small island states are likely to suffer the most from sea level rise. Nevertheless, it is important to remember that temperature change and sea level rise are

[6] This report focuses on the scientific and methodological aspects of the Brazilian Proposal for differentiation of commitments to reduce GHG emissions, see section 3.3.3.

[7] The Swedish target is defined as reducing per capita emissions from the present level of 8.3 tons of CO_2 equivalents per capita to 4.5 tons by 2050, and continued reductions thereafter.

[8] Radiative forcing is the change in radiative budget of the surface-troposphere system following a pertuberation to an atmospheric trace constituent (Fuglestvedt et al. 2003).

the impacts we are essentially concerned about. The *rate of change* (usually given per decade) is also a factor to bear in mind, as rapid changes can impair the adaptive capacity of species and increase the risk of large-scale singular events (WBGU 1995, 1997, 2003). Temperature increase and/or rate of change are indicators that have been proposed by the EU, national governments (e.g. the Dutch government and the Brazilian government during the Kyoto negotiations) and researchers (e.g. UNAGGG 1990; WGBU 1995, 2003; Torvanger et al. 2004). The UN Advisory Group on Greenhouse Gases has also published targets based on sea level rise and rate of sea level rise (UNAGGG 1990).

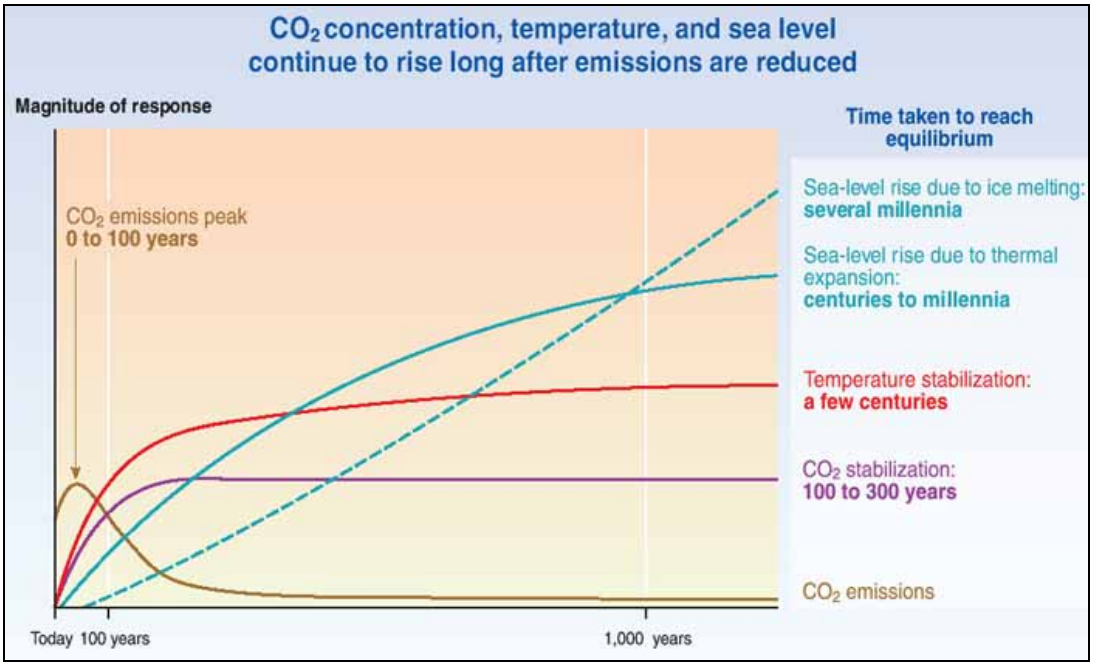

Figure 2.3: ***The time-lag between CO_2 emissions, atmospheric concentrations stabilization, surface air temperature continues to rise slowly for a century or more. Source: SPM-5: IPCC 2001***[9]

Indicators based on impacts

As already mentioned, Article 2 of the UNFCCC emphasizes that climate change actions should take place "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" (UNFCCC 1992, our emphasis).[10] Studies have responded to this challenge by proposing targets on the basis of their ability to safeguard against 'unacceptable' climate change damage using indicators such as coral reef damage, disintegration of the West Antarctic Ice Sheet (WAIS) and thermohaline circulation (THC) shutdown (O'Neill and Oppenheimer 2002); the number of additional people placed at increased risk (Parry et al. 2001); and decline in European ecosystem productivity (van Minnen et al. 2002). More ambitious assessments examine the implications of climate change for a broad range of sectors, spanning two or more of the three areas mentioned in Article 2 (Arnell et al. 2002; Hare 2003; WGBU 2003).

[9] *http://www.grida.no/climate/ipcc_tar/vol4/english/012.htm#figspm5*

[10] Sulphur emissions causing acid precipitation is one example of successfully developed consensus around a level of critical load. These emissions are regulated through the Gothenburg Protocol under the Convention on Long-Range Transboundary Air Pollution (LRTAP).

Impacts-based climate targets are typically calculated using a 'back-tracking' methodology whereby the critical tolerance limits for specific climate-sensitive indicators are identified and the temperature change or GHG concentration level expected to correspond to this limit is calculated. This approach has two main drawbacks that would make framing a long-term climate goal in these terms problematic. The first is that choosing an indicator, or even a selection of indicators out of an infinite number of possible indicators, inevitably involves making a value judgment, which is likely to make reaching a consensus difficult. The second is that it assumes that there is an explicit level of comparability between indicators, which is also a somewhat contentious proposal. Otherwise the best scientists can do is to present a matrix of indicators and impacts, with a geographical dimension, and leave all comparisons to decision makers. A possible way of overcoming these problems could be to use impacts-based indicators as a climate policy tool rather than as a long-term target in itself. For example, if a matrix incorporating emissions levels and their related regional impacts could be compiled (and this is perhaps a big if), it could be used to identify the most vulnerable regions and likely impacts given a climate change scenario, and therefore either form a basis for setting a global allowable emissions target or provide a means for encouraging participation in a global climate policy regime. While impacts-based targets score highly on account of their closeness to society and ecosystems, they fare poorly in terms of certainty and political feasibility.

2.2.2 Target: choosing indicator level and timing

Discussion of long-term climate target levels must necessarily take place within the context of specific climate change indicators. In line with UNFCCC objectives, the majority of the literature and government policy has presented targets in terms of either atmospheric concentrations of greenhouse gases or temperature change. We now turn our attention to these indicators. Table 2.2 provides a summary of some of the targets and levels that have been proposed in recent years. These options have been divided into two categories: concentration and temperature-based targets and impacts-based targets (see section 2.2.1).

Table 2.2: Summary of proposed targets

Study	Concentration and temperature-based targets
Enquette Kommission (1991)	+2°C; maximum rate of increase 0.1°C/decade
WBGU (1995)	+0.2°C/decade
European Commission (1996)	+2°C; 550 ppmv CO_2 should "guide reductions"
Azar and Rodhe (1997)	+2°C is a 'critical level'; 350-400ppmv CO_2 stabilisation
Klimatkommiten, Sweden (2000)	550ppmv stabilisation of six KP GHGs by 2050 (500ppmv CO_2 equivalent)
UK Government (DEFRA 2003)	550ppmv stabilisation of six KP GHGs (500ppmv CO_2 equivalent)
WBGU (2003)	+2°C; maximum rate of +0.2°C/decade (also examines implications in terms of impacts)
Torvanger et al. (2004)	+2.5°C
	Impacts-based targets
UN Advisory Group on GHGs (1990)	30cm SLR from 1990; +3cm/decade; limit of +1-2°C; +0.1-0.2°C/decade
Parry et al. (2001)	Examines risk to humans - 450ppmv CO_2 would "achieve very great reductions"
O'Neill and Oppenheimer (2002)	WAIS destruction + THC shutdown, but not coral damage, may be prevented at 450ppmv CO_2
Arnell et al. (2002)	Investigates impacts to eight indicators and concludes that a limit of 550ppmv CO_2 is "necessary to avoid…most of the projected impacts"
van Minnen et al. (2002)	Finds that even at 450ppmv CO_2, impacts could exceed 'critical' levels in 9-13% of Europe
Hare (2003)	+1-2°C leads to a significant increase in risk; "above 2°C the risks increase very substantially involving potentially large extinctions or even ecosystem collapses"

Key: KP = Kyoto Protocol; SLR = sea level rise; WAIS = West Antarctic Ice Sheet; THC = Thermohaline Circulation.

The former group of proposals consists of political commitments (i.e. from the EU, and the Swedish and UK governments), and a body of literature which largely uses historical climate variations as a basis for target level-setting (e.g. WGBU 2003 investigate observed variations in global mean temperature over the last several hundred thousand years and set a future target level they estimate will not stretch the earth beyond its adaptive capacity).

2.2.3 Setting emissions paths

Whether or not the international community manages to agree on a long-term target, it will need to consider which global and national emissions paths it believes should be followed in the short-term. While Section 3.3 discusses how commitments may be distributed internationally, in this section we investigate how an international near-term target may be determined, either within the context of a long-term target or in its absence. As there are an almost infinite number of possibilities, each with its own economic and political implications, the major challenge is to identify an option that is both acceptable to all parties and environmentally sound. Figure 2.4 demonstrates how wide the range of potential paths that may lead to a long-term target is. The graph on the left-hand side illustrates a range of CO_2 emissions paths that are compatible with (a) the Kyoto Protocol (dark grey triangle), and (b) the various baselines explored by the Special Report on Emissions Scenarios (SRES) of the IPCC (lighter shaded area). The figure to the right shows how wide possible CO_2 pathways leading to a target may be: the paths shaded in the top right-hand side of the diagram illustrate potential routes leading to stabilisation at 550 ppmv, and the lower shaded area shows ways in which an upper concentration limit of 450 ppmv may be reached.

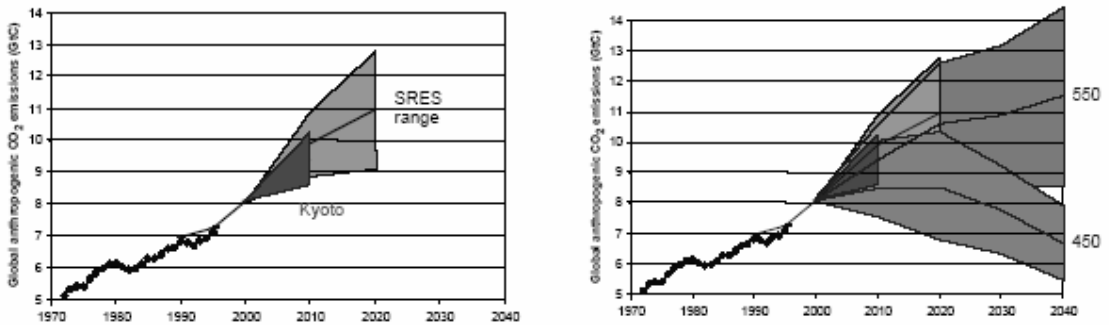

Figure 2.4: Possible global CO_2 emissions pathways to 2020 (left); Possible global emission stabilisation pathways 2000-2040 (right). Source: Morita et al. 2001 in Corfee-Morlot and Höhne 2003:287

Central to the discussion about how to set short-term emissions paths (potentially leading to a long-term target) is the issue of timing. Should actions to mitigate climate change emphasise near-term actions or can the thrust of the effort be deferred to a later date when the uncertainties about climate impacts have been reduced? The remainder of this section focuses on addressing these questions. It begins with the case for delayed action and proceeds with arguments for early action.

