CLIMATE CHANGE MITIGATION NEGOTIATIONS, WITH AN EMPHASIS ON OPTIONS FOR DEVELOPING COUNTRIES

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Capacity development for policy makers: addressing climate change in key sectors

The UNDP "Capacity development for policy makers" project seeks to strengthen the national capacity of developing countries to develop policy options for addressing climate change across different sectors and economic activities, which could serve as inputs to negotiating positions under the United Nations Framework Convention on Climate Change (UNFCCC). The project will run in parallel with the "Bali Action Plan" process – the UNFCCC negotiations on long-term cooperative action on climate change set to conclude in December 2009 in Copenhagen at the fifteenth Conference of the Parties.

This paper is one of a series produced for the project that provides in-depth information on the four thematic building blocks of the Bali Action Plan – mitigation, adaptation, technology and finance – as well as on land-use, land-use change and forestry. The project materials also include executive summaries for policymakers, background briefing documents and workshop presentations. These materials will be used for national awareness-raising workshops in the participating countries.

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CONTENTS

Acronyms

Annex I	Annex to the Convention listing industrialised and transitioning countries
Annex II	Annex to the Convention, listing mostly OECD countries, with additional commitments to assist developing countries with funding and technology transfer
AR4	Fourth Assessment Report (of the IPCC, see below)
AWG-KP	Ad hoc Working Group on further commitments of Annex I Parties under the Kyoto Protocol
AWG-LCA	Ad Hoc Working Group on Long-term Cooperative Action under the Convention
BASIC project	Linking national and international climate policy: capacity building for challenges ahead for Brazil, China, India and South Africa
CCAP	Center for Clean Air Policy
CDM	Clean Development Mechanism
CFL	Compact fluorescent light
CH4	Methane
CO_2	Carbon dioxide
COP	Conference of the Parties (to the UNFCCC)
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
DEAT	Department of Environmental Affairs & Tourism, SA
DEFRA	Department of Food and Rural Affairs, UK
EU	European Union
FYR	Former Yugoslav Republic of Macedonia
G77	Group of 77, mostly Latin American, African and South Asian countries
GDP	Gross domestic product
GEREF	Global Efficiency and Renewable Energy Fund (established by the EU)
GHG	Greenhouse gas
HDI	Human Development Index
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land use, land use change and forestry
MRV	Measurable, reportable and verifiable
N2O	Nitrous oxide
NAI Parties	Non-Annex I Parties, mostly developing countries
PAMs	Policies and measures
PPP	Purchasing power parity
QELROs	Quantified emission limitation and reduction objectives, established under the Kyoto Protocol
REDD	Reducing emissions from deforestation in developing countries
RSA	Republic South Africa
SBI	Subsidiary Bodies on Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SD-PAMs	Sustainable development policies and measures
SO2	Sulphur dioxide
SRES	Special Report on Emission Scenarios (of the IPCC)
UNFCCC	United Nations Framework Convention on Climate Change (the Convention)
WG I	Working Group I (of the IPCC, see above), assesses the literature on the physical science basis of climate change
WG II	Working Group II (of the IPCC, see above), assesses the literature on the impacts, vulnerability and adaptation to climate change
WG III	Working Group III (of the IPCC, see above), assesses the literature on the mitigation of climate change, i.e. reducing GHG emissions
WRI	World Resources Institute

Units and Measures

CO_2-eq	CO_2-eqivalent
GJ	Gigajoules: 10^9 Joules, a billion Joules
GW	Gigawatts: 10^9 Watts, a billion Watts
J	Joule, standard international unit of energy, defined as a Newton-meter, or approx. the energy required to lift a small apple one meter straight up
kW	Kilowatts (power measurement)
Mt	Megatons, 10^6 tons, a million tons
$MtCO_2$	Megatons of carbon dioxide, a million tons CO_2
MW	Megawatt: 10^6 Watts, a million Watts
PJ	Petajoules: 10^{15} Joules
ppmv	parts per million by volume
tC	tons of carbon
tCO_2	tons of CO_2

1 INTRODUCTION

Climate change is one of the greatest threats to our planet and its people. Reducing emissions of greenhouse gases (GHG) is called mitigation. Responding to the impacts of climate change is called adaptation. A certain amount of adaptation will be necessary, no matter what we do. But, there will come a point where it will not be possible to adapt our way out of the problem.

Mitigation has been at the heart of the climate negotiations from the outset. As the next round of negotiations focuses on what developing countries might do on mitigation, the topic remains highly relevant.

The remainder of this introduction briefly sketches the history of the climate negotiations, ending with the most recent agreements in Bali. The paper then turns to the scientific basis of the work on mitigation. Section 3 introduces background concepts for proposals on mitigation, leading into the next section, which identifies not only different schools of thought but a number of specific proposals as well. The "hot" topic of how mitigation actions can be made 'measurable, reportable and verifiable' (MRV) is examined in section 5, before concluding with some questions for discussion. Information on the terminology used in this paper can be obtained from the glossary in Annex 4.

1.1 Background to the climate negotiations

In Rio de Janeiro in 1992[1], the United Nations Framework Convention on Climate Change (UNFCCC) was negotiated, including its ultimate objective and the principles on which climate action is to be based. For developing countries, it is important to underscore that Article 2, the objective of the Convention, not only refers to stabilisation of atmospheric concentrations in the atmosphere, but also refers to doing this in a way that allows sustainable development to proceed – ecologically ("ecosystems adapt"), socially ("food security") and economic development.

The Convention sets a framework for future action, it outlines the 'rules of the game' to enable to the international community to agree on future action as the science improves or new tools and technologies become available. New information indeed became available through the Second Assessment Report from the Intergovernmental Panel on Climate Change (IPCC) in 1995, informing the negotiation of the Berlin Mandate which in turn led to the Kyoto Protocol.

In Kyoto in 1997,[2] based on the principle of equity and common but differentiated responsibilities and respective capabilities, it was agreed that Annex I Parties would take the leaders through quantified emission limitation and reduction objectives (QELROs) (UNFCCC 1997). For Annex I Parties, policies and measures (PAMs) are a means to achieve QELROs[3]. Progress is to be reported by means of annual inventories and national communications[4].

In Kyoto, non-Annex I (NAI) Parties continued with qualitative mitigation measures[5], without quantifying the outcome. Parties considered this appropriate, given that development would imply increasing emissions. There is no mandatory requirement for particular PAMs, so that these could in future be a possible form of commitment in themselves. Reporting for NAI Parties includes national inventories, as well as "a general description of steps taken or envisaged"[6] and in practice includes a section on mitigation programmes.

There was agreement in 1992, that Annex II Parties would make available the "full agreed incremental costs" for NAI Parties to implement their commitments, including those to mitigation, as well as assist with technology transfer[7]. By Montréal in 2005[8], the Kyoto Protocol had entered into force, and Parties agreed to launch a two-track approach. The Kyoto track set up an Ad-hoc Working Group on further commitments of Annex I Parties (AWG-KP) to negotiate commitments for Annex I Parties for subsequent commitment periods, as mandated by Article 3.9 of the Protocol. The Convention

[1] United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, 3-14 June 1992.
[2] The third Conference of the Parties to the UNFCCC (COP 3) was held in Kyoto, Japan from 1 - 11 December 1997.
[3] Indeed, PAMs are the first item listed in Protocol Article 2.1(a).
[4] Reporting for Annex I in terms of Protocol Articles 5, 7 and 8 and FCCC Article 12.2.
[5] FCCC Article 4.1b mitigation programmes for all Parties.
[6] FCCC Article 12.1 on reporting by all Parties, including developing countries, governs inter alia NAI inventories and national communications.
[7] FCCC Articles 4.3, 4.5 and 4.7 on financial and technology transfer, and both (4.7).
[8] COP 11 and the first Conference of the Parties serving as the meeting of the Parties (COP/MOP 1) were held from 28 November to 9 December 2005 in Montréal, Canada.

track was not a formal negotiation process, but initiated a discussion in four workshops over two years. Given that major developed countries had not ratified the Protocol, action for mitigation by such Parties has had to be considered under the Convention track rather than the Protocol track, i.e. the AWG-KP. (For an overview regarding Conference of the Parties (COP) decisions relevant to mitigation, please refer to Annex 1).

1.2 The Bali Action Plan

In Bali,[9] the attempt was to retain the Annex I/non-Annex I balance of mitigation commitments, but also to increase the sense of urgency on both sides. The balance was outlined in **paragraphs (b)(i) and (b)(ii)**:

> "(b) Enhanced national/international action on mitigation of climate change, including, interalia, consideration of:
>
> (i) Measurable, reportable and verifiable nationally appropriate mitigation commitments or actions, including QELROs, by all developed country Parties, while ensuring the comparability of efforts among them, taking into account differences in their national circumstances;
>
> (ii) Nationally appropriate mitigation actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner;"

One priority for developing countries in Bali was that all developed countries, including the US, take on QELROs. This was included only as an option in the final text, but comparability of efforts was introduced in (b)(i). Raising the level of effort for developed countries includes both broader participation, (i.e., including Annex I Parties that have not ratified the Protocol), but also, in the AWG-KP, more stringent efforts by Kyoto ratifiers in the second commitment period. In respect of the latter, the range of -25% to -40% from 1990 levels by 2020 is the key benchmark being negotiated. This range has not, to date, been agreed in the Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA).

In paragraph (b)(ii), the same language of MRV applies to mitigation actions by developing countries, but also to support through finance, technology and capacity-building. While there will always be different interpretations of agreed text, the Chair of the Group of 77 and China (G77) made clear in his interpretive statement in the final plenary that MRV applied to both mitigation and support[10]. Most legal interpretations confirm that the comma prior to the last clause in (b)(ii) has the effect of applying it to the entire paragraph.

This short paragraph, then, reflects two very significant shifts. Firstly, developing countries have agreed to negotiate MRV mitigation action. In other words, developing countries are now willing to negotiate 'quantifiable' mitigation actions, or to use the exact words "measurable, reportable and verifiable". Not only can the emissions implications of actions be measured, they could also be reported to the international community and be capable of verification.

Secondly, technology transfer and financial resources by developed countries need to pass the test of being verifiable, too. This similarly is a significant departure from the past, when much financing was through voluntary contributions to funds and the quantum of technology transferred was not measurable. In future, finance and technology will be subject to MRV.

The Bali Action Plan in these key paragraphs refers to developed countries and developing countries, rather than Annex I and NAI Parties. This opens the possibility of defining what is meant by the new categories. The main implication is that some developed countries deal with mitigation under the AWG-KP, but all developed countries also address mitigation "commitments or actions, including QELROs" in (b)(i). It is the only place where mitigation can be discussed for those Annex I Parties that have not ratified the Protocol. No further distinction is made among developing countries in the Bali Action Plan, so that all G77 members would understand their mitigation actions to be dealt with under (b)(ii).

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[9] COP 13 and COP/MOP 3 were held from 3 - 14 December 2007 in Bali, Indonesia.

[10] The Chair (Pakistan) in the final plenary in Bali indicated all the group was "asking for is that we are ready to have measurable, reportable, and verifiable mitigation but then that has also to qualify financing and technology." The statement can be viewed on the UNFCCC webcast.

The balances between paragraphs b(i) and b(ii) are likely to remain central in refining the architecture of the climate regime after 2012. The negotiations on mitigation in the AWG-LCA on mitigation continue to be difficult, reflected in the work plan for 2008, which was unable to agree on workshops on mitigation issues such as MRV, comparability of effort and others. During this year, mitigation will be treated as one of the five agenda items (mitigation, adaptation, finance, technology and shared vision), with all five being considered by every meeting of the AWG-LCA in 2008.

2. SCIENTIFIC BASIS FOR MITIGATION AND DEVELOPMENT

All work under the Convention and its Protocol is done on the basis of the best available scientific information. Workshops on mitigation in the AWG-LCA are likely to happen in 2009. In the meantime, however, there is significant scientific information, in particular from the IPCC. The IPCC assesses our state of knowledge on climate change.

In 2007, the IPCC issued its Fourth Assessment Report (AR4). The science (Working Group I, abbreviated WG I) is now "unequivocal" that human activity is contributing to climate change, and the impacts (Working Group II) are already being observed in all sectors – food, water, health, agriculture, energy, etc[11]. The contribution from Working Group III deals with mitigation (IPCC 2007b).

IPCC AR4 assessed several stabilisation levels in the literature. This information provides clear information about what mitigation is needed to keep stabilisation levels low and hence avoid the worst impacts of climate change (see Table 1). The impacts themselves are outlined in Working Group II report (IPCC 2007a). If we are to avoid the worst damages and keep concentrations at the lowest level assessed (450 parts per million by volume (ppmv), which would still see climate impacts), then **what is required are absolute emission reductions by Annex I and relative emission reductions[12] for developed countries.** In fact, the pattern of action applies for 550 ppmv as well, only with less stringent requirements – but also correspondingly higher climate impacts. Only at 650 ppmv is no 'deviation from baseline' emissions required in developing countries – and then only up to 2020 – but there would also be more dramatic impacts. (For more details, please refer to IPCC AR4 Section 3.)

IPCC AR4 also found that "climate policy alone will not solve the climate problem" (IPCC 2007a). Development policy is at least as important. Policy on technology, industry, agriculture, energy, housing and a whole range of other areas will be important, not only climate policy conceived as environmental policy alone.

Table 1: Ranges of emission reductions required for various stabilisation levels
The range of the difference between emissions in 1990 and emission allowances in 2020/2050 for various GHG concentration levels for Annex I and non-Annex I countries as a groupa.

