Which way forward?

Issues in developing an effective climate regime after 2012

Aaron Cosbey, Warren Bell, Deborah Murphy, Jo-Ellen Parry, John Drexhage, Anne Hammill and John Van Ham

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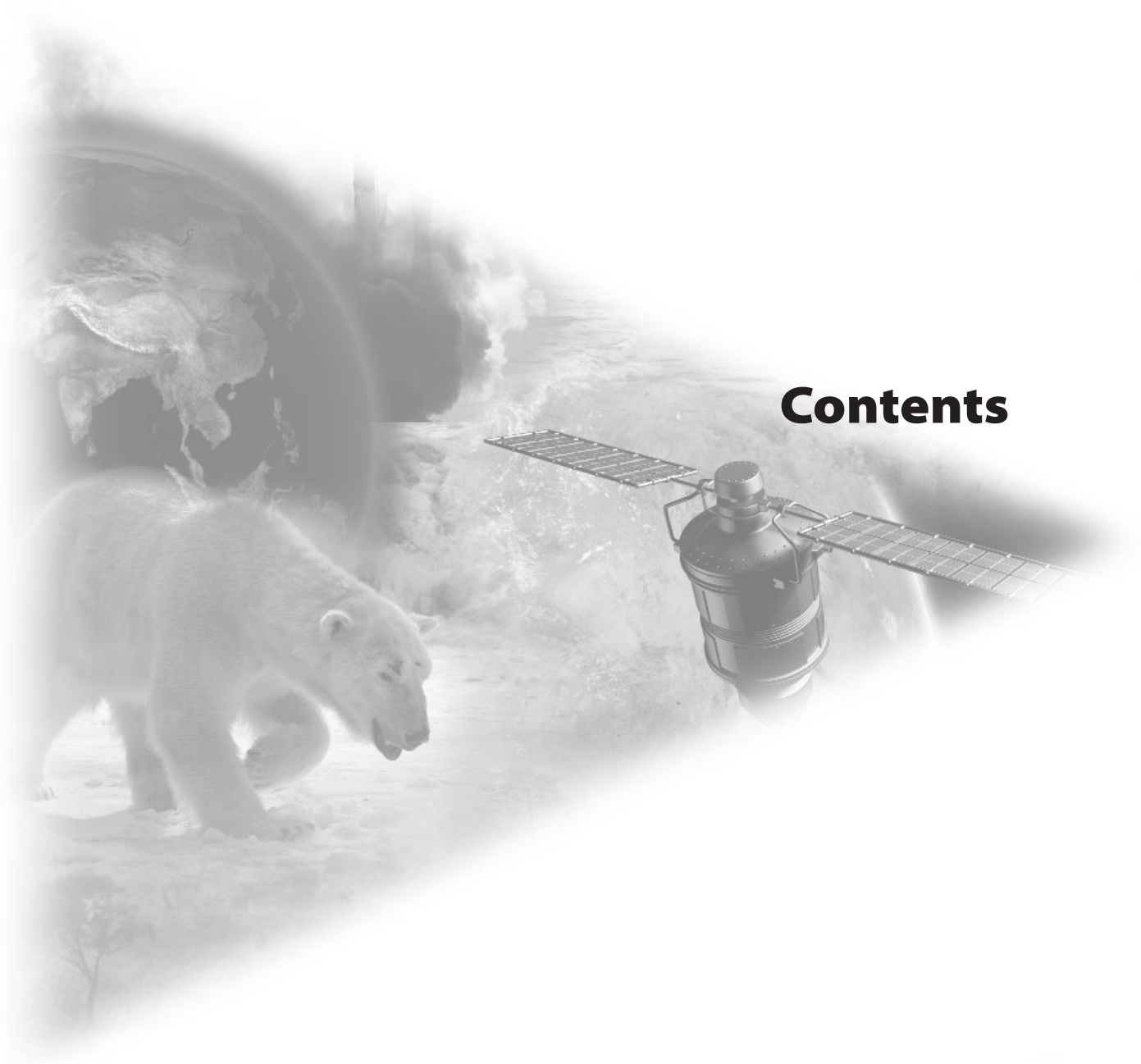
Abbreviations and Acronyms