The case for delayed action

In the face of uncertainty, it can be argued that it is prudent to adopt a 'wait and see' approach. First and foremost, the economic literature has traditionally favoured delayed action. Research into 'least cost pathways,' which attempts to identify the most cost-effective path to reaching a given long-term target, has tended to report that modest early action followed by (rapid) later action incurs the lowest overall cost (Wigley, Richels and Edmunds 1996; OECD 1999). This is largely because technological advancement is expected to bring

down the cost of undertaking emissions reductions in the future. Over time learning about consequences of climate change and new technologies means that uncertainty is reduced, which provides a better information platform for efficient policies. Aaheim et al. (2001) show that such uncertainty can be best handled through a long-term policy directed towards carbon dioxide reductions (which are long-lived), whereas methane reductions (which are short-lived) should be used to manage shorter-term fluctuations in atmospheric concentrations and be kept as a reserve to be used if it turns out that stricter and faster working measures are needed.

An emphasis on delayed action may also secure broader political support for short-term initiatives. Implementing only gradual reductions until more concrete evidence of the link between greenhouse gases emissions and their impacts is available may bring on board reluctant (but important) actors, such as Bush, who currently question the scientific basis for global warming (Taylor 2002).

The argument for early action

Conversely, the fact that knowledge about the future impacts of climate change is uncertain can be seen as a strong argument for early action. Taking precautionary measures, as advocated by Article 3.3 of the UNFCCC, may prevent the climate system from crossing critical thresholds early on that could cause irreversible damage to ecosystems and humankind (Smith 2003). The idea of 'keeping options for the long-term open' has been the subject of several studies, most notably, the COOL project (Berk 2001c). This international dialogue proposes that short-term targets are set with the ultimate objective of keeping low long-term stabilisation goals within reach in case new information should emerge to suggest that this is desirable (also see Azar and Rodhe 1997; Toth and Mwandosya 2001; Corfee-Morlot and Höhne 2003). The 'Tolerable Windows Approach' takes a similar standpoint. Developed by the German Advisory Council on Global Change (WBGU 1995, 1997, 2003), it sets defined constraints or 'guardrails' that exclude both 'intolerable climate change' and unacceptable mitigation measures, and proposes that short-term targets be determined within this corridor (Bruckner et al. 1999).

Early action is likely to be advantageous for environmental, political and economic reasons (Storey 2002:22-5). Taking *environmental* considerations first, implementing more stringent targets early on is likely to lead to a slower temperature rise, which may buy time for humans and other species to adapt to climate change.

In *political* terms, delaying action presupposes that making more significant cuts at some point in the future will be politically feasible. However, this cannot be guaranteed and introduces a risk that no concerted action will be taken at all. Delayed action also raises intergenerational issues and runs contrary to Article 3.1 of the UNFCCC, which states that "the Parties should protect the climate system for the benefit of present *and future generations*, on the basis of equity" (our emphasis).

While conventional *economic* thinking suggests that delayed rather than early action is more cost-effective, many economic models producing these results have been criticised for their handling of technological change. Traditional methodology treats technological change as exogenous. However, this assumption has been questioned by the Porter Hypothesis, which suggests that environmental regulations can stimulate innovation and drive costs down faster than would have been the case otherwise (Porter and van der Linde 1995). Models applying this hypothesis refer to this effect as 'induced technical change' and tend to conclude that the abatement costs associated with early action might not be as high as previously predicted (Storey 2002:24-5).

In sum, if abiding by the precautionary principle, uncertainty with regard to both economic opinion and knowledge about future climate impacts suggests that it may be advisable for the international community to undertake short- and medium-term actions that keep future options open.

3 Climate policy frameworks

What will be the best basis for future action? In this chapter we would first like to examine different frameworks for future commitments. The discussion is structured around three levels organized in a hierarchical manner. The highest level relates to the architecture of future actions. Architecture refers to fundamental decisions in the design of global climate policy, such as the following: whether or not the policy fully or in part builds on United Nations (UN) institutions such as the Climate Convention (UNFCCC) and the Kyoto Protocol; whether it aims for a specific long-term target, short-term emission targets or rather aims to implement measures that move us in the right direction through reduced global emissions; the coordination level of the policy; grouping of countries; and choice of level of heterogeneity of commitments both within nations (e.g. more than one commitment type possible for each nation) and between nations. Other fundamental issues for global climate policy design are integrating development and climate policy in poor countries, and combining emissions abatement with adaptation to climate change. However, these issues are outside of the scope of this survey. The second level is represented by climate policy commitment types. We present different types of commitments that all could contribute to reduced emissions, but in different ways (Section 3.2). The third level relates to various ways of differentiating such commitments, given that one or more commitment types have been selected (Section 3.3). Lastly, we discuss criteria that are useful for assessing these schemes (Section 3.4).

3.1 Architecture of future actions

In this section we first discuss to what extent future climate policy should be framed under the United Nations' institutions, the UNFCCC and the Kyoto Protocol.

3.1.1 The United Nations Framework Convention on Climate Change

The UNFCCC has entered into force and provides a general basis for global climate policy efforts. A long-term target specified in Article 2 is adopted, but only formulated in general terms. Furthermore it commits countries to reporting emissions and climate policy measures using a common format. However, climate policy developed under UNFCCC is based on participation of all nations and unanimous decisions. This means that single nations opposing such initiatives have many opportunities to block progress. Thus some authors propose alternative processes that could supplement this UN process and make more progress possible. One such idea is for the keenest parties to join in some kind of "coalition of the willing" and agree upon a framework and commitments for the post-2012 period. Such a coalition could to a large extent be regional and, for example, include the EU, other European countries, Canada, Japan, and the most interested developing countries (Bodansky 2003). The Global Commons Institute and more recently the WBGU have proposed the launch of a *Global Climate Community* of core states (the EU, some industrialized states and developing countries) which they propose should adopt emissions reductions according to the contraction and convergence principle (WBGU 2003:58). Another idea is to negotiate a separate protocol on impacts and adaptation under the UNFCCC (Müller 2002c), which would faciliatate a more active participation by developing countries in both adaptation efforts and emission abatement efforts (see section 4.1).

3.1.2 The Kyoto Protocol

It is still uncertain *whether* and *when* the Kyoto Protocol will enter into force. The outcome depends solely on Russian ratification. In any case there are important reasons for considering to what extent post-2012 climate policy should build upon the Kyoto Protocol structure.

The main argument for building on the Kyoto Protocol is that is represents a huge political and intellectual effort of over six years of intense international negotiations. During this

period numerous proposals and options have been assessed, discussed and refined. The 180 Parties to the UNFCCC that took part in the negotiations have managed to agree and build bridges across disparate and diverse values, interests, views and levels of understanding. As Grubb et al. states, "such achievement should not be lightly discarded." (Grubb et al. 2001:13). The most valuable features of the Kyoto Protocol are specified and legally binding commitments for industrialized countries to reduce their emissions of greenhouse gases, differentiated commitments, and flexibility both with respect to greenhouse gases (a comprehensive approach containing a basket of six gases) and with respect to where emissions are abated through the three flexibility mechanisms. The six gases basket approach and the flexibility mechanisms enhance the attainable level of national and international cost-effectiveness. In our literature survey, there seems to be broad support for building upon the Kyoto structure (Pershing 2003; WBGU 2003). The Kyoto structure may also be a basis for a future regime, albeit one that must be adjusted or reformed to take into account broader participation and stronger commitments. Berk and den Elzen (2004) discuss potential ways to salvage the Protocol should Russia fail to ratify. They evaluate alternatives such as relaxing Kyoto targets, amending the 55 per cent requirement (for Kyoto to come into force), implementing targets without ratifying, extending the role of the CDM, and developing an improved CDM that could function outside the Kyoto Protocol. These modifications, however, would lead to narrower participation and weaker commitments, and may serve to undermine the core features of the Protocol. Furthermore, the authors warn that some of these amendments may encounter major practical and/or legal problems.

The main criticisms of the Kyoto Protocol are limited participation (no commitments for developing countries), the lack of linkage between short-term targets and a long-term target, the absence of a clear and transparent methodology to differentiate commitments, a weak enforcement system, insufficient attention to adaptation as a policy alternative, and uncertain compliance costs (Berk et al. 2001a:15; Barrett 2003; Tonn 2003). Barrett (2003) is a particularly vocal critic of the Kyoto Protocol, and argues that the treaty is fundamentally flawed due to its weak compliance mechanism and failure to provide a structure for extending the breadth and depth of cooperation over time (2003). Cost and uncertainty are the main obstacles for broader participation and more stringent commitments. Addressing these obstacles is the best possible incentive to engage developing countries.

3.1.3 Specific short-term targets or just a long-term goal

Even if a global climate policy agreement aims at a long-term target, for example, a maximum allowable temperature change by 2100, the agreement does not necessarily have to specify short-term targets in terms of e.g. allowable global emissions by 2020. The alternative is to be more concerned with moving in the right direction, that is, abatement of emissions and implementing measures accordingly. An illustration of this is the difference between a tax on GHG emissions and an emissions trading system based on a cap on GHG emissions. Introducing a tax will reduce emissions, but we have no way of knowing in advance how fast and how big the effect will be. Of course, the tax level can be adjusted at a later date when more is understood about its potential effects. The important question to ask is whether it would be helpful for the development of global climate policy if actions are more focused on moving in the right direction than on meeting specific short-term emission targets.

3.1.4 Coordination level: global, regional, national or sectoral?

Climate policy is about the management of a global public good, which we may call a stable climate system. To induce broad participation and avoid free-rider problems, as well as to enhance cost-effectiveness, a climate policy should be coordinated. Since this is a global problem, it makes intuitive sense that coordination be undertaken at the global level, which is also the major reasoning for developing the UN-based regime represented by the UNFCCC and the Kyoto Protocol.

If the global approach faces large problems, an alternative is coordination of policy at a regional level. Coordination in Europe and in particular through the European Union (EU) is the most likely regional arena for such an agreement: Also other industrialized countries might be participants (e.g. Japan, Canada and New Zealand). An internal redistribution of EU's Kyoto commitments was already in place before the Kyoto negotiations (Article 4). The EU has already developed a relatively common climate policy, but further development of domestic policies and measures (PAMs), such as product standards, taxes and research, will continue. Furthermore, the EU has developed its own emissions trading scheme for the period 2005-2007, and could be willing to sustain and develop this further even if the Kyoto Protocol fails to enter into force. Also, global and regional agreements might reinforce and strengthen each other. Bretteville et al. (2003) argue that despite the fact that the climate change problem is global, it might be better dealt with through regional cooperation than through a global treaty. Rypdal et al. (2004) find that some indirect GHGs (such as ozone precursors) and aerosols best can be regulated through regional agreements with links to a global climate agreement. Regional agreements may be the appropriate level to regulate emission sources responsible both for emissions of GHGs and air pollutants (Holloway et al. 2003). In Europe some of these substances (causing acid precipitation) are regulated through the Gothenburg Protocol under the LRTAP convention.