SCENARIO CATEGORY	REGION	2020	2050
A-450	Annex I	-25% to -40%	-80% to 95%
ppmv CO_2 -eq[b]	Non-Annex I	Substantial deviation from base Line in Latin America, Middle East, East Asia and Centrally-Planned Asia	Substantial deviation from baseline in all regions
B-550	Annex I	-10% to -30%	-40% to 90%
ppmv CO_2-eq	Non-Annex I	Deviation from baseline in Latin America and Middle East, East Asia	Deviation from baseline in most regions, especially in Latin America and Middle East
C-650	Annex I	0% to -25%	-30% to -80%
ppmv CO_2 -eq	Non-Annex I	Baseline	Deviation from baseline in Latin America and Middle East, East Asia

a The aggregate range is based on multiple approaches to apportion emissions between regions (concentration and convergence, multistage, Triptych and intensity targets, among others). Each approach makes different assumptions about the pathway, specific national efforts and other variables. Additional extreme cases – in which Annex I undertakes all reductions, or non-Annex I undertakes all reductions – are not included. The ranges presented here do not imply political feasibility, nor do the results reflect cost variances.

b Only the studies aiming at stabilization at 450 ppmv CO_2-eq assume a (temporary) overshoot of about 50 ppmv CO_2-eq (see Den Elzen and Meinshausen, 2006).

Source: IPCC Working Group III (WG III) 2007. Chapter 13. Box 13.7.

[11] For more information, please refer to the paper produced for this series entitled "Adaptation to climate change: The new challenge for development in the developing world".

[12] Absolute reductions would be lower than in a previous year, the base year, while relative reductions are typically defined to be below pro-jected future levels. If emissions are projected to increase, a relative reduction might still see total, absolute emissions rising.

Making development more sustainable by changing development paths can thus make a significant contribution to climate goals. We should think of development paths not as mapped-out paths, but the result of many decisions by different actors in various places. To make this more concrete, WG III gives a few examples of how this might work:

- GHG emissions are influenced by, but not rigidly linked to economic growth: policy choices make a difference.
- Sectors where effective production is far below the maximum feasible production with the same amount of inputs – i.e., sectors that are far away from their production frontier – have opportunities to adopt 'win-win-win' policies, i.e. policies that free up resources and bolster growth, meet other sustainable development goals and also reduce GHG emissions relative to baseline.
- Sectors where production is close to the optimal given available inputs – i.e., sectors that are closer to the production frontier – also have opportunities to reduce emissions by meeting other sustainable development goals. However, the closer one gets to the production frontier, the more trade-offs are likely to appear.
- What matters is not only that a 'good' choice is made at a certain point in time, but also that the initial policy is sustained for a long time - sometimes several decades – to truly have effects.
- It is often not one policy decision, but an array of decisions that are necessary to influence emissions. This raises the issue of coordination between policies in several sectors, and at various scales.

Not only do development policies matter, but there is also much evidence that pursuing **local** sustainable development has co-benefits, also reducing GHG emissions. A development-oriented approach to mitigation is of particular interest for developing countries, where poverty and development are higher on the agenda than climate policy.

It also means that a much wider set of actors need to be involved in mitigation, particularly in the context of development. Within government, it would not only be environmental departments or meteorologists who would consider climate policy, but also departments of energy, forestry, housing, finance and virtually any other department, including sub-national and local governments. For mitigation, the role of the private sector will be equally important, particularly in countries where most emissions are due to industrial activity. Civil society will need to play an important role in advocating for climate policy as well.

Given all of this, the role of focal points on climate change may in future require a much greater element of coordination. Coordination will be needed to align policies across spheres of government, across sectors and across the economy and society more broadly. Coordinated work at the national level[13] would provide a solid basis for considering the various proposals in the multilateral negotiations.

[13] For more information, please refer to the paper in this series titled *National policies and their linkages to negotiations over a future international climate change agreement,* sections 4 and 5.

3. BACKGROUND CONCEPTS IN PROPOSALS FOR MITIGATION

As can be seen from section 1, Convention[14] negotiations can result in decisions and wording that are broad and offer room for different interpretations. This section outlines key mitigation concepts and principles that must be understood in order to assess mitigation option proposals, before specific proposals are outlined in section 4.

The principles of the Convention include that **"Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and common but differentiated responsibilities and respective capabilities",** which leads to the requirement that developed countries take the lead (Art 3.1). Further principles include:

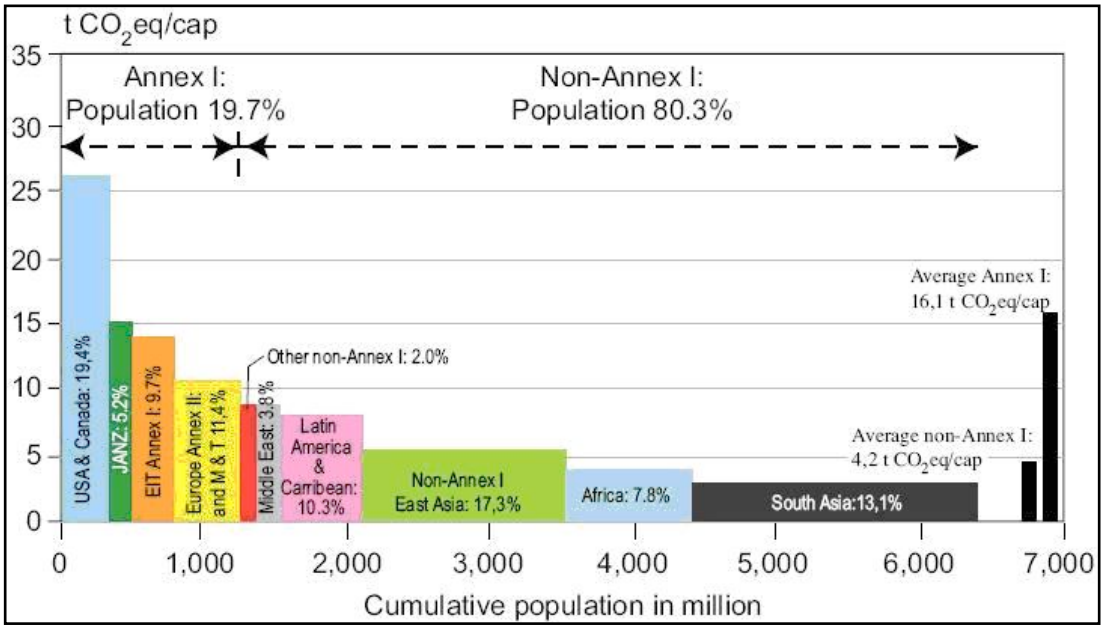
- The specific needs and special circumstances of developing countries;
- Taking a precautionary approach (i.e. scientific uncertainty is no excuse for inaction);
- The right to promote sustainable development; and
- Sustainable economic growth[15].

If one wants to quantify responsibility and capability, it matters what metric is chosen to approximate these concepts. The numerical outcome for a particular country will differ, depending on whether we consider:

- Particular gases (only CO_2 or all six Kyoto Protocol gases)[16];
- Which sources of emissions (energy only, or also land use, land-use change and forestry (LULUCF);[17]
- Which time-frame (annual or cumulative emissions); and
- At what scale (national, or per capita emissions)

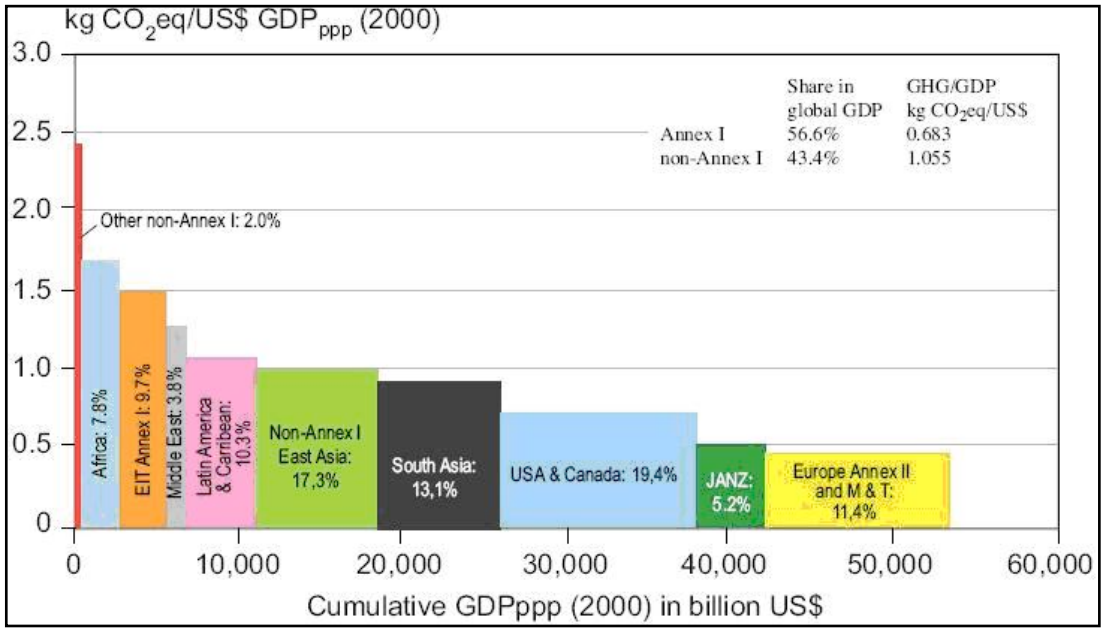
[14] FCCC Article 3 contains a set of principles.
[15] For the full text, see FCCC Articles 3.2, 3.3, 3.4 and 3.5
[16] The six GHGs listed in Annex A to the Kyoto Protocol are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_20), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs) and sulphur hexafluoride (SF_6).
[17] Please refer to the paper produced for this series titled, *Key issues on land use, land use change and forestry (LULUCF) with an emphasis on developing country perspectives*.

Figure 1: Annual emissions by region, per capita



Note: Year 2004 distribution of regional per capita GHG emissions (all Kyoto gases, including those from land-use) over the population of different country groupings. The percentages in the bars indicate a regions share in global GHG emissions.

Figure 2: Annual emissions by region, per $ Gross domestic product (GDP)



Note: Year 2004 distribution of regional GHG emissions (all Kyoto gases, including those from land-use) per $ of GDPppp (with ppp = purchasing power parity) over the GDPppp of different country groupings. The percentages in the bars indicate a regions share in global GHG emissions.
Source: IPCC 2007. Climate Change Synthesis Report

The more recent assessment of the IPCC illustrates the differences (see Figures 1 and 2). The upper graph shows the emissions per capita for different regions on the vertical axis, with the population added along the horizontal axis. On the lower graph, annual emissions (for the year 2004) are shown. For Africa, the bar is higher on an annual basis than a per capita basis; while for South Asia, per capita is lower. Such comparisons can be made for other regions and measures – the point is that it matters what you count. In the negotiations, countries will typically favour measures that show them in the most favourable light or support their interests.

IPCC AR4 found that the scenarios in the Special Report on Emissions Scenarios (IPCC 2000), without any mitigation, project an increase of baseline global GHG emissions by a range of 9.7 to 36.7 $GtCO_2$-eq (25-90%) between 2000 and 2030. Two thirds to three quarters of this increase in energy CO_2 emissions is projected to come from NAI regions, with their average per capita energy CO_2 emissions being projected to remain substantially lower (2.8-5.1 tons of CO_2 (tCO_2)/cap) than those in Annex I regions (9.6-15.1 tCO_2/cap) by 2030.

That is as far as the best available scientific information goes. Eventually, however, the allocation of emissions and burden sharing is a deeply political matter. **There have been suggestions that, instead of leaving such allocation purely to political horse-trading, it might at least be possible to establish some analytical criteria.** Political concepts, such as responsibility and capability in FCCC Article 3.1, could be approximated by analytical measures. In that way, principles could be operationalised into key criteria that would cut across different approaches (Ott et al. 2004):

- **Responsibility has been defined in the Brazilian proposal directly in relation to the contribution to temperature increase** (see section 4.2.3 for further details). A reasonable approximation of the more complex measures of responsibility is cumulative emissions of fossil CO_2 over 1990 to 2000 as an indicator of responsibility. The relatively recent period avoids 'punishing' countries for historical emissions, when the consequences were less widely known. At least since the IPCC's First Assessment Report in 1990, the implications can be said to be well-known internationally.
- **A country may have high responsibility for contributing GHG emissions, but nonetheless be too poor to mitigate.** For this reason we include indicators reflecting capability. Emissions do not have to be linked to human development, but under given socio-economic and technological conditions, a certain level of emissions will be necessary to guarantee a decent life for poor people. We consider two indicators of capability, the human development index (HDI) and GDP per capita. Countries with higher levels of national income and a higher rank on the HDI might be expected to carry a higher burden of mitigation.
- **The potential to mitigate can be related to three factors – emissions intensity, emissions per capita and emissions growth rate.** A high value for CO_2/GDP would suggest high potential to mitigate. The more efficient an economy already is (lower CO_2 emissions per unit GDP), the less potential there is (at a given cost) to mitigate further through efficiency. However, the level of emissions per capita needs to be taken into account as well. High per capita emissions suggest unsustainable consumption patterns, which should provide potential to mitigate without endangering a basic level of development, e.g. by lifestyle changes. National circumstances such as resource endowments also influence mitigation potential. Finally, the growth rate of absolute emissions gives an idea of whether the rate of increase is still high or has already been curbed.

Of course there are many other criteria, e.g., natural resource endowments or population per square kilometer, that could be introduced, or variants to the criteria above (see the further information and readings suggested in the references and Annex 3 below).

The acceptability of the criteria may be affected by whether they apply only to developing countries or to all countries. For example criteria that apply to all countries might include a longer historical period for cumulative emissions than criteria that apply only to developing countries. As mentioned below, the appropriate weighting of the criteria depends on whether market mechanisms can be used to meet the commitments. If they can be used, then the ability to pay becomes more relevant and potential for emissions reductions becomes less important because emissions do not need to be reduced domestically.