AAUs	Assigned Amount Units
ACIA	Arctic Climate Impact Assessment
ADB	Asian Development Bank
AF	Adaptation Fund
AfDB	African Development Bank
APF	Adaptation Policy Framework
BAT	Best Available Technologies
CAN	Climate Action Network
CCS	Carbon Dioxide Capture and Storage
CBDAMPIC	Capacity Building for the Development of Adaptation Measures in Pacific Island Countries
CERs	Certified Emission Reductions
CDM	Clean Development Mechanism
CLIMAP	Climate Change Adaptation Program for the Pacific
COP	Conference of the Parties
CTI	Climate Technology Initiative
DD&D	Development, Deployment and Diffusion
DEFRA	U.K. Department for Environment, Food and Rural Affairs
EC	European Community
ECA	Export Crediting Agency
EGTT	Expert Group on Technology Transfer
ERUs	Emission Reduction Units
EU	European Union
EU ETS	European Union Emissions Trading Scheme
FDI	Foreign Direct Investment
GCM	Global Circulation Models
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Green Investment Scheme
ICCTF	International Climate Change Task Force
IEA	International Energy Agency
IET	International Emissions Trading
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Rights
JI	Joint Implementation

LDC	Least Developed Country
LDCF	Least Developed Countries Fund
LOI	Lines of Inquiry
LULUCF	Land Use, Land-use Change and Forestry
MDGs	Millennium Development Goals
MOP	Meeting of the Parties
NAPA	National Adaptation Programmes of Action
NGDO	Non-governmental Development Organization
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development
ppm	Parts per million
R&D	Research and development
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCCF	Special Climate Change Fund
SIDS	Small Island Developing States
TAR	Third Assessment Report
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VARG	Vulnerability and Adaptation Resource Group
WEF	World Economic Forum
WTO	World Trade Organization
ZETT	Zero-Emissions Technology Treaty



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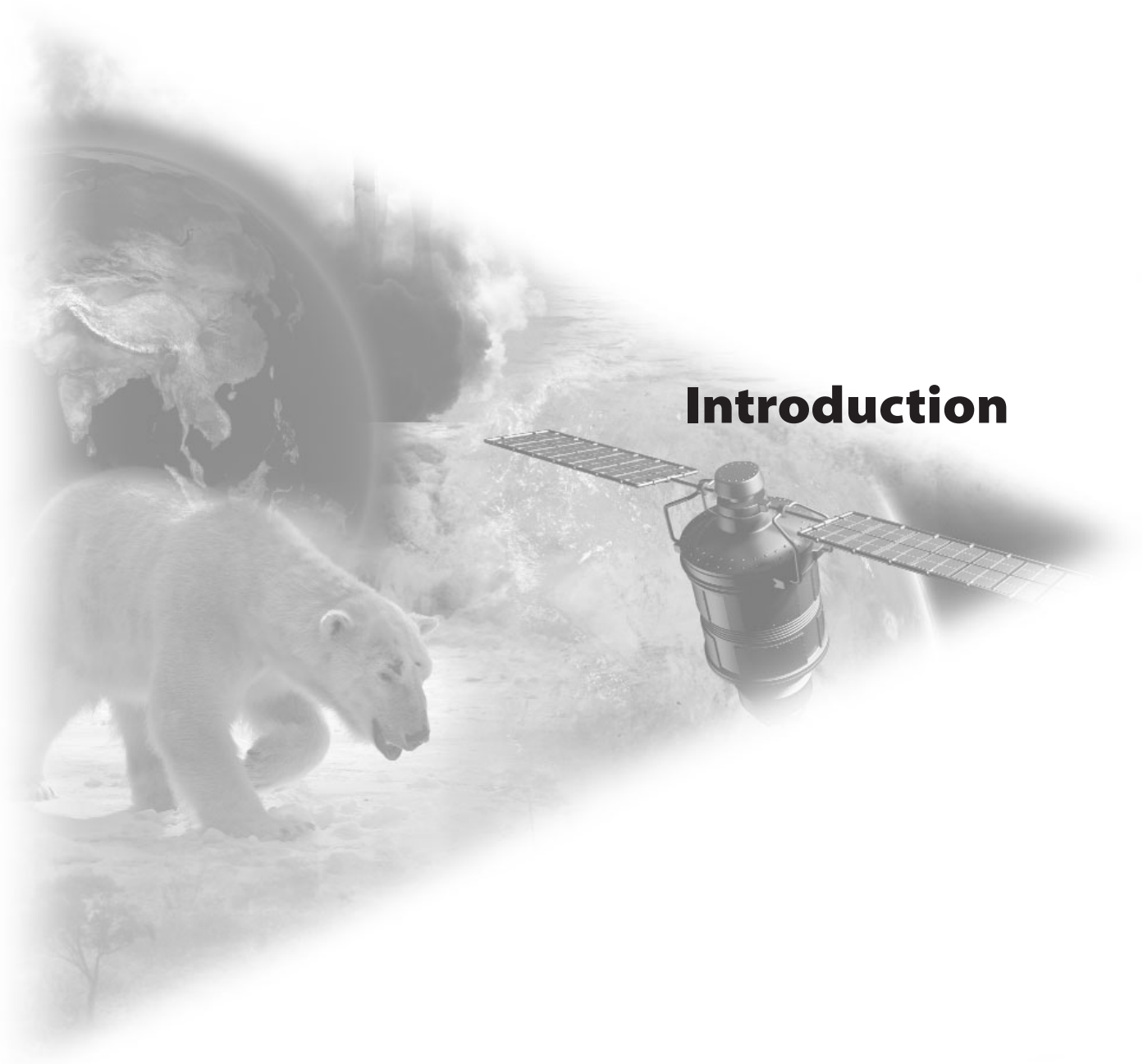