Next, coordination could be international but sector-based. Thus, for example, measures to reduce GHG emissions from the aviation industry could be globally coordinated to give all airlines stronger incentives to participate and to abate emissions in a cost-effective manner, and also to avoid leakages if only parts of the industry is regulated. On the other hand, a large cost-saving potential would be forgone if climate policies should not be coordinated across different sectors.

Finally, coordination can take place at the national level, whereby a national target can be met in a cost-effective manner. Obviously unilateral and uncoordinated national policies will be a very inefficient response to climate change as a global problem, and incentives for free-riding will be substantial.

3.1.5 Grouping and participation of countries

A major issue in designing climate policy agreements is differentiation in space and time, that is, in terms of grouping of nations and in terms of what year or period commitments will be associated with.

Under the UNFCCC, *all* Parties have already certain general commitments, such as preparing national inventories of greenhouse gas emissions, implementing policies and measures, and cooperating in preparation for adaptation to the impacts of climate change. As the Convention builds upon the principle of common but differentiated responsibilities and capabilities of Parties, the Parties are divided into three groups for the purpose of differentiating commitments, see Figure 3.1:

- Parties included in Annex II to the Convention encompass the countries that were members of the Organization for Economic Co-operation and Development (OECD) in 1992.
- Parties included in Annex I to the Convention (Annex I Parties) encompass both the countries that were members of the OECD in 1992, and countries with "economies in transition" (EITs), that is, the Russian Federation and other Central and Eastern European countries.
- Parties not included in Annex I to the Convention (Non-Annex I Parties) encompass those countries that are not members of Annex I, including all newly industrialized countries and developing countries.

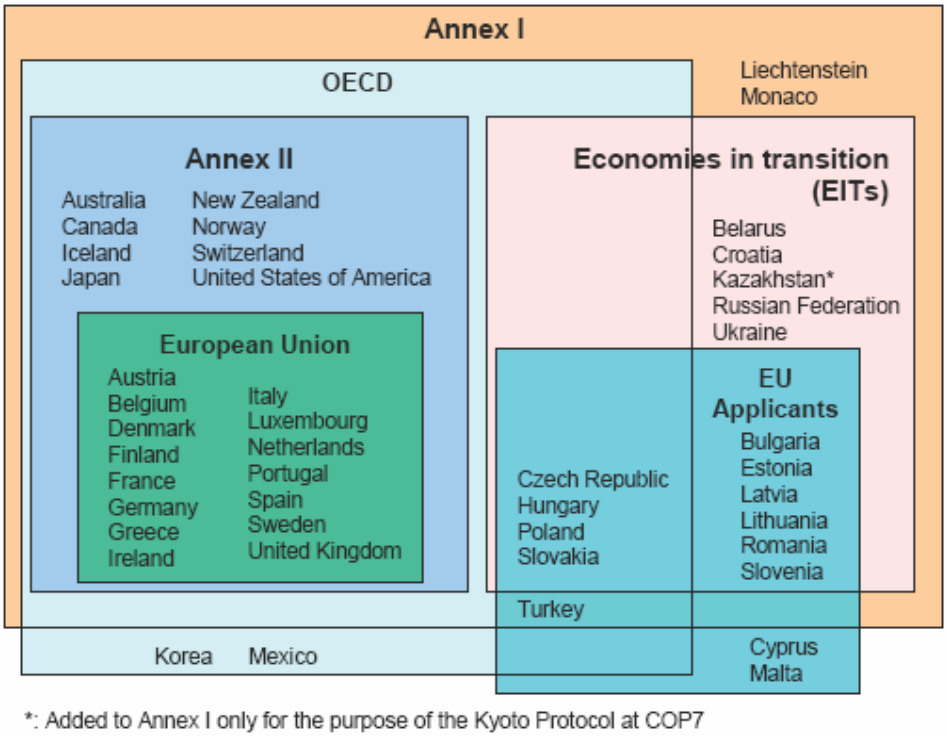

Figure 3.1 Country groups (Höhne et al. 2003:4)

The division between Annex I and Non-Annex I Parties has developed into a very rigid divide which has been further reinforced by the Kyoto Protocol: The Annex I Parties are committed to absolute targets or emissions caps, while the large and heterogeneous group of Non-Annex I Parties are without any emissions commitments.

In future agreements, it is a likely option that the Parties, particularly the Non-Annex I parties, are differentiated and split in different groups. Such grouping for the purpose of differentiation of commitments could be based on a given indicator or a combination of several, such as emissions per capita, GDP per capita, human development index, total emissions, or historical responsibility for temperature change (Claussen and McNeilly 1998; Bodansky 2003).

Participation thresholds

The most contentious future negotiation issue seems to be which Parties should be subject to commitments. One option is that *all* countries participate, as advocated by Schmalensee (1996, 1998); for example, some could have absolute emissions caps, while others may have indexed emission caps which are growth- or intensity-based (Stavins 2001, also see Section 3.2).[11] Participation could also be *voluntary* such as the Kazakhstan case, but the commitment becomes binding once agreed by the Conference of the Parties to the UNFCCC. Otherwise, a Party can also be subject to commitments defined by a *threshold for participation*.

Such a participation threshold would in practice mean that all those countries whose e.g. emissions per capita are above a certain level have to participate and take on some sort of commitment. There are numerous proposals and attempts to classify, group or regroup the parties (e.g. Claussen and McNeilly 1998, Gupta 1998; Storey 2002; Höhne et al. 2003; Bodansky 2003). There could be different indicators and thresholds of participation in an

[11] Indexed emission caps are alternatively named relative or dynamic emission caps.

agreement or protocols to a future climate regime. Table 3.1 shows the proposal by Storey 2002 as an example. Based on a mix of criteria of capacity and opportunity, he proposes dividing the developing countries into four groups with different levels of responsibility or commitments (stages).

Table 3.1: Storey's proposed framework for the future (Storey 2002:33)

Country group	Type of target
The Industrialised countries (Group 1)	Binding fixed targets, as they are applied at present,
Developing countries (Group 2) *– grouped according to criteria of capacity and opportunity as discussed in section 4*	Binding dynamic targets
Developing countries (Group 3) *- grouped according to criteria of capacity and opportunity as discussed in section 4*	Non-binding fixed targets
Developing countries (Group 4) *– the poorest developing countries (measured in terms of GDP per capita)*	No targets

'Increasing participation' or multi-stage approaches have been developed by Gupta (1998), Stewart and Wiener (2001) and den Elzen et al. (2001). "The aim with such a system is to ensure that countries with comparative circumstances in economic, developmental and environmental terms have comparative responsibilities/commitments under the climate regime. Moreover, the system defines when their level of responsibility/commitment change as their circumstances change" (Berk et al. 2001a:29). Another grouping of parties is based on Gupta (1998) and has been used in the COOL-project's *Multi-stage approach*. The parties may be grouped according to mainly economic criteria and emissions levels. Gupta proposed a categorisation of five different groups that have different commitments depending on their capabilities: less-developed countries (LDCs including AOSIS) with low emissions; LDCs (including AOSIS); MIC – middle-income developing countries; and high-income developing countries (HIDC) (Gupta 1998).[12] In addition, Stewart and Wiener (2001) aim to promote developing country participation by using four instruments that are compatible with a Kyoto framework: (1) a simplified CDM, (2) voluntary participation in emissions trading without quotas, (3) voluntary entry into a quota system, (4) accession to an emissions quota system once a specified level of GDP per capita has been reached.

3.1.6 Homogenous or heterogeneous actions

In terms of differentiation and grouping across parties, even actions or tasks each group undertakes could be heterogeneous (Hahn 1998). In the Kyoto Protocol, Annex I Parties are all subject to homogenous actions. They are committed to reducing or limiting their emissions of GHGs for a fixed time period. In a future regime, this approach could either be mixed with or even totally substituted by other different types of actions or commitments.

The most likely option is that different countries or groups are committed to different types of actions or commitments. In a future regime, the commitments could be heterogeneous in both *what* kind of actions or targets the parties are subject to and *when* they have to/should comply with it. Also parties within a group might be subject to heterogeneous actions, for instance various LDCs could propose different voluntarily initiatives or optional commitments.

Regarding different commitments, countries could agree on a set of legitimate commitment types – a "menu" (see Section 3.2 for a discussion of commitment types). Then each country

[12] AOSIS is the Alliance Of Small Island States.

is free to choose one or more of these options as a basis for their climate policy, see Figure 3.2 for an illustration. In this illustration, Non-Annex I countries (developing countries) are assumed to find indexed (intensity-based) emission caps and technology programs attractive (see section 3.2). The last step would be to agree on how much a country should do under each commitment type. One challenge of such an approach is to compare efforts under different commitment types and how much each contributes to reaching e.g. a common GHG concentration target in the atmosphere.

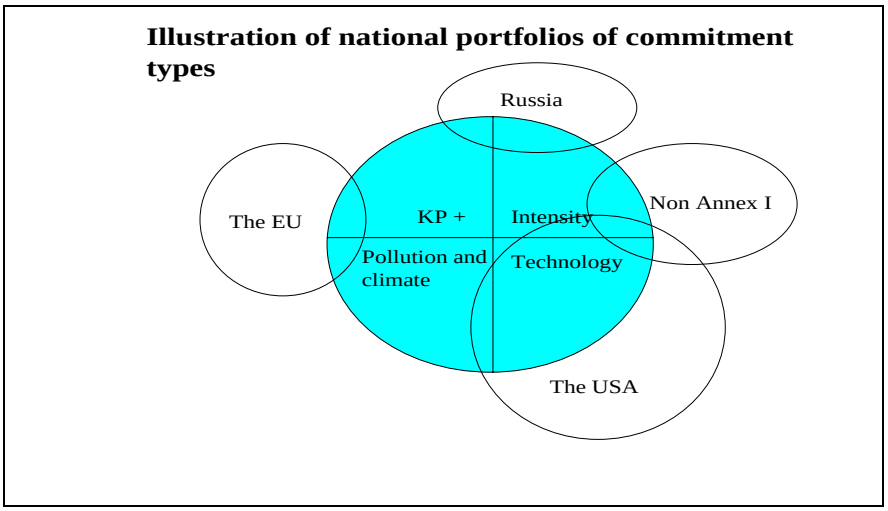

Figure 3.2: An illustration of heterogeneous commitment types

3.2 Commitment types

A key element of a future climate framework will be what type of commitment structure to employ.[13] There could for example be a whole menu of different types of commitments that the parties may choose from. The nature of the climate change problem as a classic global public good that is vulnerable to free riding, as well as the history of international environmental cooperation, implies the need for binding commitments. Experience has shown that voluntary measures only achieve limited emission mitigation efforts, and are not likely to result in the significant emission reductions needed to control man-made global warming (confer section 2.2.3).[14]

There are huge differences between countries in terms of development level, technology, energy system, population size, economic structure, resource base, etc. Thus, allowing countries to fulfil their commitments in various ways which take national circumstances into consideration would enhance both the attractiveness of climate policy and cost-effectiveness. Presenting a menu or a variety of different types of commitment may be a vital move to broaden participation and encourage the parties to take upon stronger commitments. As this section will illustrate, there are a variety of different types of commitments and numerous ways of combining them, and among them voluntarily commitments may certainly play an important role. However, up to now, quantified emission limitation targets have been the

[13] Climate change negotiations have focused on "commitments," i.e. requirements that a state itself assumes, rather than on "obligations," a broader term that includes norms externally imposed (Bodansky 2003). By making a commitment to reduce GHG emissions, a state agrees to limit its future freedom of action; it promises to behave in a certain way or to achieve a certain result. While its acceptance of a commitment is voluntary, its fulfilment of the commitment is not.