Many of the proposals found in the literature have some basis in numerical parameters or indicators – be they top-down approaches (e.g., the Brazilian proposal based on historical cumulative emissions; or per capita approaches) or bottom-up (e.g., based on intensity). These are considered in section 4. One possible set of implications of different criteria for selected developing countries are shown in Table 2. Historical responsibility would be based primarily on cumulative emissions; per capita might be another indicator of responsibility; ability to pay uses GDP/capita as a key measure; while emissions intensity is measured by GHG per unit of GDP. Table 2 illustrates with numerical values that it matters which indicators are used to assess responsibility, capacity and potential to mitigate in developing countries.

Table 2: Possible indicators for responsibility, capability and potential to mitigate in selected developing countries emissions by various measures[18]

		ARGENTINA	BRAZIL	CHINA	INDIA	MEXICO	SOUTH AFRICA	SOUTH KOREA	WORLD
Annual emissions	Emissions in 2004 of CO_2, energy, excl. LULUCF, $MtCO_2$ (Mt = Megatons, 106 tons)	146	346	5,205	1,199	415	428	507	29,734
	% of world total	0.5%	1.2%	17.5%	4.0%	1.4%	1.4%	1.7%	100%
Annual emissions	Emissions in 2000, six gases, including LULUCF, $MtCO_2$-eq	347	2,222	4,915	1,861	609	420	522	41,363
	% of world total	0.8%	5.4%	11.9%	4.5%	1.5%	1.0%	1.3%	100%
Per capita allowances	Emissions per capita in 2000, six gases, including LULUCF, $MtCO_2$-eq	9.4	13.1	3.9	1.8	6.2	9.5	11.1	6.8
Per capita allowances	Emissions per capita in 2000, six gases, excluding LULUCF, $MtCO_2$-eq	7.9	5.0	3.9	1.9	5.2	9.5	11.1	5.6
Historical responsibility	Cumulative emissions 1950 - 2000, only CO_2 (energy and LULUCF), $MtCO_2$-eq	6916	68,389	110,675	17,581	13,698	10,250	7,800	1,113,122
	% of world total	0.6%	6.1%	9.9%	1.6%	1.2%	0.9%	0.7%	100%
Ability to pay	GDP / capita, Int'l $, ppp 2000 $, value for 2002	10,134	7,480	4,379	2,555	8,798	9,813	17,662	7,643
Mitigation potential i.t.o. emissions intensity	CO2 / GDP, kg CO_2 / int'l $ GDP ppp 2000	343	263	616	399	438	787	563	521

[18] Table 2: Possible Indicators for responsibility, capability and potential to mitigate in selected developing countries emissions by various measures is an updated version of a table produced in earlier work (Winkler et al. 2002b). The earlier analysis included information on emission reductions, but these depend on underlying assumptions and are not included here. Readers are referred to the earlier work.

Table 3: Emissions from developing regions by various measures

		AFRICA (SUB-SAHARAN AND NORTH)[19]	NON-ANNEX I ASIA[20]	LATIN AMERICA AND CARIBBEAN[21]
Cumulative emissions 1950 - 2000, only CO_2, only energy	$MtCO_2$	21,197	157,085	33,744
	% of world total	2.7%	20.0%	4.3%
Cumulative emissions 1950 - 2000, only CO_2 (energy and LULUCF)	$MtCO_2$	61,553	321,105	138,447
	% of world total	5.6%	29.2%	12.6%
Annual emissions in 2000, only CO_2 (energy and LULUCF)	$MtCO_2$	2,277	11,758	3,681
	% of world total	7.2%	37.2%	11.7%
Annual emissions in 2000, all six gases	$MtCO_2$-eq	3,271	15,690	4,918
	% of world total	8.0%	38.1%	12.0%
Per capita emissions in 2000, all six gases	tons CO_2-eq per person	4.2		
	global average	6.8	4.5	9.6
Carbon intensity of economy in 2002,	tons of CO_2 / mill intl $ of GDP	469	562	354
	global average	507		

Source: WRI 2003. Climate Analysis Indicators Tool.

The time-frame (annual or cumulative) matters: For South Africa, for example, the share of world emission is 1.4% by annual energy CO_2 emissions, but 0.9% by cumulative emissions; for China, the share drops from 17.5% to 9.9%. For Brazil, the inclusion of LULUCF in the consideration increases its share from 1.2% to 5.4%, reflecting the predominance of this source in the country's emissions profile. Population matters: India may have 4.0% to 4.5% of total annual world emissions (depending on gases and sources), but on a per capita basis, its emissions are well below the global average. Many other comparisons can be drawn from Table 2 – and comparing these to other countries, including Annex I Parties. In the scope of this paper, an indication is given for a few developing countries.

To be more comprehensive, Table 3 presents various measures of emissions (annual, cumulative, per capita) for three regions of developing countries. Developing regions include only NAI Parties, which are listed in endnotes for each region. NAI Parties that are not included in any of the regions in Table 3 and Table 4: 4 are Albania, Belarus, Bosnia & Herzegovina, Cyprus, Macedonia (FYR), Malta, Moldova, Serbia & Montenegro; which together comprise

[19] The region 'AFRICA' in this table includes the following non-Annex I countries: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Congo, Dem. Republic , Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauri-tania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome & Principe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.

[20] The region 'ASIA' in this table includes the following Non-Annex I countries: Afghanistan, Armenia, Azerbaijan, Bahrain, Bangladesh, Bhutan, Brunei*, Cambodia, China, Chinese Taipei, Cook Islands, Fiji, Georgia, India, Indonesia, Iran, Iraq*, Israel, Jordan, Kazakhstan, Kiribati, Korea (North), Korea (South), Kuwait, Kyrgyzstan, Laos, Lebanon, Malaysia, Maldives, Mongolia, Myanmar, Nauru, Nepal, Niue, Oman, Pakistan, Palau, Papua New Guinea, Philippines, Qatar, Samoa, Saudi Arabia, Singapore, Solomon Islands, Sri Lanka, Syria, Tajikistan, Thailand, Tonga, Turkmenistan, United Arab Emirates, Uzbekistan, Vanuatu, Vietnam, Yemen.

[21] The region 'LATIN AMERICA AND CARIBBEAN' in this table includes the following Non-Annex I countries: Antigua & Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salva-dor, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Kitts & Nevis, Saint Lucia, Saint Vincent & Grenadines, Suriname, Trinidad & Tobago, Uruguay, Venezuela.

0.5 % of emissions of six gases in 2000. All countries for which no data is available in CAIT (WRI 2005, 2003) are also not included. Again, a few observations illustrate the differences made by removing the larger countries. Removing South Africa from Africa reduces Africa's share from 2.7% to 1.4%. Per capita emissions in developing Asia increase from 4.5 tons to 5.7 t CO_2-eq per person, when China, India, Indonesia and South Korea are removed. The increased level of absolute emissions is more than outweighed by not counting the large populations in those countries. Not including Brazil in the region Latin America and Caribbean increases emissions intensity from 354 to 386 t CO_2-eq/$ of GDP, as Brazil's hydro-based electricity system is no longer taken into account.

Table 4: Emissions from developing regions by the same measures, excluding certain countries[22]

		AFRICA (SUB-SAHARAN AND NORTH)	NON-ANNEX I ASIA	LATIN AMERICA AND CARIBBEAN
Cumulative emissions 1950 - 2000, only CO_2, only energy	$MtCO_2$	10,995	55,066	16,904
	% of world total	1.4%	7.0%	2.1%
Cumulative emissions 1950 - 2000, only CO_2 (energy and LULUCF)	$MtCO_2$	51,303	104,760	56,360
	% of world total	4.7%	9.5%	5.1%
Annual emissions in 2000, only CO_2 (energy and LULUCF)	$MtCO_2$	1,926	3,998	1,489
	% of world total	6.1%	12.7%	4.7%
Annual emissions in 2000, all six gases	$MtCO_2$-eq	2,851	5,327	2,087
	% of world total	6.9%	12.9%	5.1%
Per capita emissions in 2000, all six gases	tons CO_2-eq per person	3.8	5.7	8.6
	global average	6.8		
Carbon intensity of economy in 2002,	tons of CO_2 / mill intl $ of GDP	359	619	386
	global average	507		

Source: WRI 2003. Climate Analysis Indicators Tool.

Having seen in overview some of the key parameters and how they differ depending on what indicator is used, we turn next to specific proposal for mitigation in developing countries.

[22] Developing regions include the same countries as for Table 2, except that in Table 4: , the following countries are excluded: South Africa from AFRICA; Brazil and Mexico from LATIN AMERICAN AND CARIBBEAN; and China, India, Indonesia and South Korea from NON-ANNEX I ASIA.

4. OVERVIEW OF OPTIONS FOR MITIGATION IN DEVELOPING COUNTRIES

4.1 Different approaches

A wide variety of approaches under the mitigation building block for the architecture of the climate regime up to and beyond 2012 have been proposed. Some of these include:

- Extending fixed targets Kyoto-style;
- Universal carbon taxes;
- Allocations of emissions per capita (Aslam 2002; Meyer 2000; Gupta & Bhandari 1999);
- The Brazilian proposal which allocates emissions allowances in relation to the contribution to change in temperature (Brazil 1997; La Rovere et al. 2002; Pinguelli Rosa & Kahn Ribeiro 2001; UNFCCC 2002);
- Common but differentiated convergence (Höhne et al. 2006a);
- Emissions intensity (Herzog et al. 2006; Kim & Baumert 2002; Chung 2007);
- Sector-based Clean Development Mechanism (CDM) (Samaniego & Figueres 2002; Sterk & Wittneben 2006); technology agreements (Edmonds & Wise 1998);
- Various sectoral approaches (Ward 2006; Schmidt et al. 2006; Ellis & Baron 2005);
- Triptych approach extended to the global context (Groenenberg et al. 2001; Den Elzen et al. 2007);
- Converging markets (Tangen & Hasselknippe 2004; Victor et al. 2005);
- Safety valve approaches (Philibert 2002); greenhouse development rights (Baer et al. 2007); and,
- Sustainable development policies and measures (SD-PAMs) (Winkler et al. 2002a; Winkler et al. 2007).

The preceding list does not necessarily cover all proposals put forward in the burgeoning literature. The literature includes many more, as well as an evaluation of several proposals focusing specifically on adequacy and equity (Baer & Athanasiou 2007). There have been processes bringing together perspectives from North and South, including the South-North Dialogue (Ott et al. 2004); an on-going future action dialogue among selected negotiators (CCAP 2007) and the Sao Paolo Proposal (BASIC Project 2006). IPCC AR4 assessed the proposals, and Table 13.2 provides probably the most authoritative overview of recent proposals for international climate agreements, at least up to the cut-off date for literature assessed (mid-2006). The table is reproduced in Annex 3.

Relatively few of these proposals originate from developing countries, and a smaller sub-set of those have come from developing country Parties. The Brazilian Proposal stands out as a major exception to this rule, having been formally tabled prior to Kyoto (Brazil 1997). At the time, it took a scientific approach to burden-sharing among Annex I Parties, calculating the contribution to temperature increase and hence responsibility for mitigation. By focusing on responsibility, the Brazilian proposal had a strong basis of equity. It also has also has a strong scientific basis, since the key factor determining temperature change is cumulative emissions, rather than annual ones.

To understand the multiplicity of proposals, two things may be helpful. Firstly, it may be helpful to consider the broader, underlying approaches within a simpler conceptual framework. This is done in the rest of this section. The second part is to elaborate at least some of the proposals in a little more detail, which is considered in section 4.2 below.

Table 5: Summary of approaches/schools of thought

	ATMOSPHERE FIRST	EQUITY FIRST	DEVELOPMENT FIRST	TECHNOLOGY FIRST
Objective	Stabilizing GHG concentrations	Ensuring fairness of allocation of mitigation burdens (historic contributions)	Making development more sustainable	Development and transfer of low carbon technologies
Stringency	Agreement on "safe" GHG concentration level or global GHG reduction targets & timeframes	Agreement on "safe" GHG concentration level	Not a distinctive feature	Set in terms of technology goal or budgetary contribution to RDD
Quantified GHG related commitments	**-Carbon budget is back calculated & allocated among countries based on current & future emissions reduction potential** **-Carbon markets vital incentives to join the regime** **-"Trigger" for participation at various stages**	**-Carbon budget is allocated among countries according to historical responsibility** **-"Trigger" for participation, but usually later than atmosphere first** **-Carbon markets vital with large flows to developing countries**	Not the focus, contribution depends on number and ambition of SD policies implemented -Not only carbon markets	No quantified commitments, hence limited or no carbon markets
Coverage	All GHGs including LUCF and int. transport 80% of global emissions. Minimum inclusion of 20-30 main emitters	All GHGs including LUCF and int. transport. Inclusion of all countries	Unlikely to cover all gases and sectors	Several technology agreements to cover all sectors. Unlikely to cover all gases and sectors
Policies and measures	(SD-)PAMs for countries before the trigger for e.g. deforestation and low carbon energy & transportation	(SD-)PAMs for countries before the trigger for e.g. deforestation and low carbon energy & transportation	**Richer countries would pay the cost of implementing SD PAMs in developing countries: e.g., enforcing the efficiency standards** **List of good/best practice policies could serve as information**	(Coordinated) energy efficiency standards and renewable energy targets
Technology R&D Demonstration Deployment Transfer	Not a distinctive feature	No obligation for additional technology transfer	**Provision of finances and technology for developing countries**	**Cooperation to increase development, transfer & deployment among technologically advanced countries**
Adaptation Human health Ecosystems Agriculture/forestry Water supply Coastal zones Infrastructure Extreme events	Funded from levy on market mechanisms Not distinctive as focus on prevention	**Compensation of damage costs paid according to historical responsibility**	Funded also through SD-PAMs	Not a distinctive feature
Response measures	Funded from levy on market mechanisms Not distinctive as focus on prevention	Historically larger emitters to assist losers adjust to the transition	Tailor made SD-PAMs allow for diversification	Efforts could be geared towards technology that is contributing to diversification
Participation and compliance	Main 20-30 emitters must be included early on or at the outset of the agreement	Normative definition of historical responsibility for the trigger	High participation, high degree of international coordination and information exchange	Several technology agreements with different participation

Note: Bold indicates a distinctive feature of an approach

Source: DEAT & DEFRA 2007. Scenarios for future international climate change policy

There are various ways of thinking about the different types of architecture that are represented in the diversity of proposals, introduced above and elaborated in section 4.2 below. A paper (prepared jointly by the United Kingdom and South Africa) was presented at an informal Ministerial discussion in Sweden (DEAT & DEFRA 2007) and identified the following four schools of thought or approaches (see Table 5 for an overview):

- Atmosphere first;
- Equity first;
- Development first;
- Technology first.