Introduction

When the global community gathers at the end of 2005 in Montreal for the Eleventh Conference of the Parties (COP-11) to the United Nations Framework Convention on Climate Change (UNFCCC) and the First Meeting of the Parties to the Kyoto Protocol, it will do so in an atmosphere of uncertainty regarding the future direction of international efforts to address climate change.

The Montreal Climate Conference is expected to mark the official start of critical negotiations on the development of an international strategy for addressing climate change after 2012, the end of the Kyoto Protocol commitment period. The challenge before the international community is immense.

Deep reductions in the release of greenhouse gas emissions are needed to prevent an increase in the Earth's average temperature of more than 3°C. As cautioned by leading scientists at the 2005 Exeter Conference, crossing this threshold could result in serious, large-scale, irreversible disruption of the Earth's system. Already, there is increasing evidence that climate change is affecting important physical and biological systems.

At the same time, significant energy development is needed to help raise billions of people out of poverty. The world's energy deficit—the difference between supply and demand—is continuing to grow, a situation that needs to be reversed if countries are to reach their economic potential and improve the well-being of their citizens.

A post-2012 climate regime will need to balance the diverse needs of all countries while striving to prevent the potentially serious economic and social consequences of the impacts of climate change. A common understanding of the issues associated with four key elements of a potential post-2012 climate regime could support the emergence of an internationally acceptable approach to this critical issue. These four elements are:

- the need to ensure sustainable economic development;
- the effective development and penetration of clean technologies;
- the establishment of an effective international carbon market over the long term; and
- the integration of adaptation in development and natural resource management decision-making.

The International Institute for Sustainable Development (IISD) has prepared a series of four discussion papers on these critical elements to help set the table for constructive discussions at COP-11 and beyond. The purpose of these papers is to review options on how best to create an effective and inclusive international climate regime that will:

- achieve the large reductions in global emissions necessary to avoid the dangerous environmental impacts of climate change while simultaneously adapting to a changing climate; and
- fairly and equitably reflect the diverse circumstances of countries while promoting sustainable economic development.