[14] One example of this is the recommendation in the UNFCCC that industrialized countries should stabilize their GHG emissions at 1990 level by 2000, which very few countries were able to meet.

principal type of climate commitment. In the Kyoto Protocol, the targets are fixed, pegged to historical emission levels. The question is, should we continue in that direction, or would another approach be more expedient? Different types of targets may complement or even replace the Kyoto commitments. In the following section we will present the main types of and dimensions of climate commitments.

The content of a commitment has both formal (binding vs. non-binding) and substantive dimensions. There are a variety of possible future mitigation commitments, including quantified and non-quantified objectives. Pershing (2003) suggests four main paths for post 2012 climate policy, which probably should be combined: a Kyoto-like structure; technology; development first; and bilateral or regional approaches. Storey (2002) sees five alternatives to the Kyoto Protocol: coordinated policies and measures; non-binding targets; price-based commitments; price cap proposals; and indexed (and intensity) targets. Another reference is Höhne et al. (2003), who presents numerous alternative approaches to a future climate framework: continuing Kyoto; indexed targets; contraction and convergence; global Triptych; multi-sector or "bottom-up" approaches; equal mitigation costs; multi-stage approach (FAIR); and coordinated policies & measures.

From these and other references the major broad categories of commitment types can be described as follows:

- Absolute emissions-based cap
- Indexed emissions-based cap
- Financial support
- Policies and measures

Thus the parties in a climate regime could be committed to not only reducing GHGs, but also to providing financial contributions to the climate funds and to implementing various policies and measures, including technology standards, incentives for further research and development of cleaner (energy) technology, use of taxes, and removal of subsidies.

3.2.1 Binding vs. non-binding commitments

A hot topic at particularly COP7 in Marrakech and a regular issue of discussion in the climate change negotiations is the parties' level of commitment: should these commitments be binding or non-binding? Non-binding commitments would reduce cost uncertainty. They may take a form similar to that adopted in the UNFCCC, where Annex I Parties were to "aim" to return emissions to 1990 levels. However, there would be no penalties for exceeding the goal. This option is essentially similar to the price cap option, in which the price is set to zero. Even non-binding targets may – through emissions trading – provide an incentive for emission reductions. Sales could occur if emissions are less than the targets. The primary problem with the non-binding target option lies in the limited certainty it provides on emission reductions. However, for developing countries non-binding targets may be a better choice since the possible emission mitigation effect may be higher than with fixed, binding targets, as these are likely to be rejected, or only accepted if they provide excess allowances (Philibert et al. 2003).

Bodansky (2003) outlines four main categories or levels of commitment:

Non-binding "commitments" are an *aim* or a *recommendation* ("should" rather than "shall"). The emissions target in the UNFCCC for Annex I Parties, to return emissions to earlier levels (4.2a) or 1990 levels (4.2b) by the year 2000, was worded as an aim rather than a legal requirement. Other examples are commitments formulated in a very general sense, such as formulations in the UNFCCC on implementation of policies and measures, support of research and provision of regular reports (Höhne et al. 2003:25).

One-way ("no-lose") commitments are an aim, although non-binding, which could have legal consequences if it can provide a country with certain legal benefits. "Project baselines established under Kyoto's Clean Development Mechanism (CDM) are, in essence, one-way "commitments," since a country (or firm) faces no penalty if its project exceeds a baseline, but receives certified emission reduction credits if the project reduces emissions below the baseline" (Bodansky 2003).

Legally binding commitments could be expressed in binding language, 'shall', such as used in the targets and timetables in the Kyoto Protocol. "Even though most international commitments do not have any specific compliance mechanisms, they are legally binding and must be complied with by those states that accept the commitment" (Bodansky 2003). Kazakhstan has voluntarily applied to become a member of Annex I, but, once agreed by the COP, its target would nevertheless be *binding* Höhne et al. 2003:25).

Enforceable commitments is a "*binding* commitment which can be subject to a mandatory compliance system, with authority to respond to violations, such as the dispute settlement system adopted under the World Trade Organization" (Bodansky 2003). A compliance procedure was finally established with the Marrakech Accords. However, imposing consequences for non-compliance assumes that the party has ratified the amendment to the Protocol.

3.2.2 Choice of commitment types and policy tools

In many cases there is no strict boundary between commitment types and policy tools. A tax on GHG emissions can be considered both a policy tool and a commitment type (which we have grouped under polices and measures). However, in this context we refer to such alternatives mainly as commitment types. One reason for the increased interest for commitment types is the US rejection of the Protocol and the launch of the intensity targets-proposal. Another reason is that intensity targets and other alternatives to Kyoto-type targets are seen as a way of stimulating participation from Non-Annex I-Parties. As illustrated by Table 3.2, the three main commitment categories are emissions caps, financial commitment, and policies and measures.

(i) Emission cap related commitments

Absolute – Within international environmental agreements, there is a long tradition of negotiating fixed, absolute targets. Until recently, this option has also gained most attention in the climate change regime. The Kyoto Protocol requires industrialized countries to achieve predetermined, fixed levels of emissions for the 2008-2012 commitment period. Philibert et al. argue that absolute targets represent a "relatively simple form of quantitative objective to negotiate as well as to implement" (2003:14). A major advantage of using quantitative instruments (such as absolute targets) is that they ensure "certainty" with regard to emissions levels, although they leave the marginal and total costs of abatement uncertain.

Indexed – Because emissions depend on a wide range of variables that are difficult to anticipate (economic growth, weather, technological change, etc.), an emission target can be pegged to one or more of these variables (e.g. emissions per unit of GDP), rather than defined in fixed terms, like the Kyoto targets. The Bush administration's *carbon intensity target* and the proposed Argentine target are both examples of indexed GDP-based targets. Indexed targets are attractive since they allow higher emissions in cases of higher economic growth and may allow more stringent targets to be adopted if the uncertainty regarding costs is reduced (Philibert et al. 2003). That may make participation more attractive for developing countries and the US. Other authors who propose replacing absolute caps with indexed caps are Ellerman and Sue Wing (2003), Müller et al. (2002), Philibert and Pershing (2002), and Pizer (2003). However, indexed targets could lead to absolute increases in emissions in case

of strong economic growth. Furthermore, if economic recession should occur, a country with a carbon intensity target would face a double hit. Müller et al. 2002 and Moor et al. 2002 recommend indexed targets only for developing countries.

Table 3.2 Different types of commitments

Commitment type	Subcategory/example/description	References
Emission caps	**Absolute emission cap** *Flat rate*: every country reduces emissions by same percentage *Differentiated*: every country achieves predetermined, fixed levels of emissions, "Kyoto style"	
	Indexed targets Such targets are indexed according to an agreed variable, e.g. on actual economic growth *Carbon intensity*: CO_2 emissions per unit of GDP *Bush's Proposa*l: emissions per unit of GDP, proposal for voluntary developing country participation *Argentine target*: indexed GDP-based target, voluntary developing country participation. However, this is outdated since the DCs cannot participate in the Kyoto Mechanisms. Emissions per unit of e.g. population, exports, energy consumption, etc.	Höhne et al. (2003); Baumert and Kete (2002); Girardin and Bouille (2003); Bouille and Girardin (2002);
	Conditional If the specified conditions are not satisfied, then the target either would not apply at all or would be modified in some fashion. E.g. the '*Tonn target*': when a party's emissions per capita exceeds 1 metric tonne of Carbon, it has to participate in the regime	Tonn 2003:299
	Sectoral Specified targets for particular sectors or industries that are particularly important, politically easier to address, or comparatively insulated from international competition	Bodansky (2003); Samaniego and Figueres 2002)
Financial	Annex II parties are already committed to financial contributions – collectively – to the climate funds under both the UNFCCC and Kyoto Protocol (Marrakech Accords). A related commitment type is transfer of technology and knowledge to DCs.	
Policies and measures	Countries obliged to implement coordinated policies and measures, e.g.: *Technology and performance standards* – e.g. generally agreed energy efficiency standards. *Taxes* – e.g. a common tax on CO_2. *Subsidy removal* – elimination of climate adverse subsidies. *Emissions trading*— e.g. the European Union directive on emissions trading *Technology R&D and incentives* – that the parties are committed in various forms to participate in or contribute to e.g. an international hydrogen initiative.	Höhne et al. (2003); Bodansky (2003)

Conditional – In contrast to the Kyoto targets, which apply come what may, a target could be formulated in conditional terms: if the specified conditions are not satisfied, then the target either would not apply at all or would be modified in some fashion. One option is to make commitments conditional on a state's achievement of a minimum level of wealth. For example, per capita GDP could be used as a "graduation criterion" for the assumption of commitments by developing countries (Tonn 2003).

Sectoral commitments – A target can also be specified on a narrower basis than total national emissions. For example, targets could be specified for particular sectors or industries that are particularly important, politically easier to address, or comparatively insulated from

international competition. Sectoral targets might be a pragmatic first step towards more comprehensive action in developing countries. Sectoral targets might be fixed or indexed, "no-lose", binding or non-binding (Philibert et al. 2003; Bodansky 2003). Sectoral targets could also be the natural progression in the evolution of the Clean Development Mechanism (CDM) (Samaniego and Figueres 2002). Under such a scheme, countries might choose to expand from a specific "project" under the CDM to a broad policy covering an entire sector, setting a no-lose, sectoral emission target.

(ii) Financial commitments

Rather than focusing on emissions, a target can be specified in financial terms, as an amount of money to be earmarked for climate change mitigation or adaptation, either domestically or internationally. Both the UNFCCC and the Marrakech Accords set forth collective financial commitments that apply to Annex II countries as a whole, rather than individual targets for each state. Related commitments could be expressed in terms of a transferral of know-how and technology to developing countries.

(iii) Policies and measures

In contrast to a target-based or quantified objective approach, a commitment regarding policies and measures is an *obligation of conduct* rather than an obligation of result: it requires countries to act in certain ways, but does not require them to achieve any particular level of emissions or financial contribution. During the negotiation of the Kyoto Protocol, the European Union pushed for the inclusion of commitments related to policies and measures, but due to strong resistance from the United States, the Protocol includes only an illustrative list of possible policies and measures, without requiring states to adopt them. An obligation in the UNFCCC commits all Parties to undertake policies and measures that help mitigate climate change. The policies and measures of current interest for either an extended Kyoto framework or alternatives to the Kyoto Protocol might be technology agreements and policy tools such as subsidy removal (i.e. elimination of coal production and consumption subsidies) and (GHG) taxes – e.g. a tax on CO_2 (which could be harmonized across parties).

Technology agreements – One means of promoting the development and diffusion of advanced technologies is focusing on an agreement – or a set of agreements – promoting climate-friendly technologies (Edmonds and Wise 1999; Benedick 2001; Barrett 2001, 2003). Such agreements could impose specific standards (e.g. energy efficiency) in a particular sector (e.g. power sector), or more directly subsidize research and development efforts. They may also aim at broadening existing markets for technologies such as renewable energy sources, as discussed during the World Summit on Sustainable Development.