In reviewing a range of proposals, the Working Group III SPM of AR4 concluded that there was high agreement and much evidence "that successful agreements are environmentally effective, cost-effective, incorporate distributional considerations and equity, and are institutionally feasible" (IPCC 2007c). Thus some criteria can be established to evaluate different schools of though on the architecture of the climate regime.

It is unlikely that any 'pure' approach would be adopted in its entirety. Just as there is no single, definitive list of elements, though, there is not a single conception of a balanced package. Indeed, it seems highly unlikely that any single package proposed by anyone would be adopted 'as is' by everyone. Rather, it is more helpful to think of several packages along a theoretical continuum.

Negotiators will need to merge packages while carefully balancing key elements and interest. So the focus turns to a continuum of packages that might be capable of consensus – or to use another phrase, that are in the political contract zone. After Bali, the core elements or building blocks of a package deal have emerged. The balance between adaptation and mitigation is clearly reflected. Deeper cuts from all developed countries and actions by developing countries are part of the agenda, as is comparable effort. And the importance of the means of implementation, notably finance and technology, is encoded in the Bali Action Plan.[23] On the road from Bali to Copenhagen, the details of the four building blocks and the shared vision will have to be elaborated. In those negotiations, specific approaches to the future of the climate regime may become important.

4.2 More detailed description of selected approaches

A wide variety of approaches to future commitments have been proposed – most of them informally or in the academic literature, with only few having been officially endorsed. This section does not summarise every approach, but concentrates on selected types of approaches. This short document does not allow all approaches to be elaborated; the reader is referred to surveys of approaches in the further reading (see bibliography below).

Different people will categorise various proposals in different ways. The proposals described in this short paper are selected to illustrate different the different schools of thought. The approach of putting the 'atmosphere first' could be represented by extending Kyoto targets to a broader set of countries (see section 4.2.1). Putting equity first can mean several things, at least two of which – equal entitlements for each person and historical responsibility – are reflected in per capita approaches and the Brazilian proposal (4.2.2 and 4.2.3).

Others argue that the right to (sustainable) development is also a matter of equity. And indeed, equity relates not only to mitigation, but also to adaptation, finance and technology. Specific approaches that put development first would include GDP as a measure of development in intensity targets (4.2.4), explicitly start from sustainable development policies (4.2.5) or build on the development aspects of the CDM (4.2.6). Sectoral approaches are linked to putting technology first, while the Global Triptych approach disaggregates standards for just three sectors (4.2.7 and 4.2.7).

4.2.1 Kyoto-style fixed targets

Kyoto-style fixed targets take the form of an agreed percentage reduction against annual emissions in a base year, 1990. An absolute number of tons of CO_2 to be reduced is calculated. By starting from the countries' own emissions, the approach 'grandfathers' existing differences between countries in emissions. The challenge for many Annex I Parties lies more in returning to base year level of emissions, rather than the reduction negotiated. In numerical terms, the growth of emissions since 1990 is

[23] Decision 1/CP.13, the Bali Action Plan.

often larger than the percentage inscribed in Annex B of the Protocol.

Mechanisms exist in the Convention and Protocol to bring more countries into Annex I by voluntary commitments from the Parties or a COP decision to amend Annex I (Depledge 2002). These could be used to broaden the set of countries taking on this type of target. The approach has the attraction of directly building on known institutions and frameworks, including the CDM, other flexible mechanisms and the reporting and monitoring system.

Type of mitigation commitment:	Allowance calculated as reduction (less than 100%) or limit (greater than 100%) on emissions in base year, yielding tons of CO_2 allowance. Flexible mechanisms can be used.
Participation:	All countries who agree to commitments inscribed in Annex B of the Kyoto Protocol
Institutional requirements:	Institutional architecture exists, but new countries would have to set up institutions for monitoring, reporting and verification under Protocol Articles 5, 7 and 8. Internationally, a sufficient number of Parties must ratify the amendment
Legal nature (voluntary/binding):	Binding, once the Party has agreed to make a commitment and it is ratified.
Accountability procedures:	Compliance provisions of the Kyoto Protocol
Sensitivity to national circumstances:	Limited, although differences in percentages possible
Timing:	Commitment periods, first one is five years, future ones may be longer.

Questions:

- Would your country be ready to take on this type of mitigation commitment? What are the implica-tions of such an approach for your country?
- Does the institutional capacity exist in your country to implement this approach?
- Can one say that Kyoto-style absolute targets are 'harder' than other types of mitigation commitments?
- Would 'growth caps' (i.e. Kyoto-style targets), but with generous increases of emissions above base year levels, be an acceptable mitigation commitment for developing countries?

4.2.2 Per capita

Per capita entitlements takes as its starting point the equal right of each person to use the atmosphere as a global commons. In a pure per capita approach, there is no reference to current emissions levels, but simply a global budget allocated equally to countries based on population. The Centre for Science and Environment has promoted per capita approaches from an early stage, (Agarwal & Narain 1991) and particularly includes an allowance for basic sustainable emission rights (Agarwal 2000). The targets of absolute emissions in tons of CO_2 thus differ radically from Kyoto-style targets.

Emissions allowances are tradable in most per capita proposals, resulting in large benefits for populous nations with low per-capita emissions. It is worth noting that India and China stated at COP-8 in New Delhi that they would not consider any other approach than one based on per capita (Vajpayee 2002). The approach is less attractive to less populous nations, who would argue that there is more than one dimension to equity.

Per capita approaches are favoured by some developing countries. While there is an extensive literature formulating climate regimes based on this principle, Parties have tended to focus on the underlying principle, the negotiations have not yet formally considered an architecture based on per capita emissions. For example, the Indian Prime Minister indicated at COP 8 in Delhi that "we do not believe that the ethos of democracy can support any norm other than equal per capita rights to global environmental resources" (Vajpayee 2002). The essential equity-based argument is that each person should have the same right to use the absorptive capacity of the atmosphere.

Other variations of the per capita approach start from current levels, but require convergence on equal per capita emissions over a period of time.(e.g., Meyer 2000) This convergence happens in the context of overall contraction of global emissions, with a global emission budget set to achieve a particular atmospheric concentration of GHGs. The combination of contraction and convergence results in trajectories of emissions, giving absolute numbers of emission allowances over a period of time, e.g. up to 2100.

A variant is "Common but Differentiated Convergence" (Höhne et al. 2006a), the key modification being a later convergence for developing countries. Annex I allowances converge to a low level, but NAI emission only start later,

when their per capita emission are a certain percentage above the global average. Before then, developing countries can take voluntary actions.

Type of mitigation commitment:	Each country receives entitlement, i.e. tons of CO_2 allowance, rather than a specified reduction. Entitlements are tradable.
Participation:	Potentially all countries.
Institutional requirements:	Would depend on the design of the regime; likely that nation-States would still receive allowances on behalf of the population.
Legal nature (voluntary/binding):	Could be either.
Accountability procedures:	Consequences of exceeding per capita allowances would need to be defined.
Sensitivity to national circumstances:	Sensitive to population, but not other differences, e.g. re-source endowments.
Timing:	Long-term goal; per capita emissions converge over time.

Questions:

- Is per capita a useful principle for defining equity? What other dimensions of equity are there?
- Would your country be ready to take on mitigation commitments on a per capita basis? What are the implications of such an approach for your country?
- Does the institutional capacity exist in your country to implement this approach?

4.2.3 Brazilian Proposal

The Brazilian proposal (Brazil 1997) bases its burden-sharing approach on historical responsibility for change in temperature to individual countries. The original Brazilian proposal attributed responsibility among Annex I countries for an overall reduction of 30% below 1990 levels by 2020. While the detailed derivation of emission reductions based on this system goes beyond the scope of this paper, a key difference to most other approaches is the use of cumulative historical emissions rather than current annual emissions (La Rovere et al. 2002).

As with other approaches, the detailed parameters used will matter – they will define the stringency of the mitigation action for specific countries. For the Brazilian proposal, of particular significance are the gases and sectors (forestry) chosen, the end date for analysis, and the representation of atmospheric chemistry in the model. The approach requires significant data, and this may limit applicability.

The approach has since been extended to a global scheme involving developing countries as well (e.g., UNFCCC 2002; Pinguelli Rosa & Kahn Ribeiro 2001). The proposal is the only approach for a future climate regime officially proposed to UNFCCC Parties.

Type of mitigation commitment:	Emission reductions based on historical responsibility for existing temperature change.
Participation:	Initially only Annex I, but potentially all countries.
Institutional requirements:	Data requirements, see text.
Legal nature (voluntary/binding):	Could be either.
Accountability procedures:	Would need to be defined; original suggestion was to contribute to the Clean Development Fund.
Sensitivity to national circumstances:	Historical responsibility would account for some; but not explicitly adjusted for.
Timing:	Long-term, taking into account effect of GHGs in atmosphere over long time.

Questions:

- Is the data available in your country to calculate historical responsibility? Does the institutional capacity exist in your country to implement this approach?
- Is historical responsibility a useful criterion to inform mitigation commitments?
- When should we begin counting historical cumulative emissions? 1990? 1950? 1860?

4.2.4 Emissions intensity

Emissions intensity requires reductions of emissions relative to economic output (GHG/GDP). The approach therefore allows growth in emissions if there is economic growth. To account for different national circumstances, commitments could be formulated as a percentage decrease from each country' own emissions intensity. Emissions intensity goals would be harder to meet if economic growth remains lower than expected, given the reduced capacity. If successful, reduced intensities should assist in decoupling emissions from economic growth. The approach is often considered 'softer' than absolute targets since it quantifies emissions in relative terms, but this cannot be known without the stringency of both approaches (KEI 2002; Ellerman & Wing 2003; Kim & Baumert 2002). A recent review of intensity targets has been conducted (Herzog et al. 2006).

Type of mitigation commitment:	Reduction is emissions per unit of economic outputs (t CO_2/$ GDP).
Participation:	Most suitable for developing countries, as it accounts for economic developemnt (GDP). Also adopted nationally by some developed countries.
Institutional requirements:	Requires assessment of GDP, as well as emissions.
Legal nature (voluntary/binding):	Could be either.
Accountability procedures:	Compliance could be established if intensity target is missed. Variant: a weaker compliance target and a stronger selling target.
Sensitivity to national circumstances:	Sensitive to change in GDP; does not explicitly adjust for other circumstances.
Timing:	Could be voluntary for developing countries initially, becoming binding at a later date.

Questions:

- Would your country be ready to take on an intensity target?
- Does the institutional capacity exist in your country to implement this approach?
- Given that emissions grow if GDP increases, is this approach acceptable for both developed and developing countries?
- How might GDP in developing countries be measured, reported and verified?

4.2.5 SD-PAMs: Sustainable development policies and measures

Some countries frame the concern about equity in terms of per capita emissions (see 4.2.2 above); others argue that consideration of historical responsibility is a basis for a fair deal (see 4.2.3), while for others again, the dimension of equity relates to development. This approach draws on Article 2, in particular that climate protection should occur in a manner that "enable[s] economic development to proceed in a sustainable manner".

More broadly, it argues that sustainable development in developing countries, including its ecological and social dimensions, are indispensable for an equitable solution, given that developed countries went through their process of industrialization without carbon constraints. In earlier debates under the Convention, the Republic of South Africa (RSA) put forward the approach of sustainable development policies and measures (RSA 2006b).

SD-PAMs suggest that developing countries themselves identify more sustainable development paths and commit to implementing these with financial support (RSA 2006a; Winkler et al. 2002a). A similar motivation is expressed in 'human development goals with low emissions' (Pan 2002). A more elaborate discussion of national policies may be found in the paper by Tirpak, et. al.: "National policies and their linkages to negotiations over a future international climate change agreement", which has been produced part of this series.

The approach starts by considering a country's own long-term development objectives. Next, policies and measures are identified that would make the development path more sustainable. These SD-PAMs aim to encompass large-scale policies and measures, not only projects as in the CDM. Each country would define what it means by making development more sustainable, but when registering SD-PAMs, the international community would have to accept that the policy constitutes sustainable development.

Funding for SD-PAMs could build on existing commitments in Convention Article 4.1(b) and

Kyoto Protocol Article 10, but since they are development oriented, they could also mobilise domestic and international development finance. Both climate and non-climate funding can be mobilised to implement SD-PAMs.

Progress in achieving both the local sustainable development benefits and climate co-benefits might be monitored

through national institutions, but could also be reviewed internationally. Recent work has identified four broad methodologies for quantifying the benefits (Winkler et al. 2008). A potential weakness of SD-PAMs is that the environmental outcome is uncertain – it depends entirely on the number and extent of policies implemented.