The first paper, *International Climate Change Cooperation and Sustainable Economic Growth*, notes that the speed and scale of socio-economic transformation required to avoid the risk of serious harm caused by climate change are unprecedented in human history. Yet that change must be pursued in a manner that will not unduly compromise the pursuit of development and economic prosperity. The paper sketches out some of the characteristics of an international policy framework for cooperatively engaging the best tools of the scientific and policy communities to address this challenge over the short and long term.

The second paper, *Climate Change and Technology*, examines how a post-2012 global climate regime could more effectively promote the development, deployment and diffusion (DD&D) of the appropriate technologies expected to play a critical role in mitigating and adapting to climate change. Meeting the long-term objectives of the UNFCCC will require, over decades or centuries, that societies reduce greenhouse gas emissions to near zero. Achieving these reductions will require a significant transformation of the conventional technology used to produce and distribute energy, manufacture goods and provide transportation.

A successful global climate regime will also require an efficient and effective carbon market. As examined in the third paper, *Climate Change and the International Carbon Market*, market-based approaches can encourage innovation; enable cost-effective reductions; increase the feasibility of achieving deep, long-term reductions; and promote the development, deployment and transfer of low-carbon energy technologies. The paper examines how a future global climate regime might make the most effective use of market forces, including the promotion of a robust and efficient carbon market.

The book concludes with an examination of *Climate Change and Adaptation*. Adaptation to the impacts of climate change will need to be addressed in a more prominent manner in a post-2012 climate regime, reflecting the growing scientific evidence that impacts are already affecting economic, socio-cultural and ecological systems. This fourth paper examines research and policy developments relevant to determining how a future regime could support a long-term, integrated approach to addressing adaptation to climate change by all countries.

These papers are intended for anyone interested in becoming further informed on the status of the research and thinking on the fascinating and complex challenge of establishing an effective global climate regime after 2012: from Ministers to graduate students; from environmentalists to industry stakeholders.

On behalf of IISD, I would like to thank all of the individuals whose critical insight contributed to the development of this publication, particularly Erik Haites, Kirsty Hamilton, Mark Jaccard, M. J. Mace, Deborah Stowell and Murray Ward. The views contained in this document, though, remain those of IISD.