Technology agreements could possibly build on and link together current initiatives with similar aims, such as the IEA implementing agreements, the Climate Technology Initiative, or some programmes of the Global Environment Facility. The parties could be committed in various ways to participating in or contributing to *technology R&D,* e.g. an international hydrogen initiative. Barrett puts forward the case for a research and development protocol, founded on building incentives for climate-friendly technologies (2001, 2003). This approach would involve establishing common technology standards and supporting collaborative research. However, costs are a vital parameter for the feasibility of agreements, and while technology agreements can potentially promise a high degree of environmental effectiveness, they are unlikely to be the most efficient or cost-effective solution (Aldy et al. 2003a, b; Philibert et al. 2003). Furthermore, policy-makers take a risk if they start with sub-optimal (inefficient) institutions like technological agreements, since that could lead to a lock-in which may be difficult to change in the future (Woerdman 2002; Aldy et al. 2003a, b).

Carbon taxes (or more generally GHG taxes) have been suggested as an alternative to the Kyoto framework. Under a commonly assessed form (Cooper 1998, 2001; Nordhaus 1998,

2002), domestic carbon taxes could be harmonized at the international level. In this case, carbon taxes would equalise the marginal cost of abatement globally and, like emissions trading, have the important feature of cost-effectiveness. However, such price instruments leave uncertain the level of actual emissions reductions that will be achieved by this system (Philibert et al. 2003:19). Moreover, an international carbon tax has been politically unacceptable to some developed countries – even more so than quantified commitments to limit emissions of GHGs, It also seems clear that developing countries would be unwilling to adopt such an instrument.

All of these approaches might be able to complement one another, even though policies and measures and target-based approaches are often seen as competitors – or even contradictory. Bodansky claims that, "a target could be used to specify the overall result to be achieved, while policies and measures could specify the means for reaching that result… an international target and trading approach would be most cost-effective if combined with national policies and measures ensuring that domestic trading systems are complementary" (2003: 43).

Quantitative commitments and emissions trading offer the possibility of addressing cost-effectiveness and equity in allocating assigned amounts. As illustrated in the previous sub-sections, there is a variety or a whole menu of possible future mitigation commitments, including quantified and non-quantified objectives, from which the parties may be able to choose. Some are most viable options for near-term commitments (in an extended Kyoto framework) and while others belong to alternative future frameworks. Philibert and Pershing (2003) claim that quantified objectives such as fixed targets, indexed targets, a price cap and non-binding targets, are compatible with an extended 'Kyoto framework'. Within the Kyoto framework there might be alternatives to quantified objectives at the country level, namely policies and measures, technology agreements, carbon taxes, and sectoral targets.

The Kyoto framework could also be modified in other ways to address the regularly addressed concerns of costs and thereby broaden participation:

A price cap – Introducing a price cap could take the form of making supplementary permits available in unlimited quantity at a fixed price – at country level (for domestic entities) or at the international level (for countries). Emission trading systems with a price cap is also referred to as hybrid schemes (McKibbin 1997, 2000, 2002; Aldy et al. 2001). According to Philibert and Pershing (2003), "concerns have been raised that a price cap could undermine the environmental "integrity" of any agreement…While indexed targets might help deal with cost uncertainty driven by economic growth and other factors, price caps might help deal more broadly with abatement cost uncertainty. In particular, price caps could accommodate uncertainties in future technology developments and relative energy prices". WBGU are sceptical to a price cap as a way of limiting the uncertainty around future costs of climate change mitigation, but proposes to establish a Climate Central Bank to avoid and smooth disproportionately strong price spikes (WBGU 2003:61).

3.2.3 Who will be subject to commitments?

A third dimension of commitment types is related to *who* should be subject to commitments. Even though the international climate negotiations so far have sought to establish obligations only for states (which are Parties to the Convention/Protocol), it is conceivable that private entities, such as firms, organizations or cities might be subject to some kind of commitments. Under the Kyoto Protocol, national governments can establish commitments for private entities as part of implementing the national emission target. However, it would be very difficult to impose obligations directly on private entities due to implementation and enforcement problems, in particular with respect to individuals and firms located in countries that are not participating in the international regime (Bodansky 2003: 44).

3.3 Differentiation of commitments

This section addresses the somewhat contentious issue of how the global effort can most effectively be divided up among the participants of a future international climate regime, assuming that a climate target has been agreed. The subject is commonly referred to in the literature as burden sharing; however, we prefer to use the UNFCCC term 'differentiation of commitments,' which some argue has fewer negative connotations and is therefore less politically sensitive (Storey 2002; RIVM 2004).

There are strong arguments in favour of an international approach to the climate change problem, both on economic and environmental grounds. Not only is global participation an important condition for cost-effectiveness, but stabilization of greenhouse gases in the atmosphere is unlikely to be feasible without a concerted international effort. In short, "a global problem such as climate change requires a global solution" (Houghton, IPCC Chairman, WG1). Given that involvement in international climate negotiations is voluntary, a necessary condition for the success of a future agreement is that it is both fair and *perceived to be fair* by all parties (Ashton and Wang 2003). Equity, however, is a subjective issue, and one which is often hard to disentangle from interests. Bush has stated, "I oppose the Kyoto Protocol because it exempts 80 per cent of the world, including major population centres such as China and India, from compliance, and would cause serious harm to the US economy…there is a clear consensus that the Kyoto Protocol is an unfair and ineffective means of addressing global climate change concerns" (2001). At the same time, developing countries have also forwarded the equity argument, pointing to the fact that they are the least responsible for climate change, but most vulnerable to its consequences (Müller 2002a). How does one distinguish between the different responsibilities, capabilities and needs of the different parties when allocating commitments?

Given that equity is likely to be central to this debate, we begin with a summary of the way in which the issue is currently dealt with in the UNFCCC and Kyoto Protocol (Section 3.3.1). This is followed by a discussion of how the concept may be applied to climate change (3.3.2). We then go on to provide an overview of the main approaches to allocating commitments (3.3.3), and conclude the section with a brief look at how differentiation methods may be evaluated (3.3.4).

3.3.1 Equity and current climate agreements

The issue of equity is a key feature of the UNFCCC (see Article 3.1, Box 3.2). The convention presents the climate system as a public good which everyone has a right to enjoy and a duty to protect. This entitlement extends across geographical and generational dimensions.[15] Perhaps most significantly, it identifies "common but differentiated responsibilities" and commits developed countries to take the lead.

In addition, the IPCC acknowledges that climate change can have implications for equity between *and* within nations (see Box 3.2).

Equity is also addressed in the Kyoto Protocol, where commitments are already differentiated in the following manner:

- *Between Annex I and non-Annex I countries* – the former have agreed to cut their collective emissions by 5.2 per cent below 1990 levels by 2010, the latter are exempt from specific targets.
- *Within Annex I countries* – differentiated commitments range widely, with some countries obliged to make emissions reductions (e.g. the EU block must make cuts of 8 per cent),

[15] Rose and Stevens relate the geographical (or 'inter-country') dimension to the concept of *static* equity and inter-generational dimension to *dynamic* equity (1998:332).

some having pledged to achieve stabilisation (New Zealand, Ukraine Russia) and others permitted to make increases (Iceland, Australia and Norway may oversee a rise of up to 10, 8 and 1 per cent respectively).

"The Parties should protect the climate system for the benefit of present and future generations, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly the developed country Parties should take the lead in combating climate change and the adverse impacts thereof" *Article 3.1 of the UNFCCC, 1992*

"The challenge of climate change from an equity perspective is to ensure that neither the impact of climate change nor that of the mitigation policies exacerbates existing inequities both within and across nations" *IPCC, Second Assessment Report, 1996*

"The impacts of climate change are likely to fall disproportionately upon the poorest countries and the poorest persons within countries, and thereby exacerbate inequities in health status and access to food, clean water and resources" *IPCC, Third Assessment Report, 2001*

Box 3.2: UNFCCC and IPCC references to equity

3.3.2 Principles of fairness

There are numerous ways of defining, categorising and analysing principles of equity within the context of global climate change. Rose et al. (1998) offer a good starting point, by drawing a distinction between fairness criteria that relate to: (1) the initial *allocation* of commitments, (2) the final *outcome* of the implementation of an agreement, and (3) the *process* through which commitments are negotiated or allocated (see Table 3.4). Allocation-based criteria interpret fairness in terms of inherent rights (e.g. egalitarian), while outcome-oriented approaches to equity are more concerned with the resulting net welfare implications of an agreement.

Table 3.4 Alternative equity criteria for global warming policy. Source: Rose et al. 1998:30

Criterion	Basic definition
Allocation-based	
Sovereignty	All nations have an equal right to pollute and be free from pollution
Egalitarian	All people have an equal right to pollute and be free from pollution
Ability to pay	Mitigation costs should vary directly with national economic well-being
Outcome-based	
Horizontal	All nations should be treated equally
Vertical	Welfare gains should vary inversely with national economic well-being; welfare losses should vary directly with GDP
Compensation	No nation should be made worse off
Process-based	
Rawls' Maxim	Welfare of worst-off nations should be maximised
Consensus	International process is fair
Market justice	Market is fair

The process-based perspective views the negotiation and allocation processes themselves as mechanisms for promoting for justice. While this may be a useful way of categorising fairness criteria, the majority of the literature (Claussen and McNeilly 1998; Carzorla and Toman 2000; Berk and den Elzen 2001; CICERO/ECN 2001; Sijm et al. 2001; Evans 2002; Ringius et al. 2002; Storey 2002; Torvanger and Ringius 2002; Ashton and Wang 2003; Höhne et al. 2003) refers to one or more of the following equity principles as a benchmark for evaluating burden sharing approaches: need, responsibility, opportunity, capacity, and comparability of effort. These criteria provide a valuable analytical tool, and are discussed in turn below.

Need
This criterion adheres to the principle that everyone deserves the right to emit a minimum quantity of greenhouse gases that allows them to meet their basic human needs. It implies that any international climate agreement should help, or at the very least not hinder, a person's ability to secure a decent standard of living.

Responsibility
Also referred to as 'guilt' in the literature (Berk and den Elzen 2001; CICERO/ECN 2001), this notion relates to the polluter pays principle, whereby the party responsible for causing a problem is expected to bear the cost of resolving it. The International Institute of Applied Systems Analysis (IIASA) estimates that industrialised countries are responsible for about two thirds of cumulative emissions since 1800, and it is partly for this reason that the Kyoto Protocol asks developed countries to lead the mitigation effort. Applying this principle from a burden sharing angle, however, becomes less straightforward when the link between cause and consequence is uncertain, as in the case of climate change. It also raises questions about whether or not a polluter can legitimately be held responsible for the harmful effects of their past actions when the dangerous implications of their behaviour was not known to them at the time.

Opportunity
Some countries, such as those with energy inefficient economies (i.e. high carbon intensity), are better placed than others to make low-cost emissions reductions, and it is argued that a fair agreement should take account of this.

Capacity
This relates to the idea of ability to pay for GHG emission reductions, and is usually measured in terms of GDP per capita.

Comparability of effort
Ashton and Wang claim that any agreement secured by a party must not only be formulated fairly and deemed acceptable in its own right, but must also be seen to be just in relation to the deals negotiated by others (2003:66).