Type of mitigation commitment:	Pledge to implement sustainable development policies, and to report on them under the UNFCCC. Quantifies GHG reductions as co-benefits of actions motivated by local sustainable devel-opment. Useful interim step.
Participation:	Developing countries only
Institutional requirements:	Builds on national development capacity. In the multi-lateral system would require a COP decision and at least a register of SD-PAMs, possibly a new Annex to the Convention.
Legal nature (voluntary/binding):	Voluntary
Accountability procedures:	Methodologies to quantify both the emission reductions and local sustainable development benefits would need to be devel-oped. Not subject to compliance.
Sensitivity to national circumstances:	Built in, as countries set their own development objectives.
Timing:	Could be implemented in short-term; might continue in long-term for Least Developed Countries

Questions:

- Would your country be ready to pledge the implementation of SD-PAMs?
- Should funding for SD-PAMs be limited to public investment, or should they be linked to the carbon markets?
- How would we know whether implemented SD-PAMs reduce emissions, sufficiently?
- How would we know whether emission reductions are attributable to the implemented policy?

4.2.6 Evolution of the Clean Development Mechanism (CDM)

A major way in which developing countries are already engaging in mitigation is through the CDM. The CDM is a project-based mechanism, and particularly, the one which allows cooperative action between countries that have a cap on emissions and those that do not. As for other market mechanism, this shifts the focus from where mitigation takes place to who pays for mitigation. Extending the CDM is not a commitment to reduce emissions domestically, but it could be an important form of nationally appropriate mitigation action in developing countries. The CDM is evolving beyond a strict project basis to programmatic CDM. Programmatic CDM is in principle agreed, and adjusted PDDs and other mechanisms are being put into place. So the extension of the CDM from projects to programmes is highly likely.

CDM could also be extended to sectors. The sectoral CDM approach suggests a direct scaling up extended to particular economic sectors, or geographic sectors (e.g., cities)(Samaniego & Figueres 2002; Sterk & Wittneben 2006). It could extend the project-based mechanism of the CDM to national sectors, e.g. cement or power. Of all the approaches discussed above, it builds most directly on the CDM. It would extend the current architecture of the CDM to allow coverage of an entire sector.

Finally, "policy CDM" is a possibility. In many respects, policy CDM would be similar to SD-PAMs – except that the former would be financed from the carbon market, while the latter relies on public funding and investments.

Type of mitigation commitment:	No new commitment, but extension of CDM architecture to enhance mitigation action in developing countries.
Participation:	Developing countries
Institutional requirements:	Use established CDM institutions, scaling up to programmatic and possibly sector level
Legal nature (voluntary/binding):	Voluntary, between project participants. Parties to Kyoto Protocol only.
Accountability procedures:	Validation, monitoring and verification procedures at project level. Not subject to compliance at national level.
Sensitivity to national circumstances:	Countries choose which projects to approve and that these con-tribute to sustainable development
Timing:	Immediate. CDM not available to Parties who take on Kyoto targets

Questions:

- Would your country be ready to extend the CDM to other scales?
- Does the institutional capacity exist in your country to implement this approach?
- In which dimensions might CDM best evolve– programmes, sectors, policy? Or some combination thereof?

4.2.7 Global Triptych

The Triptych approach focuses on three sectors – electricity generation, energy-intensive industries and 'domestic sectors' (including residential and transportation). Triptych was originally used to share the burden of the Kyoto targets within the European Union (EU) "bubble" (Phylipsen et al. 1998). Analysis has considered extending this sectoral approach to all countries (Groenenberg et al. 2001).

Apart from taking a sectoral approach, Triptych also takes into account the technological opportunities available in various sectors. For domestic sectors, convergence to equal per capita emissions is assumed, while for energy-intensive industries, rates of efficiency improvement are set. The sectoral targets are added up to constitute a national target. The calculations involved are complex and not easily communicated. Targets eventually set are defined in absolute national emissions, but can vary from significant reductions (-30%) to 'growth caps' (+200%). The Triptych approach has more recently been examined a method for allocating future GHG emission reductions among countries under a post-2012 climate regime (Den Elzen et al. 2008). Emission allowances are decomposed according to sectors and explicit allowance is made for delayed participation by developing countries.

Type of mitigation commitment:	National emissions target, ranging from reductions to growth caps. Based on sectoral and technological possibilities.
Participation:	Potentially all countires, or for technologies in one of the three sectors.
Institutional requirements:	Establishment of sectoral benchmarks or other means to promote best available technologies.
Legal nature (voluntary/binding):	Voluntary at multi-lateral level; could become binding for sectors.
Accountability procedures:	Would depend on sectors.
Sensitivity to national circumstances:	Could define technological criteria to account for for structural differences.
Timing:	Short- to medium-term.

Questions:

- How important are the three sectors in Triptych in terms of your country's emissions?
- Would your country be ready to take on a Global Triptych approach?
- Does the institutional capacity exist in the three sectors in your country to implement this approach?

4.2.8 Sectoral Approaches

The Bali Action Plan includes as one option in the mitigation building block "cooperative sectoral approaches and sector-specific actions, in order to enhance implementation of Article 4, paragraph 1(c), of the Convention".[24] People mean many different things by 'sectoral approaches' (Akimoto et al. 2008; Den Elzen et al. 2008; Höhne et al. 2006c; Ward 2006; Ellis & Baron 2005; Bosi & Ellis 2005; Schmidt et al. 2006), including sectoral CDM; benchmarks across trans-national sectors; technology transfer in specific sectors; the sector-based Triptych approach, and sectoral crediting mechanisms. The UNFCCC Secretariat was given a mandate in June 2008 to prepare a paper to better define this term.

Given the various types of sectoral approaches, two distinctions may help clarify:

- Is the proposal to implement at the domestic, national level only, or transnational?
- Is the focus on a new agreement, or the efforts that Parties make?

Different ends of the spectrum would then be domestic sectoral efforts and transnational sectoral agreements.

In terms of the Bali Action Plan, domestic sectoral efforts would be closer to nationally appropriate mitigation actions, while transnational sectoral agreements probably amount to mitigation commitments – at least for the sectors concerned. Whatever one's interpretation, it is clear that sectoral approaches are closely related to technology in the Bali Action Plan.[25]

Developing countries have expressed concern about transnational sectoral agreements, as introducing commitments without recognizing the principles of equity and CBDR&RC. For Annex I countries, policies and measures

[24] Sectoral approaches in para 1.b (IV) of decision 1/CP.13.

[25] Para b (iv): "Cooperative sectoral approaches and sector-specific actions, in order to enhance Implementation of Article 4, paragraph 1(c), of the Convention". Article 4.1 refers to "development, application and diffusion, including transfer, of technologies".

(many of which are implemented at the sectoral level) are intended by the Kyoto Protocol achieve national caps or QELROs.[26] However, there appears to be more agreement that – whatever the multi-lateral agreement – sectoral efforts are important in implementation at the national level. Framed appropriately, sectoral approaches may be helpful as one tool for mitigation.

A recent version may be of particular interest to developing countries may be sectoral crediting baselines (Ward et al. 2008). This particular variant would be implemented domestically in developing countries, with 'no lose' meaning that the exceeding a specified benchmark entitles a country to trade surplus emission reductions, but there is no penalty for not achieving any sectoral standard, but an incentive to exceed the benchmark. Beyond the advantage of 'no lose', this variant may be attractive due to its focus on incentives and being voluntary.

Type of mitigation commitment:	Various – technology benchmarks, crediting baselines, dual markets, industry initiatives.
Participation:	Sectors in all participating countries. Not economy-wide.
Institutional requirements:	Involvement of multiple sectors, possibly organisations working in sectors internationally.
Legal nature (voluntary/binding):	Sectoral efforts would be voluntary (or in pursuit of a separately set binding target); transnational sectoral agreements could be binding.
Accountability procedures:	Sector-specific.
Sensitivity to national circumstances:	Countries could select in which sectors to participate. How-ever, may imply global standards in certain sectors.
Timing:	Medium-term.

Questions:

- Which sectors are the major sources of emissions in your country? Would your country be ready to take on transnational sectoral agreement in these sectors?
- What are the implications of such an approach for your country?
- Does the institutional capacity exist in these sectors to implement this approach?
- Which variant of sectoral approaches has the most potential to assist the negotiations?
- How could the multi-lateral system assist countries and industries with sectoral efforts?

[26] Indeed, PAMs are the first item listed in Protocol Article 2.1(a).

4.2.9 Conclusions

In this short paper, it is not possible to describe all proposals. Given the different schools of thought, some examples of proposals that put atmosphere, equity, development and technology first, respectively, have been examined. In considering these proposals, decision-makers in developing countries will need to consider the implications for their country. Discussing the questions posed for each approach may also lead to the formulation of new proposals, combining elements of the existing proposals – maybe even entirely new ones. For a summary of options to address mitigation actions, see Annex 2.

Most, but not all of the approaches described here relate to mitigation commitments. Particularly for those aimed at developing countries only (e.g. SD-PAMs or CDM), they focus on nationally appropriate mitigation actions, consistent with para b(ii) of the Bali Action Plan. It should be noted that Annex II Parties also have commitments relating to funding and possibly technology cooperation. Approaches that make use of market mechanisms allow Parties to pay for mitigation elsewhere, in which case domestic emission reduction potential becomes a less important consideration and ability to pay becomes a more important consideration for equity.

In this respect, the question of how both mitigation actions and support can be made MRV is highly relevant. The paper considers MRV in the following section.

5. MEASURABLE, REPORTABLE AND VERIFABLE

MRV mitigation actions are a key component in the Bali Action Plan, and likely to be central to the negotiations about the future of the climate regime. MRV is pertinent in quantifying mitigation actions, and the old balance between commitments/QELROs and qualitative actions. It is now also being applied to the means of implementation, technology and finance. And, it is central to the balance between action on climate change and support.

Three questions will need to be addressed in negotiating paragraphs 1(b)(i) and (b)(ii) of the Bali Action Plan:

- How measurable, reportable and verifiable mitigation commitments by all developed countries should best be made comparable?
- What does measurable, reportable and verifiable mean in relation to support by developed countries on technology, finance and capacity-building for developing countries?
- What does measurable, reportable and verifiable mean in relation in relation to nationally appropriate mitigation actions by developing countries?

While there are two sub-paragraphs, there are three key questions – because the MRV in paragraph (b)(ii) is understood to apply both to mitigation and the support. The remainder of this section considers each of these components in turn.

5.1 MRV mitigation action by developing countries

MRV applies to both nationally appropriate mitigation actions and to the provision of technology, financing and capacity-building. With the debate around MRV being politically charged, a way of making some progress may be to focus on details – clearly defining what is meant by measurable, reportable and verifiable.

5.1.1 Measurable

Measurement is a fundamental starting point for any kind of mitigation action. Considering measurement in a practical way needs to ask what can be measurable. For example, promoting renewables may require national legislation, regulations, zoning laws, scoping studies, contracts, investment packages, construction, etc. These different efforts can be measured, but in the end, it is the outcome, in terms of electricity produced and emission reduction, that needs to be measured.

Methodologies are available to quantify or measure the benefits of various bottom-up approaches, using case studies and national modelling; others such as allocation models or comparative analysis are more suitable to top-down approaches (Winkler et al. 2008). It would greatly assist developing countries to quantify both the local sustainable development benefits and the climate co-benefits of particular policies and measures. Methodologies could be further elaborated by a group of experts.

All countries are committed to develop, periodically update, publish and make available to the COP inventories of GHG emissions and removals by sinks.[27] It is difficult to imagine a system of measurement that would not draw on this fundamental data –the status of emissions in a country. The unit of measurement clearly should be tons of CO_2-equivalent.

A key question will be how developing countries should report on inventories? Perhaps the periodicity could be less often than for Annex I, but establishing trends will be important in the long run.

Inventories measure emissions, not reductions. If developing countries implement unilateral mitigation actions (e.g. CDM, but also other policies and measures, or investment in cleaner technologies), how would one assess reductions?

Changes in inventories would reflect not only mitigation supported with multi-lateral support, but also unilateral action. MRV would require separate tracking of domestically-financed and internationally-supported action. Changes in inventories would reflect reductions only if all actions are considered. The question of whether such inventories would be reviewed must be addressed under verification.

Another option might be 'national inventories with footnotes'. The idea of the footnotes would be to provide a place for describing action for emission reductions. They would allow developing countries to report a little more on their actions, and thus gain recognition for action taken.

Perhaps inventories for developing countries could start

[27] FCCC Article 4.1(a).

in sectors where there is the best information. This would allow for the required human and institutional capacity to be developed, improving coverage over time.

To measure 'deviations from baseline' and recognize relative emission reductions, one effectively needs to establish national baselines. The experience gained the CDM with project baselines provides a valuable basis for moving to larger scales. Already, the CDM is evolving to include programmes, and the discussions for the period after 2012 may include further evolution, possibly to a sectoral level. The CDM experience indicates that we will have to consider whether national baselines including provision for suppressed demand,[28] and exclude national policies or not? The 'long-term goal' in this context would be to work MRV of actions towards MRV based on inventories, for all.

Questions:
- What practical experience exists in your country to measure emissions, and the activities leading to emissions?
- What institutions are needed for effective measurement?

5.1.2 Reportable

All Parties have existing reporting commitments under the Convention.[29] Rather than adding new provisions on reporting, use of the existing provisions could be enhanced through new and improved procedures. A simple extension of existing reporting requirement might be to have more regular reporting of GHG inventories by developing countries. This could still be less frequent that the annual reporting by Annex I Parties, for example every two or three years.

National communications provide an obvious avenue for reporting, but arguably an already overloaded one. A separate format for reporting might be considered. For SD-PAMs, for example, there have been suggestions to establish a new register to give recognition to mitigation actions by developing countries, voluntarily pledged. A new procedure could be developed to report on the implementation of SD-PAMs. Such a procedure might be elaborated by a group of experts.

Reporting would ideally include both unilateral mitigation actions and those implemented with international support (MRV finance and technology). The purpose may differ, with unilateral action reported to provide recognition of action by developing countries and a comprehensive picture of the actions by a country, while internationally support action would be reported to enable verification.