John Drexhage, Director, Climate Change and Energy
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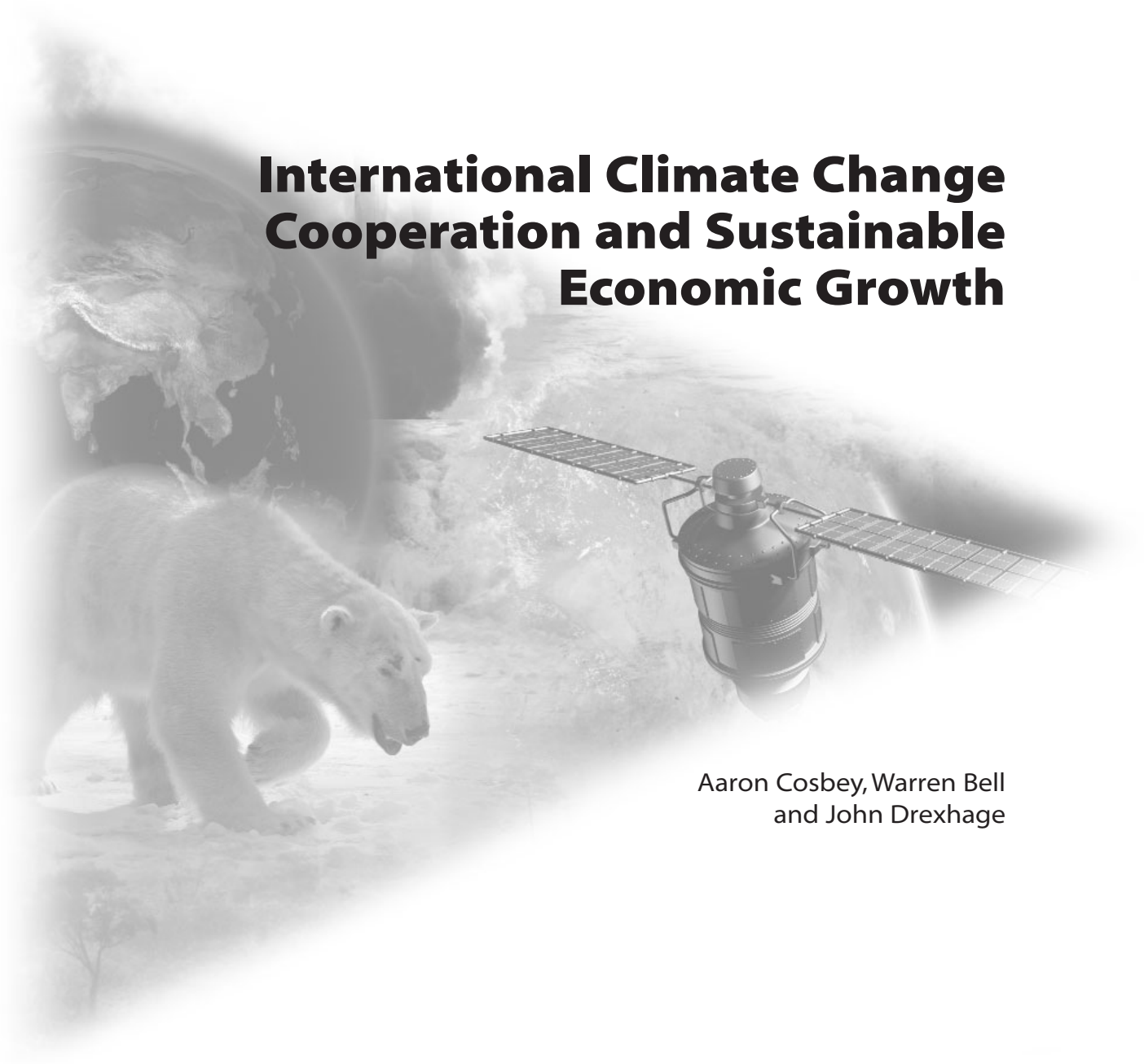
International Climate Change Cooperation and Sustainable Economic Growth



Aaron Cosbey, Warren Bell
and John Drexhage

1.0 Setting the Context

The passage of time brings us ever more agreement on, and understanding of, the challenges posed by global climate change. In the Gleneagles Agreement of July 2005, heads of the G8 governments called it a "serious and long-term challenge that has the potential to affect every part of the globe." In the most definitive statement yet delivered by global business leaders, a group meeting in advance of the G8 argued that "climate change poses one of the most significant challenges of the 21st century" (WEF 2005).

The need for action is clear. A changing climate will disrupt complex environmental, social and economic systems that have built up over centuries, and which cannot withstand rapid fundamental change. The IPCC's Third Assessment Report in 2001 warned that global warming, even at existing levels, had already impacted a number of important physical and biological systems (IPCC 2001). And it predicted significant further impacts, including:

- increased risk of flooding for tens of millions of coastal dwellers worldwide;
- increased incidence of extreme weather events;
- reduced yields of the world's food crops; and
- decreased water availability in many water-scarce regions.

The International Scientific Steering Committee, meeting four years later in Exeter, found that the evidence of threats had solidified (ISSC 2005, hereinafter *The Exeter Report*). It also explored the temperature thresholds that could trigger irreversible catastrophic events such as the melting of the Greenland icecap and the shutdown of the Atlantic thermohaline circulation that warms the North Atlantic countries. They cautioned that an average temperature rise above 3°C would likely have "serious risk of large scale, irreversible system disruption." At that level, the massive social and economic disruptions caused by climate change clearly make it a global security issue.