Before we apply fairness principles, however, it is necessary to outline the various burden sharing alternatives for an international climate agreement. This is addressed in the next section.

3.3.3 Distribution of mitigation commitments

Choosing a suitable method for distributing climate change mitigation commitments is a politically sensitive task due to its associated cost implications at the national level. There are essentially two basic questions to be answered: (1) which indicator(s) should be used as a basis for differentiating commitments? and (2) how should this indicator be applied to determine specific national obligations? To illustrate this two-step process, the Kyoto Protocol uses national 1990 emission levels as an indicator, i.e. a 'grandfathering' approach, and allocates allowances as a percentage of these emissions. The percentages vary across nations as a result of the Kyoto Protocol negotiations. Another example is taking per capita emissions as an indicator and applying it by promoting convergence towards a common level in the future across all countries. Other examples of possible differentiation criteria can be found in Box 3.3 below.

Various methods have been proposed for allocating responsibilities among the parties to a potential climate change agreement. Table 3.5 summarises some of the main approaches that have been suggested. The first five can be thought of as 'single dimensional' because they use just one indicator to determine national contributions. As discussed above, grandfathering is based on a historical benchmark. The historical responsibility approach, as proposed by Brazil, focuses on *cumulative past emissions*, arguing that those who have contributed most to

- Current or historic emissions
- Contribution to temperature increase
- Population
- GDP or other measure of wealth or income
- Geographic area
- Reduction potential
- Costs or benefits of reductions
- Sectoral benchmarks
- A combination of sectoral targets added to a national target

Box 3.3 Potential differentiation criteria. Source: Höhne et al. 2003

the global warming problem in the past should bear the greatest responsibility for making future emissions reductions.[16] The third option is founded upon the basic human right to equal treatment, and involves allocating commitments so that *per capita emissions* are equalised over time. This alternative has gained support in recent years, and is often presented as part of a broader climate model of 'contraction and convergence,' which was developed by the Global Commons Institute, proposing that emissions contract over time and converge at a level where per capita emissions are equalised by a given date. Ability to pay is commonly framed in terms of *GDP per capita*. Torvanger et al. (2004) compare the effect of several of the approaches in Table 3.5 in meeting a long-term temperature target. Differentiation of emission allowances in eight global regions is based on per capita mitigation and climate change damage costs, where the costs are weighted according to GDP per capita, greenhouse gas intensity of GDP, or historical contribution to global warming. Furthermore these results are compared to two allocation-based approaches, per capita convergence by 2070 and the Brazilian historical responsibility proposal.

More sophisticated, 'multi-dimensional' proposals such as the multi-sector, multi-criteria and menu options have also captured the attention of scholars and policy-makers. The appeal of multi-sector approaches lies in their capacity to take into account the specific circumstances of the individual parties. For example, the Triptych proposal uses analysis of three sectors (the energy intensive industry, the power producing sector and the domestic sector) as a tool for determining allowances. This methodology was used by the EU to allocate Kyoto emissions targets between Member States, and the model has since been adapted to apply to the global level, and extended to include emissions of gases more relevant to developing countries. ECN/CICERO have adopted a similar approach at the global level (Multi-Sector Convergence), but extend their analysis to seven sectors (power, industry, transport, households, services, agriculture and waste) and aim for converging per capita emissions. It also makes provision for countries with special national circumstances.

Multi-criteria proposals, on the other hand, are flexible in that they allow several indicators or 'differentiation criteria' to be taken into account when allocating commitments. Müller's Preference Score model incorporates grandfathering and per capita allocations, while Claussen and McNeilly (1998) include responsibility for past and present emissions, ability to pay, and opportunity to reduce emissions.

A 'menu approach,' which was proposed by Japan during the Kyoto negotiations, presents an alternative whereby countries are given the freedom to choose between options – in this case between emissions per unit of GDP and emissions per capita. The Japanese example also allows emissions reduction rates to be adjusted for countries with high population growth.

[16] The fourteenth session of the Subsidiary Body for Scientific and Technological Advice (SBSTA) have produced an evaluation of the scientific and methodological aspects of the Brazilian Proposal (see UNFCCC 2002), and Romstad et al. (2003) give an outline of the Proposal and discuss the choices associated with allocating responsibilities on the basis of historical emissions.

Table 3.5 Proposals for differentiation of commitments

Proposal	Description	References
Grandfathering	*A*llocation based on a historical emissions baseline	
Historical responsibility/ cumulative emissions/polluter pays principle	*Brazilian Proposal* advocates emissions target allocation according to responsibility for climate change (historical accumulated emissions)	UNFCCC (1997); den Elzen et al. (1999)
Equalising per capita emissions	Per capita emissions are equalised over time. Associated with 'contraction and convergence'	Agarwal and Narain (1991); UNFCCC (1996, 1997) (France; Switzerland; EU); Manne and Richels (1997); Meyer (2000); Aslam (2002); WBGU (2003)
Ability to pay	Allocation based on GDP per capita	UNFCCC (1996, 7) (Poland; Estonia, Russia; South Korea); Jacoby et al. (1999); Torvanger et al. (2004)
Equalising costs	Commitments distributed to equalise marginal abatement costs across countries	UNFCCC (1997) (New Zealand)
Multi-sector or "bottom-up" approaches	*Triptych* approach covers three sectors and "accounts for differences in national circumstances such as population size and growth, standard of living, economic structure and fuel mix in power generation" *Global Triptych* an extension of the Triptych approach from the regional to global level *Extended Global Triptych* includes CH_4, N_2O, and CO_2 from forestry	Blok et al. (1997); Phylipsen et al. (1998a, 1998b); Groenenberg et al. (2001) Groenenberg et al. (2002); Höhne et al. (2003)
	CICERO/ECN's *Multi-Sector Convergence* model aims for converging per capita targets based on a fixed convergence year; takes into account structural differences between countries based on analysis of seven sectors	Sijm et al. (2001)
Multi-criteria formula	*Hybrid formula* distinguishing between countries on the basis of various criteria: e.g. responsibility for past and present emissions, ability to pay and opportunity to reduce emissions; grandfathering and per capita allocations	UNFCCC (1996, 1997) (Norway; Iceland; Australia); Ringius et al. (1998); Claussen and McNeilly (1998); Müller (2002b)
Menu approach	Countries may themselves select from up to three abatement strategies, provisions are made for countries with high population growth	UNFCCC (1996, 1997) (Japan)

Sources: Evans 2002; Ringius et al. 2002; Ghersi et al. 2003; Storey 2002; WBGU 2003.

3.3.4 Evaluating methods for differentiating commitments

Differentiation options can be evaluated according to various criteria, ranging from the principles of fairness discussed in 3.3.2, to factors such as political feasibility and cost allocation. While we leave a more thorough discussion of how climate policy frameworks as a whole can be analysed to the following section, we conclude Section 3 by returning to the issue of equity, and briefly investigate the extent to which proposals for the differentiation of commitments meet the fairness criteria identified previously – namely, need, responsibility, opportunity, capacity, and comparability of effort.

Table 3.6: Evaluation of proposals for differentiation of commitments with respect to equity. Source: Storey 2002:31

	Equity Criteria			
	Need	Responsibility	Opportunity	Capacity
Flat rate targets	*	*	*	*
Per capita emissions	***	**	*	**
Cumulative emissions	**	***	*	**
GDP per capita	**	**	**	***
Intensity targets	*	*	**	*

** indicates this criteria is only weakly fulfilled, or not fulfilled at all by the proposed measure.*
*** indicates this criteria is partially fulfilled by the proposed measure.*
**** indicates this criteria is largely fulfilled by the proposed measure.*

Table 3.6 demonstrates how a selection of 'single dimensional' differentiation options measure up against four equity criteria.[17] The results demonstrate that there is a trade-off between the various equity dimensions and that no one approach to differentiation satisfies all of the criteria completely. The per capita emissions approach fares best in terms of need, but less well with respect the other factors, most notably, opportunity. Cumulative emissions proposals are strongest at meeting the responsibility criterion, but once again barely fulfil the opportunity requirement. GDP per capita is the best all-round performer of the six, partially fulfilling all four criteria and largely fulfilling the capacity criterion, which no other option achieves.

However, it is important to remember that evaluating proposals for differentiation solely on the grounds of fairness misses the broader picture. The equity dilemma should be viewed within the wider context of political acceptability; after all, in practical terms, "equity principles will not override other elements of national self-interest" (Cazorla and Toman 2000:5). Torvanger and Ringius (2002) take into account a number of political and 'operational' factors in their discussion of criteria for 'burden sharing rules'. This study examines both fairness principles and 'operational requirements' such as universal applicability, ease of implementation, simplicity, flexibility, allowance for future refinements, and provision for country-specific circumstances. Furthermore, there is a considerable body of literature that investigates the cost implications of using various differentiation schemes (see Manne and Richels 1997; Rose et al. 1998; van Vuuren et al. 2003; Torvanger et al. 2004).

Just as equity is only one of the criteria upon which differentiation options may be assessed, proposals for allocating commitments are only one component of a comprehensive climate policy framework – albeit a crucial one. We therefore take our analysis a step further in Section 3.4, where we consider an extended list of criteria – containing political

[17] Two proposals are found in this table that have not so far been introduced as possible ways of allocating commitments in 3.3.3. Flat rate targets imply that every country reduces emissions by the same percentage, which we have excluded as an option due to the fact that it is not seriously considered to be a viable alternative. Intensity targets, i.e. allocating emissions per unit of GDP, has been mentioned within the context of Section 3.2 as we believe that such targets are strictly speaking 'commitment types' rather than ways of differentiating commitments.

considerations (including equity considerations), environmental effectiveness, economic concerns, and operational criteria – which can be used to evaluate global climate policy frameworks.

3.4 Criteria for assessing future climate policy frameworks

The criteria for evaluating the potential future climate regimes can be divided into four main categories: how environmentally effective a proposal is; whether or not it is politically feasible; the extent to which it takes into account economic considerations such as cost-effectiveness; and how practical the proposal is in terms of the ease with which it can be negotiated and implemented. We discuss each of these inter-related factors in turn below.

Environmental effectiveness

As a point of departure, it is logical to expect any measures to combat climate change to be *environmentally effective*. Evans (2002:5) makes this point clearly, stating that "environmental effectiveness – measured in terms of the ability of a policy to stabilise atmospheric concentrations of GHGs – is…the overriding priority of international climate policy. Political considerations of equity, efficiency and so on must take second place to this priority: there would be little point in implementing a politically feasible approach that isn't up to the environmental job in hand." Höhne et al. (2003:33) define environmental effectiveness in terms of stringent emissions targets, international participation, and the encouragement of early action. Global participation is an important safeguard against 'leakage' and reduces the likelihood that the mitigation efforts of participants in a climate regime will be undermined (or even negated) by the activities of those outside it. One example of such leakage is increased oil consumption and related carbon dioxide emissions by countries outside of the climate regime, caused by a lower oil price due to smaller demand from the countries participating in the regime.