Questions:
- Should reporting by developing countries continue to be done mainly through national communications? If not, what are the alternatives? If yes, what needs to be improved?
- Should developing countries report on a regular basis on their national inventories?

5.1.3 Verifiable

The general questions about verification are what can be verified, how and by whom. If emission reductions are to be real, long-term and measurable, then verification is critical.

Making mitigation actions by developing countries verifiable will probably pose the biggest challenges. Should the verification be done domestically or internationally? Are some combinations of the two possible and useful?

Under any arrangement, the domestic institutional capacity in developing countries to undertake both measurement and verification will be significant. For example, we should build on national capacity to measure and verify energy efficiency savings (examples from India, South Africa, other countries). The difference between theoretical and actual savings in electricity is examined carefully and reported to national utilities or others sponsoring part of the investment. Converting energy savings to MRV emissions savings essentially only requires an emissions factor – and an effective standard has been established for grid-electricity factors, for example, in the CDM (ACM 0002).

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[28] Suppressed demand is found in situation of poverty. If a mitigation project delivers a service where there previously was none, the relevant baseline might be the service delivered with conventional technology, not the actual situation of any service at all. For example, if solar water heaters were installed, one can compare this to electric water heaters, rather than no hot water at all.

[29] FCCC Article 12.1.

More broadly, the experience gained with CDM verifying emission reductions in developing countries can be a building block for MRV. Countries have built set up designated national authorities with experience in approving mitigation projects and considering their implications for sustainable development. The process of validation – and the institutional capacity embodied in designated operational entities – could be built upon for verification beyond the project level.

Institutional capacity is probably a better guarantor that climate-friendly policies would be implemented in developing countries than any international agreement. Another important factor is broad public support within the country. The international review process to make mitigation actions verifiable should build on these dimensions. For internationally supported mitigation action, reporting on how funds have been spent is standard practice.

If mitigation actions in developing countries are supported only by national finance and do not involve technology transfer, then why would they need to be verifiable internationally? The balance struck in Bali around b(ii) was that these two matters would go together, and so the scope of mitigation actions subject to MRV could be limited to those that receive international support. This will probably have to be left to the developing country concerned.

One option to address the issue of verification of mitigation actions by developing countries: actions with international financial support would be verified internationally (e.g. using mechanisms under the carbon market, or reporting on public funds spent), but unilateral mitigation actions would be verified domestically (e.g. unsubsidised energy efficiency measures), but then reported in one reporting format/instrument under Convention.

Another option to consider might be verification by peer-review. Verification could start with national institutions, and verification by other developing countries might be more acceptable. Models of peer-review mechanisms, for example in the African Union or the WTO, might provide useful lessons. Such an approach would make reviews of developing country reporting distinct from in-depth reviews of Annex I national communications.

In the longer-term, what is needed is to work towards a system where all emissions and all emission reductions are measured, reported and verified. Since we are working on "long-term cooperation action", we should begin with that end in mind.

Questions:

- How can we work towards a system where all emission reductions by developing countries are verifiable? How might a system evolve over time?
- What elements from national and international experience with verification and validation might be useful building blocks?

5.2 MRV for means of implementation

As outlined in section 1.2, applying MRV to the means of implementation (technology and finance) is critical to the balance of the Bali Action Plan. Developing countries expect developed countries to fulfil their commitments on "measurable, reportable, and verifiable" support on technology, financing, and capacity building.

5.2.1 Making finance MRV

The starting point for finance, like all things, is the Convention in which Annex II Parties (i.e., Annex I Parties that also have commitments to assist developing country Parties with funding and technology) agreed to provide "adequate and predictable" financial resources for agreed full incremental cost of mitigation, adaptation and reporting (Article 4.3); to support adaptation in most vulnerable countries (Article 4.4) and technology transfer, including promoting and financing technology transfer, facilitating access to technology, support for the building of internal technology related capacity (Article 4.5).

Unsurprisingly, "finance" is a critical building block in the Bali Action Plan. There would be very little of any of the other building blocks – mitigation, adaptation, technology – without finance. The problem is how to ensure that the financial flows actually occur. This is in part a question of scaling up, but centrally also of operationalising MRV of finance.

What is apparent is that the current scale of funding of several orders of magnitude below what is required and will be required in future. Adaptation funding of $28-$67 billion per year in developing countries will be needed by 2030. Investment in mitigation of $200-$210 billion per year is needed by 2030. Where might such funds come from?

The simplest solution may be a mandatory formula for collecting money. One option already proposed in the AWG-LCA is that developed countries set aside 0.5% of GDP to support climate change in developing countries.

Yet there is a range of potential sources that might provide the financial flows to meet an agreed target. The UNFCCC Secretariat provided a range of illustrative options in a paper on finance and investment flows (see also the companion paper on investment and financial flows *"Negotiations on additional investment and financial flows to address climate change in developing countries"* by Erik Haites).

Variants of some of the options in Table 6 below are being considered, for example auctioning of allowances. The European Commission is proposing to amend the Emissions Trading Directive, increasing auctioning of allowances, which would generate €50 billion in 2020, and would put at least 20% into renewables and efficiency (e.g. through the Global Efficiency and Renewable Energy Fund, GEREF) and reducing emissions from deforestation in developing countries (REDD), i.e. in developing countries.

The Liebermann-Warner bill before the US Congress (S. 2191) includes provisions to auction 2.5% of allowances for use in forestry. If EPA estimates of slightly over $ 100 billion are correct, this can potentially generate $2.8 billion in 2020, and another 1.8% of auctioning revenues in domestic cap-and-trade for international adaptation and security, yielding an estimated $2 billion in 2020. The bill has not passed, but may be reintroduced in future.

What would be measurable in each of these options would be € or $ – the unit for MRV of finance would be money.

Table 6: Illustrative options for raising additional revenue for addressing climate change

OPTION	REVENUE	NOTES
Application of a levy similar to the 2% share of proceeds from the CDM to international transfers of ERUs, AAUs and RMUs	$10 to $50 million	Annual average for 2008 to 2012
	Depends on size of carbon markets post-2012	Any estimate for post 2012 requires assumptions about future commitments
Auction of allowances for international aviation and marine emissions	$10 to $25 billion	Annual average for aviation rises from 2010 to 2030
	$10 to $15 billion	Annual average for marine transport rises from 2010 to 2030
International air travel levy	$10 to $15 billion	Based on charge of $6.50 per passenger per flight
Funds to invest foreign exchange reserves	Fund of up to $200 billion	Voluntary allocation of up to 5% of foreign exchange reserves to a fund to invest in mitigation projects determined by the investors to diversify foreign exchange reserve investments
Access to renewables programmes in developed countries	$500 million	Eligible renewables projects in developing countries could earn certificates that could be used toward compliance with obligations under renewables programmes in developed countries to a specified maximum, such as 5%
Debt-for-efficiency swap	Further research needed	Creditors negotiate an agreement that cancels a portion of the non-performing foreign debt outstanding in exchange for a commitment by the debtor government to invest the cancelled amount in clean energy projects domestically
Tobin tax	$15 to $20 billion	A tax of 0.01% on wholesale currency transactions to raise revenue for Convention purposes
Donated special drawing rights	$18 billion initially	Special drawing rights are a form of intergovernmental currency provided by the IMF to serve as a supplemental form of liquidity for its member countries. Some special drawing rights issued could be donated to raise revenue for Convention purposes

Note: CDM = Clean development mechanism, ERU = Emission reduction units, AAU = Assigned amount units, RMU = Removal units, IMF = International Monetary Fund

Source: UNFCCC 2007. Report on the analysis of existing and potential investment and financial flows relevant to the development of an effective and appropriate international response to climate change.

Reporting may be specific, depending on the source of the funding. Markets – be they carbon or other markets – tend to track financial flows anyway, although robust market rules need to be established. A key question is how to track scaled-up public investment. As with mitigation in developing countries, the most difficult area is probably **verification**. Who verifies financial flows? Particularly if funds were collected at the national level, how would they be made subject to international scrutiny?

These questions raise issues of governance of the scaled-up funding that is clearly needed. The guiding principle should be equal partnership between donors and recipients, but also more specific principles recently negotiated, including one-country-one-vote; transparency; learning by doing approach; full costs of projects; and no duplication with other sources. The ideal would be to use the funding structures established under the UNFCCC and Kyoto Protocol, e.g. the Adaptation Fund.

5.2.2 MRV Technology

Measurable, reportable and verifiable transfer of technology is the second part of the means of implementation of mitigation actions in developing countries.

The simplest solution may be to apply MRV to the funding for technology. It may be necessary to distinguish different kinds of financial support, depending on broadly-defined lifestages of technologies:

- Funding for wider deployment of existing technology;
- Venture capital to commercialise emerging technology;
- Public and private investment in long-term R&D of new technology.

What needs to be measured on technology is thus broader than technology transfer (if the movement of technology that is higher cost than the commercial standard practice, and also lower-emitting). It also encompasses the diffusion of technology through commercialisation, as well as long-term R&D. What is "MRV-able" is not a question of transfer alone, but of generating new technologies as well.

However the technology discussion is defined, an institutional mechanism is likely to be needed to deal with technology issues, and to address MRV. For the purpose of measuring, reporting and verifying technology transfer, indicators will assist. Work in the Subsidiary Bodies on Implementation and Scientific and Technological Advice (SBI and SBSTA) on performance indicators should help to address the issue of **measurement**.

Indicators would also provide a useful format for **reporting**. What needs to be **verified** is the actual transfer of technology, not just long-term R&D. Useful information on technology and climate change is provided in the companion paper *"The Mitigation Technology challenge: Considerations for National Governments and an International Agreement"* by Martina Chidiak and Dennis Tirpak. Measurement would also need to include technology transfer under the CDM.

In all cases, the funding for technology would be measurable, reportable and verifiable. But at the multilateral level, investment in technology transfer does not earn carbon credits (unless we want to re-open the supplementarity debate).

The more difficult issue is how to quantify technology support where it is not financial. Important aspects relating to technology transfer, such as preferential access, collaborative R&D in the form of human resources, building local institutional capacity to apply technology are some of the less tangible forms of support.

5.3 MRV for developed countries

Having considered MRV for developing countries, both for mitigation actions (section 5.1) and for the support (5.2), we now turn to MRV for developed countries. Since the paper is aimed at developing country decision-makers, this complex matter is treated only briefly.

Mitigation commitments by developed countries are negotiated in the AWG-KP and in the AWG-LCA in terms of para 1.b(i). The further commitments for Annex I Parties under the Protocol would be measured, reported and verified according to Articles 5, 7 and 8. To ensure comparability of effort with mitigation commitments or actions, including QELROs, by developed country Parties under the Convention, the same procedures for MRV would be simplest.

What might action be compared to? If a developed country adopted "mitigation commitments or actions,

[30] FCCC/KP/AWG/2006/4, the report of the AWG-KP on its 2nd session.

including QUELROs" under paragraph b(i), to what should that be compared? In the two-track negotiations, one suggestion is to compare to the Protocol track, that is, the negotiations under the AWG-KP. These negotiations have been under way since 2006. Negotiations have been formalised in a work plan, with the major steps being (a) analysis of mitigation potentials and ranges of emission reduction objectives of Annex I Parties; (b) analysis of possible means to achieve mitigation objectives; and (c) consideration of further commitments by Annex I Parties, and at this stage is still focused on the means.[30] What provided a possible option for comparability is a range of -25% to -40% from 1990 levels by 2020 for Annex I Parties as a group.[31] How such a range would be compared to efforts under the Convention will need further work in the AWG-LCA.

Improvements on this system are of course possible. **Measurement** of comparability of efforts would be simplest when comparing QELROs, based on the compliance system Another option would be to consider the outcomes, in particular that the range of emission reductions for Annex I Parties is -25 to -40% from 1990 levels by 2020.

For **reporting**, the basis will remain Annex I national communications.[32] Improvements on the procedures for reporting could help to promote best practice.

Procedures for **verification** could reinforce existing work on measurement (incl. IPCC,[33] ISO, WRI/WBCSD,[34] etc.), with a focus on measurement at the facility level & local capacity building for implementation of IPCC methodologies for national inventory reporting.

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[31] "At the first part of its fourth session, the AWG recognized that the contribution of Working Group III to the AR4 indicates that achieving the lowest levels assessed by the IPCC to date and its corresponding potential damage limitation would require Annex I Parties as a group to reduce emissions in a range of 25–40 per cent below 1990 levels by 2020, through means that may be available to these Parties to reach their emission reduction targets." See document FCCC/KP/AWG//2007/5 for the complete text.

[32] KP Art 5, 7 and 8 and FCCC Article 12.2 (a) and (b).

[33] IPCC 2006. IPCC guidelines for national GHG inventories. Prepared by the National Greenhouse Gas Inventories Programme. Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (Eds). by E H S, B L, M K, N T and T K (Eds) Kanagawa, Japan, Institute for Global Environmental Strategies. http://www.ipcc-nggip.iges.or.jp/ public/2006gl/index.htm.

[34] WRI & WBCSD 2007. The Greenhouse Gas Protocol: A corporate accounting and reporting standard. Revised edition. Washington, World Business Council for Sustainable Development & World Resources Institute. http://www.ghgprotocol.org.

6. CONCLUSIONS

The challenges on the road from Bali to Copenhagen are many. Mitigation, in balance with adaptation, is a major one. Equity and common but differentiated responsibilities will need to be central, but more urgent action is needed by all countries.

What is common is that both developed and developing countries take MRV mitigation action. For developed countries, these are commitments to absolute emission reductions, and achieving a QELRO is the key metric of effort. For developing countries, mitigation actions need to be developed in a bottom-up manner to achieve reductions relative to baseline emissions. And they are supported by technology and finance.