At the same time, the speed and scale of the socio-economic transformation required to avoid the risk of serious harm is unprecedented in human history. Not willing to accept the risks inherent in a 3°C temperature rise, many have called for holding increases to 2°C.[1] But such a limit likely means limiting atmospheric CO_2 concentrations to less than 550 ppmv—even then, the chances of achieving the 2°C goal are estimated to be *one in 16* (European Commission 2005)[2]—which would require reducing emissions by 22 billion tonnes of CO_2 per year as compared to the baseline case by 2050 (WBCSD 2004, based on IPCC 2001). To put this into real-world perspective, achieving those kinds of cuts would require an effort that displaced two billion conventional cars for hydrogen vehicles, sequestered carbon from 1,400 1-GW coal-fired power plants and increased the world's current nuclear capacity by a factor of 10.[3]

As challenging a prospect as this might seem, if we fail to achieve these kinds of changes in the next 20 years, we will have foreclosed our options by entering a world we cannot leave by any effort—one at serious risk of major systemic changes. Of course, the longer action is delayed, the tougher the economic challenge will be. Evidence presented to the Exeter meeting suggests that even a five-year waiting period would be significant. A 20-year waiting period would mean that emission reductions would need to be three to seven times greater to meet the same temperature target (The Exeter Report 2005). As such, while long-term solutions, such as new technologies, are fundamental to achieving the deep emission reductions needed in the future, we will also need to focus on effective action in the short term.

Neither track will be easy; in the coming decades the world expects to see substantial economic development including, by 2030, some US$16 trillion investment in energy infrastructure (IEA 2003). Much of this will be in developing countries as they develop with a view to enjoying the standard of living of today's industrialized countries. A critical element of the "next 20 years" climate challenge is, therefore, how to ensure these investments in long-lived capital stock use the best "climate-friendly" technology that is available and practicable, given national circumstances. This concern holds true for industrialized countries as well as developing countries.

1 See European Commission (2005), International Climate Change Taskforce (2005), Climate Action Network (2002).

2 The EC figures are based on a CO_2 *equivalent* concentration of 650 ppmv, which is roughly equal to a CO_2 concentration of 550 ppmv. They further note that a CO_2 equivalent concentration of 550 ppmv improves the chances of reaching the 2°C goal to one in six. These estimates also fall within the range estimated by Baer and Athanasiou (2005).

3 Adapted from estimates presented by ExxonMobil to a CEPS Task Force, cited in CEPS (2005):8.

The challenge can be framed more broadly as a pursuit of the kind of deep cuts necessary to avoid serious harm, without compromising our pursuit of development and economic prosperity. Fortunately, many elements of the necessary transformation can be achieved in ways that contribute to broad development goals as well, for example by providing clean energy to the poor, by improving local environmental quality and by fostering a new generation of beneficial technologies (Venema and Cissé 2004; Kuzma and Dobrovolny 2005). And many others are good investments in the sense that they avoid the high social and economic costs of inaction.[4] Approached in this way, the challenge becomes less a narrow and costly pursuit of environmental protection, and more a broad effort to reorient our societies and economies toward a sustainable development path.

This is a challenge that will require international cooperation on a scale with few, if any, precedents, on which we must bring to bear the best tools our scientific and policy communities can deliver. This paper sketches out some of the characteristics of an international policy framework that can lead us down this path. It focuses on those options that are set within, or are complementary to, the UN system.[5] Our decisions carry much weight. The choices we make today cast huge shadows into the future, defining the ambition we can reasonably hold for prosperity and stability in the years to come.

2.0 Approaches to a Successful Regime

What are the critical design features of a post-2012 regime that achieves deep emission reductions while fostering growth and development? The list assembled below is intended to serve as a platform for discussion on this question.

Broad participation: Other things being equal, the broader the participation of countries in any international climate regime, the stronger the regime, even if the roles of different countries differ according to national circumstances (see below). The final impacts of broad participation, however, depend heavily on the depth of the commitments, particularly from key emitting countries. The ideal climate change solution would be to both broaden and deepen commitments, but the politics of reaching that result are currently difficult. As such, the value of broadening must be balanced against the difficulty of negotiating a strong agreement that will find broad consensus, and in the end there may be effective approaches that involve smaller groups of countries.