Political feasibility

While environmental effectiveness is clearly an important characteristic of a potential future framework, no agreement can ignore the political context. At the end of the day, a modest agreement that is ratified and implemented is of greater value than an ambitious proposal that fails for political reasons. We therefore introduce *political feasibility* as a second essential feature of a potential future climate framework. The term is to be distinguished from political acceptability on the grounds that a proposal may be acceptable to all parties, but infeasible due to its complexity or on account of practical obstacles such as insufficient or incomparable data (Torvanger and Ringius 2002:224). Equity issues also fall within this category, as appeals to fairness are often used to underpin political arguments (Ashton and Wang 2003:61). Höhne et al. (2003:33-4) propose that two political criteria should be met for an optimal outcome to be achieved: an agreement should be compatible with the positions of the major actors, and should respect three key equity principles, namely, need, capacity and responsibility. Ringius et al. (2002) argue that that need, taken as basic human needs, is the most important fairness principle to satisfy, followed by capacity, and finally responsibility.

Cost-effectiveness

The ideal outcome would ensure that costs at the global level are kept to a minimum. In economic terms, this is achieved by equalising marginal abatement costs both within and between countries. However, it is important to distinguish between global and national costs, as it is latter that will be the most crucial in determining whether or not an agreement is ratified (Philibert and Pershing 2001:213). Höhne et al. stress that any agreement that is to meet the necessary economic criteria must, first of all, take into account the structural differences between countries, and secondly, allow countries sufficient flexibility to meet their commitments in the way that is most cost-effective given their particular circumstances (Höhne et al. 2003:34). For example, individual countries may want to focus on different sectors and gases.

Operational considerations

The ease with which an agreement can be negotiated and implemented falls within the fourth group of criteria, also referred to in the literature as 'operational' (Torvanger and Ringius 2002) or 'technical' factors (Höhne et al. 2003). Although these considerations have political connotations, they essentially apply to the operational feasibility of a proposal. For example, from a negotiation perspective, it is an advantage that an agreement is simple and involves as few separate decision-making processes as possible (Torvanger and Ringius 2002:224; Höhne et al. 2003:34). Furthermore, the methods and data necessary for formulating the agreement and for implementing targets should be accessible and verifiable. For this reason it has been proposed that a future agreement be, as far as possible, compatible with existing UNFCCC and Kyoto Protocol structures and frameworks (Höhne et al. 2003:34).

Other criteria

Other factors that are also relevant to the design of future regimes include the following: flexibility to incorporate new information (Aldy et al. 2003a, b:378); capacity to provide for changes in national circumstances (Torvanger and Ringius 2002:225); institutional efficiency and effectiveness (NIES/IGES 2003); institution building (Berk et al. 2001a:28), capacity building (Berk et al. 2001a:28), dynamic efficiency (Aldy et al. 2003c:375-6); the role of technology (Berk et al. 2001a:28); incentives for participation and compliance (Aldy et al. 2003c:378); and the contribution to economic growth and sustainable development (Philibert and Pershing 2001:213).

Inter-linkages and conflicts

It is important to note that many of these criteria are inter-linked, and that conflicts between them are likely to mean that no single agreement will be able to fulfil all of the above criteria. For example, improving cost-effectiveness will not always result in the most environmentally sound or politically expedient outcome for all parties. Similarly, a simple proposal makes the negotiation process easy, but failure to take into account individual circumstances may make the scheme unpopular. Therefore, coming to an agreement means finding the right balance between the various factors and reaching a compromise that is acceptable to as broad a constituency as possible.

Evaluating proposals

Conducting a comprehensive evaluation of potential future climate policy frameworks is beyond the scope of this paper, although we refer the reader to studies by Höhne et al. (2003) and Aldy et al. (2003), which assess a selection of proposals using different combinations of the criteria discussed above. Their results can be found in the Annex.

4 Adaptation and sustainable development

In terms of political feasibility, it is of central importance that a future climate regime is perceived to be equitable and fair (as discussed in Sections 3.3 and 3.4). In addition to the issues we have already raised in this context, there are two further areas that deserve specific attention. As illustrated by the events at COP8, key developing country concerns also relate to (1) impacts, vulnerability and adaptation, and (2) sustainable development. Many believe that unless these issues are addressed it will be difficult to ensure the "meaningful participation" of developing countries. An overview of these two themes is presented in the two sections below.

4.1 Vulnerability and adaptation

Background

The UNFCCC mentions both mitigation and adaptation as measures to address climate change; however, adaptation has traditionally had a low-profile in international climate policy. Rather than being viewed as an issue requiring specific attention, adaptation was assumed to take place largely as a matter of course (Parry et al. 1998; Kates 2000). Moreover, dedicating resources to supporting adaptation was thought to detract from the main task in hand, namely, making emissions reductions. This was reflected in the IPCC's Second Assessment Report, which focused heavily on mitigation options and energy policy (Kates 1997).

The publication of the Third Assessment Report in 2001, however, represented a symbolic turning point. It offered the clearest indication yet that human-induced climate change was underway, and gave a more balanced treatment to adaptation and mitigation (McCarthy et al. 2001; Klein et al. 2003). Furthermore, three new funds for adaptation were established later that year at COP7.[18] As a result, adaptation has received increased attention in academic and policy spheres (Burton et al. 2002; Klein et al. 2003), and is expected to gain further recognition in the Fourth Assessment Report due in 2007.

Bridging the divide

Despite these developments, COP8 and 9 demonstrated that the Parties are still very much divided in terms of their willingness to address the issue of adaptation. At COP8, for example, the G-77 countries, and particularly the host India, were keen to discuss adaptation more explicitly, while Annex I Parties (with the exception of the US) preferred to focus on mitigation. Ott (2003) argues that the failure of COP8 to initiate discussion of commitments beyond 2012 was partly due to the Annex I-Parties' lack of response to the concerns of the developing countries. Müller (2002a) sees this as a problem of differing perceptions of climate change, with the industrialized north viewing 'nature' as the main victim, while the poorer south see innocent humans as the prime sufferers. Developing countries feel that while they are least responsible for climate change, they are most likely to face its severest consequences; at the same time, they are the worst-equipped to deal with them (IPCC 2001a, b). Climate change is seen to be an immediate threat to coping strategies, and legitimate concerns have been raised that preparations for adaptation have so far been inadequate (Ott 2003). Some developing country representatives argue for the need to redress the balance of the climate regime by referring to two articles of the Convention (Müller 2002c: 14):

[18] It is important to note that the *Adaptation Fund* under the Kyoto Protocol is the only fund dedicated solely to adaptation, while the *Special Climate Fund* and the *Least Developed Countries Fund*, both under the Framework Climate Convention, are supposed to handle adaptation alongside a number of other issues.

> The specific needs and special circumstances of developing country Parties, especially those that are particularly vulnerable to the adverse effects of climate change...should be given full consideration. *UNFCCC Article 3.2 (Principles)*

> The developed country Parties and other developed Parties included in Annex II shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects. *UNFCCC Article 4.4 (Commitments)*

Both of these articles clearly state that the developed world has a responsibility to assist developing countries in reducing vulnerability to climate change.

While it is clear that any successful future climate regime must take into account the concerns of both the developed and the developing world, bridging the gap in priorities outlined above is further complicated by the fact that Annex I and the G-77 are far from homogenous entities. The US, for example, has been known to play devil's advocate to Annex I's proposals and side with developing countries on occasion (Ott 2003). The G-77, meanwhile, is only a loose international alliance, with starkly diverse political and economic interests. This negotiating cohort represents nations ranging from the poorest LDCs and climate-vulnerable small island developing states (SIDS), to the oil-rich OPEC members and powerful economies such as China. Finding an outcome that is satisfactory to each and every party therefore presents a great challenge.

Seeking synergies between mitigation and adaptation

One potential way forward is to heed calls for a dual approach to climate change and investigate how potential synergies between adaptation and mitigation strategies might be achieved. Synergies are created when climate policy implementation has a positive effect on both mitigation and adaptation efforts, producing win-win situations (Kane and Shogren 2000). One such example would be planting trees in cities, which would serve to reduce heat stress and sequester carbon simultaneously (Klein et al. 2003). At the international level, there is potential for synergies between the implementation of the UNFCCC and other environmental agreements, such as the Convention on Biodiversity and the Convention to Combat Desertification.

Klein et al. (2003), however, warn against an over-reliance on synergies. They argue that the scope for achieving win-win outcomes is limited due to the fact that (1) different actors are usually involved in mitigation and adaptation efforts, (2) it is unlikely that there are sufficient opportunities for synergies to produce the necessary levels of mitigation and adaptation, and (3) there is a good chance that mitigative and adaptive measures carried out separately will have a higher net impact than if the equivalent resources are invested in synergies alone.

An optimal mix of mitigation and adaptation?

As mitigation and adaptation are not thought to be generally complementary (Michaelowa 2001), economists have more recently channeled their energies towards identifying the optimal mix of adaptation and mitigation. Klein et al. (2003) are once again skeptical towards this approach, stressing that no single optimal mix exists due to uncertainty, differing local circumstances, and contrasting preferences and values in society. Instead they advise that a socially, economically and environmentally justifiable mix is sought, which will vary over space and time.

The road ahead

Unfortunately, there does not appear to be a simple way of integrating mitigation and adaptation in future international climate policy. However, what is clear is that securing the support of developing countries is contingent upon greater attention being paid to the issues

that concern them, such as adaptation.[19] Investigating the potential solutions will require further research. Some innovative, preliminary suggestions have included establishing an 'Impacts Protocol' by 2005 (Müller 2002a, c), and the introduction of an 'Impacts and Adaptation Protocol', which could be seen as a suitable counterbalance to the mitigation-centric Kyoto Protocol. India also launched the idea of a separate Impacts Protocol under the Convention ahead of COP8. The reasoning behind calls for a separate protocol dealing with impacts and adaptation is that the Kyoto Protocol's main focus is on the UNFCCC Article 2's first paragraph, which concerns itself with mitigation and the stabilization of greenhouse gases. Proponents assert that a truly balanced climate convention should also address Article 2's other objectives relating to impacts and adaptation (see Section 2.2.1.ii).

4.2 Sustainable development

The World Commission on Environment and Development (WCED) defined sustainable development as, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987:43). It emphasizes "the essential *needs* of the world's poor, to which overriding priority should be given," and also stresses *limitations*, such as "the environment's ability to meet present and future needs" (ibid.). The concept therefore takes an integrated approach to addressing the issues of economic growth, environmental protection and social justice (across geographical and temporal dimensions).

The Kyoto Protocol deals with sustainable development through its Clean Development Mechanism (CDM), which has the dual aim of assisting developing countries in achieving sustainable development (Article 12) and improving the global cost-effectiveness of emissions reductions. However, it has been argued that projects that are attractive in terms of greenhouse gas abatement might not necessarily promote sustainable development. Indeed, Kolshus et al. (2001) find that there is a trade-off between cost-effectiveness and sustainability indicators.

The potential weakness of the CDM as the sole instrument for promoting sustainable development, combined with the reluctance of developing countries to commit to the international climate change effort, has led some commentators to call for a fresh approach. They have suggested that a good way of encouraging developing countries to participate in a global regime would be to set the issue of climate change firmly within a sustainable development context (Beg et al. 2002; Metz et al. 2002; Winkler et al. 2002b; Davidson et al. 2003; Najam et al. 2003). This would give more weight to the priorities of developing nations – namely, poverty reduction, economic growth, and income distribution. Such a view is taken by Metz et al. (2002), who see flaws in other alternatives. They are skeptical towards approaches such as convergence proposals, which they believe are too politically contentious, and intensity targets or multi-stage approaches, which they fear will be incompatible with low-stabilization levels. Instead they propose that framing climate change as a developmental rather than an environmental problem offers the best solution. Stressing that climate change has implications for development goals would improve the political acceptability of a global climate agreement among developing countries. A broader sustainable development strategy could be integrated into a system of differentiated commitments, and be supplemented by measures to assist technology transfer, improve energy efficiency, and promote clean air policies and sustainable forest management.