A range of specific proposals has been outlined in this document. Developing country negotiators will need to carefully consider the implications of different approaches for their respective countries. Detailed questions have already been posed for each of the specific approaches elaborated in several places in sections 4 and 5. Some broader, more general questions that may bear reflection include:

- What are the dimensions of equity and how should they be brought to bear on this discussion? What approaches are seen to be fair? And why?
- Which of the 'schools of thought' makes most sense from your perspective? Would you put atmosphere, equity, development or technology first? Or is it a combination?
- What nationally appropriate mitigation actions, in the context of sustainable development, would have most support in your country?
- How can the co-benefits of making development more sustainable be harnessed in the multi-lateral climate system?
- What positive incentives can be put in place to stimulate action by developing countries? How can we ensure that financial flows address both mitigation and adaptation needs in developing countries, and assist them to achieve their national development goals?
- How can the multilateral system provide benefits and promote the national goals of developing countries, with co-benefits for climate change mitigation?
- Can the scale and direction of action required to develop and diffuse mitigation technologies, especially in the energy sector, be realistically expected in the absence of a carbon constraint?
- What further analysis would be needed to support your country in taking nationally appropriate mitigation actions?

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Criteria: A useful summary of factors underpinning action is available in Höhne et al. (2006d).

Many specific approaches are in the references cited in this document, see references below.

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ANNEXES

Annex I. COP decisions related to mitigation

SESSION	DECISIONS	PROVISIONS
COP 1 (Berlin, 1995)	Decision 2/CP.1	Review of first communications from the Parties included in Annex I to the Convention
	Decision 4/CP.1	Methodological issues
	Decision 5/CP.1	Activities implemented jointly under the pilot phase
COP 2 (Geneva, 1996)	Decision 9/CP.2	Communications from Parties included in Annex I to the Convention: guidelines, schedule and process for consideration
	Other action taken by the COP	The Geneva Ministerial Declaration
COP 3 (Kyoto, 1997)	Decision 1/CP.3	Adoption of the Kyoto Protocol to the United Nations Framework Convention on Climate Change
	Decision 9/CP.3	Development and transfer of technologies
	Decision 13/CP.3	Division of labour between the SBI and SBSTA
COP 4 (Buenos Aires, 1998)	Decision 1/CP.4	The Buenos Aires Plan of Action
	Decision 4/CP.4	Development and transfer of technologies
	Decision 11/CP.4	National communications from Parties included in Annex I to the Convention
COP 6 (The Hague, 2000)	Decision 1/CP.6	Implementation of the Buenos Aires Plan of Action
COP 6 part II (Bonn 2001)	Decision 5/CP.6	The Bonn Agreements on the implementation of the Buenos Aires Plan of Action
COP 7 (Marrakech, 2001)	Decision 2/CP.7	Capacity building in developing countries (non-Annex I Parties)
	Decision 4/CP.7	Development and transfer of technologies (decisions 4/CP.4 and 9/CP.5)
COP 8 (New Delhi, 2002)	Decision 1/CP.8	Delhi Ministerial Declaration on Climate Change and Sustainable Development
	Decision 2/CP.8	Fourth compilation and synthesis of initial national communications from Parties not included in Annex I to the Convention
	Decision 3/CP.8	Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention
COP 9 (Milan, 2003)	Decision 2/CP.9	Compilation and synthesis of initial national communications
	Decision 10/CP.9	Scientific, technical and socio-economic aspects of impacts of, and vulnerability and adaptation to, climate change, and scientific, technical and socio-economic aspects of mitigation
COP 10 (Buenos Aires, 2004)	Decision 7/CP.10	Status of, and ways to enhance, implementation of the New Delhi work programme on Article 6 of the Convention
COP 11 (Montreal, 2005)	Decision 12/CP.11	Programme budget for the biennium 2006–20071

Annex II. Summary of Options for Addressing Mitigation Actions in a Future Regime

PROPOSED OPTIONS FOR MITIGATION	TYPE OF MITIGATION COMMITMENT	PARTICIPATION	INSTITUTIONAL REQUIREMENTS	LEGAL NATURE (VOLUNTARY / BINDING)	ACCOUNTABILITY PROCEDURES	SENSITIVITY TO NATIONAL CIRCUMSTANCES	TIMING
Fixed targets Kyoto-style	Allowance calculated as reduction (less than 100%) or limit (greater than 100%) on emissions in base year, yielding tons of CO2 allowance. Flexible mechanisms can be used.	All countries who agree to commitments inscribed in Annex B of the Kyoto Protocol.	Institutional architecture exists, but new countries would have to set up institutions for monitoring, reporting and verification under Protocol Articles 5, 7 and 8. Internationally, a sufficient number of Parties must ratify the amendment.	Binding, once the Party has agreed to make a commitment and it is ratified.	Compliance provisions of the Kyoto Protocol.	Limited, although differences in percentages possible.	Commitment periods, first one is five years, future ones may be longer.
Per capita	Each country receives entitlement, i.e. tons of CO2 allowance, rather than a specified reduction. Entitlements are tradable.	Potentially all countries.	Would depend on the design of the regime; likely that nation-States would still receive allowances on behalf of the population.	Could be either.	Consequences of exceeding per capita allowances would need to be defined.	Sensitive to population, but not other differences, e.g. resource endowments.	Long-term goal; per capita emissions converge over time.
Brazilian proposal	Emission reductions based on historical responsibility for existing temperature change	Initially only Annex I, but potentially all countries.	Data requirements, see text.	Could be either.	Would need to be defined; original suggestion was to contribute to the Clean Development Fund.	Historical responsibility would account for some; but not explicitly adjusted for.	Long-term, taking into account effect of GHGs in atmosphere over long time.
Emissions intensity	Reduction is emissions per unit of economic outputs (t CO2 / $ GDP).	Most suitable for developing countries, as it accounts for economic developemnt (GDP). Also adopted nationally by some developed countries.	Requires assessment of GDP, as well as emissions.	Could be either.	Compliance could be established if intensity target is missed. Variant: a weaker compliance target and a stronger selling target.	Sensitive to change in GDP; does not explicitly adjust for other circumstances.	Could be voluntary for developing countries initially, becoming binding at a later date.
SD-PAMs: Sustainable development policies and measures	Pledge to implement sustainable development policies, and to report on them under the UNFCCC. Quantifies GHG reductions as co-benefits of actions motivated by local sustainable development. Useful interim step.	Developing countries only.	Builds on national development capacity. In the multi-lateral system would require a COP decision and at least a register of SD-PAMs, possibly a new Annex to the Convention.	Voluntary.	Methodologies to quantify both the emission reductions and local sustainable development benefits would need to be developed. Not subject to compliance.	Built in, as countries set their own development objectives.	Could be implemented in short-term; might continue in long-term for Least Developed Countries.

PROPOSED OPTIONS FOR MITIGATION	TYPE OF MITIGATION COMMITMENT	PARTICIPATION	INSTITUTIONAL REQUIREMENTS	LEGAL NATURE (VOLUNTARY / BINDING)	ACCOUNTABILITY PROCEDURES	SENSITIVITY TO NATIONAL CIRCUMSTANCES	TIMING
Evolution of CDM	No new commitment, but extension of CDM architecture to en-hance mitigation action in developing coun-tries.	Developing countries.	Use established CDM institutions, scaling up to pro-grammatic and posisbly sector level.	Voluntary, between project participants. Parties to Kyoto Protocol only.	Validation, moni-tor-ing and verification proce-dures at project level. Not subject to compliance at national level.	Countries choose which projects to ap-prove and that these contribute to sustain-able development.	Immediate. CDM not avail-able to Parties who take on Kyoto targets.
Global Triptych	National emissions target, ranging from reductions to growth caps. Based on sectoral and technological pos-sibilities.	Potentially all countires, or for technologies in one of the three sectors.	Establishment of sectoral bench-marks or other means to promote best available technologies.	Voluntary at multi-lateral level; could become binding for sectors	Would depend on sectors.	Could define tech-nological criteria to account for structural dif-ferences.	Short- to medium-term.
Sectoral approaches	Various – tech-nology benchmarks, crediting baselines, dual markets, in-dustry initiatives.	Sectors in all par-ticipating countries. Not economy-wide.	Involvement of multiple sectors, possibly organi-sations working in sectors interna-tionally.	Sectoral efforts would be volun-tary (or in pursuit of a separately set bind-ing target); tran-snational sectoral agreements could be bind-ing.	Sector-specific.	Countries could select in which sec-tors to participate. However, may imply global standards in certain sectors.	Medium-term.

Annex III. Overview of recent proposals in IPCC AR 4

Chapter 13 of Working Group III contribution to the IPCC's AR4 deals with "Policies, Instruments and Co-operative Arrangements". A useful table from that chapter is reproduced below, summarising recent proposals for international climate agreements.

NAME (REFERENCE)	DESCRIPTION
National emission targets and emission trading	
Staged systems	
Multistage with differentiated reductions Gupta, 1998; Berk and den Elzen, 2001; Blanchard et al., 2003; Criqui et al., 2003; Gupta, 2003a; Höhne et al., 2003; Höhne et al., 2005; Michaelowa et al., 2005b; den Elzen and Meinshausen, 2006, den Elzen et al., 2006a	Countries participate in the system with different stages and stage-specific types of targets; countries transition between stages as a function of indicators; proposal specify stringency of the different stages
Differentiating groups of countries: (USEPA 2002; CAN 2003; Ott et al. 2004; Claussen & McNeilly 1998)	Countries participate in the system with different stages and stage-specific types of targets
Converging markets: (Tangen & Hasselknippe 2005)	Scenario with regional emission trading systems converging to a full global post 2012 market system
Three-part policy architecture: (Stavins 2001	All nations with income above agreed threshold take on different targets (fixed or growth); long-term targets (flexible but stringent); short-term (firm, but moderate); and market-based policy instruments, e.g., emissions trading.
Allocation methods	
Equal per capita allocation: (Agarwal & Narain 1991; Wicke 2005; Baer et al. 2000)	All countries are allocated emission entitlements based on their population.
Contraction and convergence: (GCI 2005)	Agreement on a global emission path that leads to an agreed long-term stabilization level for GHG concentrations ('Contraction'). Emission targets for all individual countries set so per-capita emissions converge ('Convergence').
Basic needs or survival emissions: Aslam, 2002; Pan, 2005 Gupta and Bhandari, 1999	Emission entitlements based on an assessment of emissions to satisfy basic human needs.
Adjusted per capita allocation: Gupta and Bhandari, 1999	Allocation of equal per capita emissions with adjustments using emissions per GDP relative to Annex I average
Equal per capita emissions over time: (Bode 2004)	Allocation based on (1) converging per capita emissions and (2) average per capita emissions for the convergence period that are equal for all countries.
Common but differentiated convergence: (Höhne et al. 2006b	Annex I countries' per capita emissions converge to low levels within a fixed period. Non-Annex I countries converge to the same level in the same timeframe, but starting when their per capita emissions reach an agreed percentage of the global average. Other countries voluntarily take on "no lose" targets.
Grandfathering: (Rose et al. 1998)	Reduction obligations based on current emissions
Global preference score compromise: (Müller 1999)	Countries voice preference for either per capita allocation or allocation based on current national emissions.

NAME (REFERENCE)	DESCRIPTION
Historical responsibility – the Brazilian proposal: UNFCCC, 1997b; Rose et al., 1998; Meira Filho and Gonzales Miguez, 2000; Pinguelli Rosa et al., 2001; den Elzen and Schaeffer, 2002; La Rovere et al., 2002; Andronova and Schlesinger, 2004; Pinguelli et al., 2004; Trudinger and Enting, 2005; den Elzen and Lucas, 2005, den Elzen et al., 2005c; Höhne and Blok, 2005; Rive et al., 2006	Reduction obligations between countries are differentiated in proportion to those countries' relative share of responsibility for climate change – i.e. their contribution to the increase of global-average surface temperature over a certain period of time.
Ability to pay: Jacoby et al., 1998; Lecoq and Cras-sous, 2003	Participation above welfare threshold. Emission reductions as a function of ability to pay (welfare).
Equal mitigation costs: Rose et al., 1998; Babiker and Eckhaus, 2002	Reduction obligations between countries are differentiated so that all participating countries have the same welfare loss.
Triptych: Blok et al., 1997; den Elzen and Berk, 2004; Höhne et al., 2005	National emission targets based on sectoral considerations: Electricity production and industrial production grow with equal efficiency improvements across all countries. "Domestic" sectors converge to an equal per-capita level. National sectoral aggregate levels are then adopted.
Multi-sector convergence: Sijm et al., 2001	Per-capita emission allowances of seven sectors converge to equal levels based on reduction opportunities in these sectors. Countries participate only when they exceed per capita threshold.
Multi-criteria: Ringius et al., 1998; Helm and Simonis, 2001; Ringius et al., 2002	Emission reduction obligations based on a formula that includes several variables, such as population, GDP and others.
Alternative types of emission targets for some countries	
Dynamic targets: Hargrave et al., 1998; Lutter, 2000; Müller et al., 2001; Bouille and Girardin, 2002; Chan-Woo, 2002; Lisowski, 2002; Ellerman and Wing, 2003; Höhne et al., 2003; Müller and Müller-Fürstenberger, 2003; Jotzo and Pezzey, 2005; Philibert, 2005b; Pizer, 2005b; Kolstad, 2006	Targets are expressed as dynamic variables – including as a function of the GDP ("intensity targets") or variables of physical production (e.g. emissions per tonne of steel produced).
Dual targets, target range or target corridor: Philibert and Pershing, 2001; Kim and Baumert, 2002	Two emission targets are defined: (1) a lower "selling target" that allows allowance sales if national emissions fall below a certain level; (2) a higher "buying target" that requires the purchase of allowances if a certain level is exceeded.
Dual intensity targets: Kim and Baumert, 2002	A combination of intensity targets and dual targets.
"No lose", "non-binding", one-way targets: Philibert, 2000	Emission rights can be sold if the target is reached, while no additional emission rights would have to be bought if target is not met. Allocations are made at a BAU level or at a level below BAU. Structure offers incentives to participate for countries not prepared to take on full commitments but still interested in joining the global trading regime.
Growth targets, headroom allowances, premium allocation: Frankel, 1999; Stewart and Wiener, 2001; Viguier, 2004	Participation of major developing countries is encouraged by unambitious allocations relative to their likely BAU emissions. To ensure benefit to the atmosphere, a fraction of each permit sold can be banked and definitely removed.
Action targets: Goldberg and Baumert, 2004	A commitment to reduce GHG emission levels below projected emissions by an agreed date through "actions" taken domestically, or through the purchases of allowances.
Flexible binding targets: Murase, 2005	A framework for reaching emission targets modelled after the WTO/GATT (World Trade Organization/General Agreement on Tariffs and Trade) scheme for tariff and non-tariff barriers; targets negotiated through rounds of negotiations.