Consideration of national circumstances: Broad participation does not imply a one-size-fits-all approach, and would need to respect the established principle of *common but differentiated responsibilities*. Different states will have different capacities for action and different vulnerabilities to competitiveness impacts. As discussed below, commitments can be of various types, from binding emission reduction targets to policy-based obligations. There are a number of possible bases for differentiation of target-type commitments, including: per capita emissions; total emissions; population; per capita income; human development (as measured by the Human Development Index, for example); institutional affiliation (e.g., membership in the OECD, receipt of ODA funds, etc.); and regulatory capacity (as measured by the World Bank's governance index, for example).[6] Any viable system would have to take into account a number of these criteria, and would, moreover, have to be subject to requests for special considerations.[7] The types of national engagement that might be appropriate in a differentiated post-2012 regime (surveyed in the following section) would need to be contingent on the foundation of Annex B countries' demonstrated success in meeting their current Kyoto commitments.

Environmental effectiveness: A key guiding criterion for any post-2012 international regime on climate change is the extent to which it contributes to the basic objective of the UNFCCC, by stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Some states have defined this threshold in concrete terms, as a specific target for average temperature rise, or as a maximum atmospheric concentration of CO_2 equivalent. At the end of the day, any effective approach will boil down to a focus on global emissions of GHGs in specific crucial time periods.

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4 For cost estimates in just one sector, see Association of British Insurers (2005).

5 The Gleneagles Agreement acknowledged that "the UNFCCC is the appropriate forum for negotiating future action on climate change."

6 For a discussion of the types of criteria for differentiation, see Torvanger *et al.* (2005).

7 Most iterations result in some obviously inappropriate country classifications, for which negotiated exceptions should be possible.

Cost effectiveness: This principle would have us seek to achieve the necessary environmental result at the least cost, with a minimum degree of economic disruption. This applies at the aggregate international level, and also at the level of countries, regions and firms, where there may be uneven burdens of cost and shifts in competitiveness. As noted below, the use of market mechanisms, where appropriate, can contribute powerfully to achieving cost-effectiveness. In the longer term, development of new technologies will be crucial to reducing costs of mitigation. And any framework should take account of existing capital stock and life cycles, and should offer predictability of investment conditions to the extent possible.

A multi-gas approach will be far more cost-effective than one that covers a more limited set of GHGs (Mann and Richels 2000; MIT 2000). Similarly, an approach covering a broad variety of types of emissions will be preferable. Any regime that did not effectively cover LULUCF-related emissions, for example—which account for some 25 per cent of global totals—would be sacrificing cost effectiveness. The benefits of breadth of coverage obviously need to be weighed in each case against the difficulties that might be anticipated in the course of negotiating and implementing that coverage.

Flexibility: A successful post-2012 regime will ideally be flexible in at least two distinct ways. First, it should be open to revision in light of new scientific knowledge and/or changes in political will for action (while respecting the need of private investors for predictability). In fact, it should have mechanisms for proactive continuous improvement. Second, it should be flexible enough to seamlessly incorporate actions taken at various levels, from sub-national efforts to industry-led efforts to the efforts of sub-sets of UNFCCC Parties in the pursuit of the Convention's objectives, such that the "orchestra" of efforts achieves some harmony.

Simplicity: Other things being equal, the simpler the regime the more likely it is to be successful in pursuing its objectives. This principle is particularly relevant in areas such as measurement and reporting.

Complementarity: A successful regime of actions will involve strengthening the linkages between mitigation efforts and the achievement of such related goals as poverty alleviation, energy security, protecting human health, reducing pollution and maintaining biodiversity.[8] In the final event, these linkages are inescapable; weak action on climate change will undercut progress on development objectives such as the Millennium Development Goals, as the poor and marginalized bear a disproportionate share of impacts (Working Group on Climate Change and Development 2004), and will mean major environmental disruption. And many of the sorts of needed changes—such as providing clean energy to the poor—are fundamental to achieving broad development and environment goals. A deliberately integrated approach will be most effective at exploiting these kinds of synergies, and will also be more robust over time in the face of competing policy objectives.

Long-term framework: While it will probably be impossible to prescribe many actions and policies in the long term, any international regime should be long-term in character. While it is specific about short-term obligations, it should also create the framework within which countries can agree to pursue climate change objectives over time.