[19] Equity issues (as discussed in Section 3.3.2) and sustainable development (see 4.2) are also salient here.

4.3 Summary

What appears to be increasingly apparent is that if the developed world is interested in securing the participation of developing countries – which is a precondition for an economically and environmentally effective climate agreement – it cannot afford to ignore the very real concerns of developing nations. Unless adaptation, development and equity issues are explicitly addressed during the post-2012 climate negotiations, it is hard to foresee that developing countries will join an international climate regime of the future.

5 Major conclusions and recommendations

5.1 Design of future climate policy

In this section we summarize and discuss what we believe to be the most promising ideas and interesting results for developing future climate policy. A well-designed climate policy should meet criteria such as environmental integrity (achieving deep global GHG emission reductions), cost-effectiveness, political feasibility (broad participation), and technical feasibility (in negotiations and implementation).

The major conclusions of this survey are summarized in six points:

1. A flexible approach is needed to ensure broad participation and significant emission reductions. The flexibility could be along four dimensions: choice of commitment type(s), methods of differentiating across countries, timing with regard to when certain groups (foremost poor countries) take on commitments, and inclusion of substances that indirectly affect climate.

2. Progress in negotiations will be best served by more focus on moving in the right long-term direction in order to keep future options open than on meeting specific short-term global emission caps.

3. Mitigation costs and participation attractiveness should be given sufficient attention when evaluating different emission paths meeting the same temperature increase ceiling.

4. All things considered, concentration and temperature targets are a better choice than impacts-based targets. However, better information on the distribution in time and space of impacts given a climate change scenario is a valuable input to decisions on emission, concentrations and temperature based targets.

5. A coalition of most willing nations could be an interesting supplement to a global UN-based process (building on UNFCCC and the Kyoto Protocol), and in particular if the Kyoto Protocol should fail.

6. Some type of international coordination of climate policy is required because of both cost-effectiveness concerns (to employ flexibility mechanisms) and attractiveness for broad participation. Increased cost-effectiveness could make more ambitious policies attainable. Nations' willingness and efforts to manage the climate system given its nature as a global common property resource will be conditional on the efforts by other nations.

Norway's contributions in particular can include the following:

1. Norway can contribute to bridging countries across the Atlantic and the North-South climate policy cleavage. In this regard Norway can take advantage of its good relations with developing countries and its large official development aid contributions. There is a potential for better integration of sustainability and climate policies in development policies and assistance. Furthermore, Norway could contribute to better integration of climate change impacts and adaptation, and emission abatement policies.

2. As a country with a strong climate research tradition, Norway could invest in conducting more research to explore essential post-2012 issues.

3. From a national perspective, Norway should consider its interest in future negotiations. For instance, does Norway prefer to build on the global Kyoto structure or on a more regional approach involving the most willing nations?

6 References

6.1 Literature providing an overview

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7 Annex

Table A1: Alternative international policy architectures for global climate change. Source: Aldy, Barrett and Stavins 2003

Alternative	Environmental Outcome	Dynamic Efficiency	Cost-effectiveness	Distributional Equity	Flexibility	Incentives for Participation and Compliance
Kyoto Protocol	Probably low, given short-term nature of commitments, and poor incentives for participation and compliance.	Requires reductions that are too large in short run, and silent on reductions required for long run.	Flexible mechanisms help cost-effectiveness, but non-participation by key countries reduces cost-effectiveness; CDM burdened by transactions costs.	Only industrial countries (ICs) face targets, but developing countries (DCs) help shape rules. DCs receive some adaptation assistance.	Emission ceilings are locked in, but only for five-year periods.	Incentives for participation and compliance are very weak.
Aldy, Orszag, & Stiglitz (2001)	Depends on safety valve price and extent of developing country participation.	Allows for policies that could be consistent with dynamic efficiency.	International emissions trading with a safety valve would likely result in common price for all participants.	Delays mandatory emissions commitments by DCs. Safety valve funds to DCs for abatement efforts.	Commitments and safety valve price adjusted over time in response to new information.	Use of sanctions, especially on trade, to promote compliance. Incentives for developing country participation.
Barrett (2001, 2003)	Depends on the agreed standards.	Technology lock-in may impair efficiency, but increased R&D may also lower costs.	Would not equalize marginal costs across all sectors.	R&D funded according to UN scale. ICs pay for technology adoption by DCs; adaptation funded by ICs.	R&D protocol provides information about technologies to lower costs, but standards may create lock-in.	R&D investment, economies of scale, network externalities, and trade restrictions create incentives for participation. No need to enforce compliance.
Benedick (2001)	Depends on levels for R&D, technology standards, etc.	Technology lock-in may be a problem, but public sector R&D may lower costs.	Would not be a global agreement, and would not equalize marginal costs across all sectors.	ICs to transfer new technologies to DCs. US to show leadership in reducing emissions unilaterally.	R&D would provide more information about new technologies.	Participation deliberately restricted, at least initially and in some areas. No explicit mention of compliance.
Bradford (2002)	Would depend on the magnitude of financial contributions to the central authority.	Could potentially support a dynamically efficient outcome.	Common offer bid for emissions allowances to all countries would insure cost-effectiveness.	Financing obligations would reflect ability to pay and expected benefits from mitigating climate change.	Central authority could adjust emissions allowances purchases with new information over time.	Does not explicitly address enforcement of financing obligations.
Cooper (1998, 2001)	Would depend on the level of the carbon tax.	Could potentially support a dynamically efficient outcome.	Common carbon tax would be cost-effective.	Tax would be uniform, but part of revenue could be redistributed to DCs.	Tax level can be changed, to adjust to new information.	Does not incorporate explicit mechanisms. Relies on a "commitment" to treaty objectives

Table A1: Alternative international policy architectures for global climate change (continued). Source: Aldy, Barrett and Stavins 2003

Alternative	Environmental Outcome	Dynamic Efficiency	Cost-effectiveness	Distributional Equity	Flexibility	Incentives for Participation and Compliance
Hahn (1998)	Depends upon levels at which instruments are set	Depends upon levels and time paths of instruments.	Could be cost- effective, due to reliance on market- based and related instruments.	Depends upon allocations.	Very flexible; instruments that perform best are continued.	No attention is given to participation and compliance.
McKibbin & Wilcoxen (1997, 2000, 2002)	Relatively low carbon emissions price implies modest near-term emissions reductions.	Could potentially support a dynamically efficient outcome.	Common carbon price across all countries supports cost-effective implementation.	DCs would receive emissions endowments in excess of current emissions.	Decadal negotiations to select carbon price allows for accounting of new information.	Does not substantially address participation or compliance issues.
Nordhaus (1998, 2002)	Relatively low carbon tax implies modest near-term emissions reductions.	Could potentially support a dynamically efficient outcome.	Harmonized carbon tax insures cost- effective implementation among participating countries.	Participation conditional on per capita income. DCs would also likely receive financial transfers.	Periodic international votes allows for adjusting carbon tax to new information.	Promotes compliance through trade measures. Developing country participation supported through financial transfers
Schelling (1997, 1998)	Would probably have little effect on emissions.	Does not front-load mitigation. Promotes R&D to reduce future mitigation costs.	Would aim to reduce emissions globally.	Financial transfers to DCs.	Emphasizes the need to act, rather than to meet a particular target	Enforcement of compliance not needed by design.
Schmalensee (1996, 1998)	Little effect in short run, but significant effects in long term.	If targets are sufficient, could be dynamically efficient.	Could be cost-effective, due to reliance on market-based and related instruments.	Little attention given to distributional equity in the cross-section, but could provide intertemporal equity.	Quite flexible, due to focus on beginning with modest targets.	No attention given to participation and compliance issues.
Stavins (2001b)	Abatement would be very modest in the short term, but much more ambitious in the long term.	If targets are sufficient, could be dynamically efficient.	Could be cost-effective, due to reliance on tradable permits, carbon taxes, and hybrid systems.	Addresses cross-sectional distributional equity through allocation of permits and use of growth targets.	Long-term targets are flexible, to allow for effects of learning.	Little attention to participation and compliance, except for incentives for DCs.
Stewart & Wiener (2001)	Would depend on the magnitude of the "headroom" allowances given to DCs.	Dynamic efficiency weakened by participation & compliance problems.	Reliance on an expanded CDM, and participation and compliance problems undermine cost-effectiveness.	Headroom allowances to DCs plus emissions trading provide potential economic gains to poor countries.	Emission commitments would need to be periodically negotiated.	Similar to Kyoto Protocol, with exception of incentives from "headroom" allowances.
Victor (2001)	Similar in targets to KP, but with safety-valve sales of additional permits.	Better than KP in its emission path, but not defined.	Includes flexible mechanisms of Kyoto Protocol; hence, can be cost-effective.	By bringing DCs into set of nations facing binding constraints only as they become more wealthy, equity is addressed.	Subsequent periods would need to be renegotiated.	Compliance is considered through buyer liability scheme, but participation is not addressed.

Table A2: Indicative assessment matrix for the qualitative comparison of the approaches. Source: Höhne et al. 2003

Criterion \ Approach	Possible weighting	Continuing Kyoto	Intensity targets	Contraction and convergence	Global Triptych (CO_2 only)	Multi-sector convergence approach	Multistage approach (FAIR)	Equal mitigation cost	Coordinated Policies and measures	Extended global Triptych	New multistage	Performance targets
Environmental criteria	**3**	**+**	**0**	**++**	**+**	**++**	**+**	**0**	**+**	**+**	**++**	**+**
Environmental effectiveness		++	+	++	++	++	++	++	0	++	++	+
Encouragement of early action by Parties that do not yet have binding commitments		-	-	++	0	+	/	--	++	0	+	+
Political criteria	**3**	**0**	**0**	**0**	**+**	**0**	**++**	**0**	**0**	**+**	**++**	**0**
Equity principles		+	0	+	+	+	++	0	-	+	++	+
Agreement with fundamental positions of major constituencies		0	+	-	+	0	+	-	0	+	+	0
Economic criteria	**2**	**0**	**0**	**-**	**+**	**+**	**+**	**++**	**-**	**++**	**+**	**++**
Accounting for structural differences between countries		/	/	--	+	+	+	++	-	++	+	++
Minimizing adverse economic effects		+	+	+	+	+	+	++	-	+	+	+
Technical criteria	**1**	**++**	**0**	**++**	**0**	**0**	**+**	**-**	**0**	**0**	**+**	**0**
Compatibility with UNFCCC and Kyoto Protocol		++	+	+	+	+	+	+	0	+	+	+
Moderate political and technical requirements of the negotiation process		++	-	++	-	-	+	--	-	-	+	-

Note: '--' criterion completely not met, '-' criterion mainly not met, '0' neutral, '/' depends on the specific variation of the approach, '+' criterion mainly met, '++' criterion completely met