NAME (REFERENCE)	DESCRIPTION
Modifications to the emission trading system or alternative emission trading systems	
Price cap, safety valve or hybrid trading system: Pizer, 1999; Pizer, 2002; Jacoby and Ellerman, 2004.	Hybrid between a tax and emission trading: after the initial allocation, an unlimited amount of additional allowances are sold at a fixed price.
Buyer liability: Victor, 2001b	If the seller of a permit did not reduce its emissions as promised, the buyer could not claim the emission credit. Enforcement is more reliable as buyers deal with developed countries with more robust legal procedures.
Domestic hybrid trading schemes: McKibbin and Wilcoxen, 1997; McKibbin and Wilcoxen, 2002	Two kinds of emissions permits valid only within the country of origin. (1) long-term permits entitle the permit owner to emit 1 tC every year for a long period; permits are distributed once. (2) Annual permits allow 1 tC to be emitted in a single year. An unlimited number of these permits are given out at a fixed price (price cap). Compliance is based on either unit.
Allowance purchase fund: Bradford, 2004	Countries contribute to an international fund that buys/retires emission reduction units. Countries can sell reductions below their BAU levels.
Long-term permits: Peck and Teisberg, 2003	Long-term permits could be used once at any time between 2010 and 2070. Depending on the time of emission they are depreciated 1% annually for atmospheric decay of CO_2. The permit would allow the emission of 1 tC in 2070, 1.01 tC in 2069 and 1.0160 (1.71) tons in 2010.
Sectoral approaches	
Sector Clean Development Mechanism, sector Crediting Mechanism : Philibert and Pershing, 2001; Samaniego and Figueres, 2002; Bosi and Ellis, 2005; Ellis and Baron, 2005; Sterk and Wittneben, 2005	Sectoral crediting schemes based on emission reductions below a baseline. Excess allowances can be sold.
Sector pledge approach: Schmidt et al., 2006	Annex I countries have emission targets, with the ten highest-emitting developing countries pledging to meet voluntary, "no-lose" GHG emissions targets in the electricity and major industrial sectors. Targets are differentiated, based upon national circumstances, and sector-specific energy-intensity benchmarks are developed by experts and supported through a Technology Finance and Assistance Package.
Caps for multinational cooperation: Sussman et al., 2004	A cap/and trade system associated with the operations of associated enterprises in developing and developed countries.
Carbon stock protocol: WBGU, 2003	A protocol for the protection of carbon stocks based on a worldwide system of "non-utilization obligations" to share the costs of the non-degrading use of carbon stocks among all states.
"Non-binding" targets for tropical deforestationa: Persson and Azar, 2004	Non-binding commitments for emissions from deforestation under which reduced rates of deforestation could generate emissions allowances.
Policies and measures	
Carbon emission tax: Cooper, 1998; Nordhaus, 1998; Cooper, 2001; Nordhaus, 2001; Newell and Pizer, 2003	All countries agree to a common, international GHG emission tax; several of the proposals suggest beginning with a carbon tax limited to emissions from fossil fuel combustion.
Dual track: Kameyama, 2003	Countries choose either non-legally binding emission targets based on a list of policies and measures or legally-binding emission caps allowing international emissions trading.
Climate "Marshall Plan": Schelling, 1997, 2002	Financial contributions from developed countries support climate friendly development; similar in scale and oversight to the Marshall Plan.

NAME (REFERENCE)	DESCRIPTION
Technology	
Technology research and development: Edmonds and Wise, 1999; Barrett, 2003	Enhanced coordinated technology research and development.
Energy efficiency standards: Barrett, 2003; Ninomiya, 2003	International agreement on energy efficiency standards for energy-intensive industries.
Backstop technology protocol: Edmonds and Wise, 1998	New power plants installed after 2020 must be carbon neutral. New synthetic fuels plants must capture CO2. Non-Annex I countries participate upon reaching Annex I average GDP in 2020.
Technology prizes for climate change mitigation: Newell and Wilson, 2005	Incentive or inducement prizes targeted at applied research, development and demonstration.
Development-oriented actions	
Sustainable development policies and measures: Winkler et al., 2002b; Baumert et al., 2005b	Countries integrate policies and measures to reduce GHG emissions into development plans (e.g. developing rural electrification programmes based on renewable energy, or mass transit systems in placed of individual cars).
Human development goals with low emissions: Pan, 2005	Elements include: identification of development goals/basic human needs; voluntary commitments to low carbon paths via no-regret emission reductions in developing countries conditional to financing and obligatory discouragement of luxurious emissions; reviews of goals and commitments; an international tax on carbon.
Adaptation	
UNFCCC impact response instrument: Müller, 2002	A new "impact response instrument" under the auspices of the UNFCCC for disaster relief, rehabilitation and recovery.
Insurance for adaptation; funded by emission trading surcharge: Jaeger, 2003	A portion of the receipts from sales of emissions permits would be used to finance insurance pools.
Financing	
Greening investment flows: Sussman and Helme, 2004	Investments through Export Credit Agencies are conditional on projects that are "climate friendly".
Quantitative finance commitments: Das-gupta and Kelkar, 2003	Annex I countries take on quantitative financial commitments – e.g. expressed as a percentage of the GDP – in addition to emission reduction targets.
Negotiation process and treaty structure	
Bottom-up or multi-facet approach, pledge (with review) and review: Reinstein, 2004; Yamaguchi and Sekine, 2006	Each country creates its own initial proposal relating to what it might be able to commit to. Individual actions accumulate one by one. The collective effect of proposals is periodically reviewed for adequacy and – if necessary – additional rounds of proposals are undertaken.
Portfolio approach: Benedick, 2001	A portfolio including: emission reduction policies, government research/development, technology standards and technology transfer.
A flexible framework: PEW, 2005	A portfolio including: aspirational long-term goals, adaptation, targets, trading, policies, and technology cooperation.
Orchestra of treaties: Sugiyama et al., 2003	A system of separate treaties among like-minded countries (emission markets, zero emission technology, climate-wise development) and among all parties to UNFCCC (monitoring, information, funding).
Case study approach: Hahn, 1998	Multiple case studies of coordinated measures, emissions tax, tradable emission permits and a hybrid system in industrialized countries to learn by doing.

a There is some potential conflict with the terminology here: "non-binding" targets may be interpreted by some as restricting the capacity of countries to trade as they do not necessarily set up caps that impose prices and thus established tradable commodities.
Source: Earlier overviews by Bodansky, 2004; Kameyama, 2004; Philibert, 2005a

Annex IV. Glossary

TERM	DEFINITION
Adaptation	Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.
Ad hoc Working Group on further commitments of Annex I Parties under the Kyoto Protocol (AWG-KP)	Article 3, paragraph 9 of the Kyoto Protocol provides that the COP acting as the Meeting of the Parties (CMP) shall initiate consideration of future commitments for Annex I Parties at least seven years before the end of the first commitment period. Pursuant to that provision the CMP at its first session held at Montreal from 28 November to 10 December 2005, established the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP).
Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA)	At its thirteenth session, the COP, by its decision 1/CP.13, launched a comprehensive process to enable the full, effective and sustained implementation of the Convention through long-term cooperative action, now, up to and beyond 2012, in order to reach an agreed outcome and adopt a decision at its fifteenth session. It decided that the process shall be conducted under a subsidiary body under the Convention, the Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA), that shall complete its work in 2009 and present the outcome of its work to the COP for adoption at its fifteenth session.
Bali Action Plan	The United Nations Climate Change Conference in Bali The conference culminated in the adoption of the Bali Road Map, which consists of a number of forward-looking decisions that represent the various tracks that are essential to reaching a secure climate future. The Bali Road Map includes the Bali Action Plan, which charts the course for a new negotiating process designed to tackle climate change, with the aim of completing this by 2009. It also includes the AWG-KP negotiations and their 2009 deadline, the launch of the Adaptation Fund, the scope and content of the Article 9 review of the Kyoto Protocol, as well as decisions on technology transfer and on reducing emissions from deforestation.
Baseline	The baseline (or reference) is any datum against which change is measured. It might be a "current baseline," in which case it represents observable, present-day conditions. It might also be a "future baseline," which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines.
Berlin Mandate	An agreement reached in 1995 in Berlin, Germany, at the first COP to the Climate Convention, in which the industrialized countries first agreed to take on targets and timetables for quantified reductions and limitations on GHG emissions.
Capacity building	Increasing skilled personnel and technical and institutional abilities.
Clean Development Mechanism (CDM)	Defined in Article 12 of the Kyoto Protocol, the CDM is intended to meet two objectives: (1) to assist parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the convention; and (2) to assist parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments. Certified Emission Reduction Units from CDM projects undertaken in Non-Annex I countries that limit or reduce GHG emissions, when certified by operational entities designated by COP Meeting of the Parties, can be accrued to the investor (government or industry) from parties in Annex B. A share of the proceeds from certified project activities is used to cover administrative expenses as well as to assist developing country parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.
Climate	Climate in a narrow sense is usually defined as the 'average weather', or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. The classical period of time is 30 years, as defined by the World Meteorological Organization (WMO).
Climate change	Climate change refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/ or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that UNFCCC, in its Article 1, defines "climate change" as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". The UNFCCC thus makes a distinction between "climate change" attributable to human activities altering the atmospheric composition, and "climate variability" attributable to natural causes

Deforestation	Conversion of forest to non-forest. For a discussion of the term forest and related terms such as afforestation, reforestation, and deforestation, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000).
Emission	In the climate change context, emissions refer to the release of GHG and/or their precursors and aerosols into the atmosphere over a specified area and period of time.
Energy efficiency	Ratio of energy output of a conversion process or of a system to its energy input.
Energy intensity	Energy intensity is the ratio of energy consumption to economic or physical output. At the national level, energy intensity is the ratio of total domestic primary energy consumption or final energy consumption to Gross Domestic Product or physical output.
Global Efficiency and Renewable Energy Fund (established by the EU) (GEREF)	Adopted by the European Union (EU) as a new fund for the promotion of investments in renewable energy technologies.
Greenhouse gas (GHG)	A gas that absorbs radiation at specific wavelengths within the spectrum of radiation (infrared radiation) emitted by the Earth's surface and by clouds. The gas in turn emits infrared radiation from a level where the temperature is colder than the surface. The net effect is a local trapping of part of the absorbed energy and a tendency to warm the planetary surface. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N2O), methane (CH4) and ozone (O3) are the primary GHG in the Earth's atmosphere.
International Energy Agency (IEA)	Paris-based energy forum established in 1974. It is linked with the Organisation for Economic Cooperation and Development to enable member countries to take joint measures to meet oil supply emergencies, to share energy information, to coordinate their energy policies, and to cooperate in the development of rational energy programs.
Intergovernmental Panel on Climate Change (IPCC)	Established in 1988 by the World Meteorological Organization and the UN Environment Programme, the IPCC surveys world-wide scientific and technical literature and publishes assessment reports that are widely recognized as the most credible existing sources of information on climate change. The IPCC also works on methodologies and responds to specific requests from the Convention's subsidiary bodies. The IPCC is independent of the Convention.
Land use, land use change and forestry (LULUCF)	A GHG inventory sector that covers emissions and removals of GHG resulting from direct human-induced land use, land-use change and forestry activities.
Mitigation	An anthropogenic intervention to reduce the sources or enhance the sinks of GHG.
Quantified emission limitation and reduction objectives, established under the Kyoto Protocol (QELROs)	Legally binding targets and timetables under the Kyoto Protocol for the limitation or reduction of greenhouse-gas emissions by developed countries.
Renewables, Renewable Energy	Energy sources that are, within a short time frame relative to the Earth's natural cycles, sustainable, and include non-carbon technologies such as solar energy, hydropower, and wind, as well as carbon-neutral technologies such as biomass.
Resource	Resources are those occurrences with less certain geological and/or economic characteristics, but which are considered potentially recoverable with foreseeable technological and economic developments.
Sink	Any process, activity or mechanism that removes a GHG, an aerosol, or a precursor of a GHG or aerosol from the atmosphere.
Source	Any process, activity, or mechanism that releases a GHG, an aerosol, or a precursor of a GHG or aerosol into the atmosphere.
Special Report on Emission Scenarios (of the IPCC) (SRES)	The storylines and associated population, GDP and emissions scenarios associated with the Special Report on Emissions Scenarios (SRES) (Nakićenović et al., 2000), and the resulting climate change and sea-level rise scenarios. Four families of socio-economic scenario (A1, A2, B1 and B2) represent different world futures in two distinct dimensions: a focus on economic versus environmental concerns, and global versus regional development patterns.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Sustainable development policies and measures (SD-PAMs)	Sustainable Development Policies and Measures. An approach to climate protection that builds on sustainable development priorities.
United Nations Framework Convention on Climate Change (the Convention) (UNFCCC)	The Convention was adopted on 9 May 1992, in New York, and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its ultimate objective is the 'stabilisation of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. It contains commitments for all Parties. Under the Convention, Parties included in Annex I aim to return GHG emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The Convention entered in force in March 1994.