Political acceptability: At the end of the day, negotiators must take the results of their work back to their respective domestic audiences, where they will face the critical test of political acceptability. In part, this is a function of how well the other principles enunciated above have been followed; for example, an environmentally ineffective agreement will likely be strongly rejected, as will one that is unnecessarily costly. Similarly, an agreement that lacks complementarity risks foundering on the rocks of competition with other political priorities. The fundamental importance of this test highlights the need for effective tools of communication, discussed below.

3.0 Elements of a Successful Regime

What are the most viable options to consider in a post-2012 international approach to climate change, given the key elements described above? This section considers three themes of central interest: how to simultaneously pursue mitigation and economic prosperity; how to time those efforts; and how to improve information and communications related to climate change.

8 The Gleneagles Agreement commits the G8 countries to act with "resolve and urgency" to meet these sorts of "shared and multiple objectives."

3.1 Climate Change Mitigation and Economic Prosperity

A central challenge in thinking about climate change actions post-2012, as outlined in this paper's opening section, is to elaborate a regime of actions at the international and national levels that simultaneously pursues climate change mitigation and economic prosperity. It is a challenge that is relevant in countries at all levels of development, and one that is underlain by the fundamental connections—perhaps more obvious in the sphere of climate change than anywhere—between economic progress and environmental integrity.

In an assessment of 44 proposed policy options (drawing on Bodansky (2004)), Bell *et al.* (2005) find that all can be categorized as belonging to one of several different general policy approaches:

- *Extension of Kyoto Approach* – the existing framework would be continued, deepening the absolute reductions required from developed countries, while gradually providing incentives for commitments from major emitting developing countries (linked, in some fashion, to their level of development).
- *Parallel Climate Policy Approach* – climate change would be addressed through either regional or sector-based approaches coordinated through a process parallel or complementary to the UNFCCC.
- *Country-/Region-specific Approach* – each country/region would develop a plan that suited its circumstances and priorities, and then would participate in trade-like negotiations to achieve agreement on equivalent or equitable efforts for each country.
- *Integrated Policy Approach* – the regime would focus on integrating climate change considerations into the development of the "mainstream" priorities of countries—particularly in areas related to energy planning, natural resources management and urban planning.

These approaches, like most of the options discussed below, are not mutually exclusive; in fact the discussion below reveals that few will, by themselves, adequately deliver the elements of a successful regime described in the previous section. Rather, they will more suitably be employed as elements in a larger constellation of coordinated efforts. Similarly, there are a number of possible complementary initiatives not discussed here that could make these options more feasible and effective. For example, mitigation, adaptation, and technology development and deployment efforts might be greatly boosted by dedicated funds administered outside the framework of the regime.

Quantitative commitments: One of the most fundamental questions to address is whether some countries will adopt quantitative commitments. These could take any of a number of forms, but three of the most commonly discussed are absolute (fixed) national emissions targets (as in the current regime), dynamic intensity targets (e.g., expressed as a ratio of emissions to GDP) and per capita emissions targets.[9] Any of the three could be set with some final objective in mind, such as atmospheric concentration levels of CO_2 equivalent, or maximum temperature increase. Fixed emissions targets offer the benefit of more direct linkage to any final objective, but are inflexible in the face of potentially high costs of action (a particular concern in the context of economic growth) (Philibert *et al.* 2003). Dynamic intensity targets, conversely, are more sensitive to cost factors, but have weak linkages to any final objective expressed in terms of atmospheric concentration or warming (which could easily worsen in the context of economic growth) (Blanchard and Perkaus 2004; Müller, Michaelowa and Vroljik 2002; Dudek and Golub 2003). Moreover, uncertainties in and potentially wide fluctuations in GDP, and disconnections between these and GHG emissions, can make this form of target unworkable in practice.[10] This is especially a concern for developing countries. Per capita targets are fundamentally more appealing on equity grounds, and allow greater space for economic growth in developing countries. However, they fail to effectively address the principle of differentiated national circumstances. They would, for example, place inappropriately heavy burdens on those countries that rely heavily on fossil fuel exports for their economic well-being.

A number of variations can be appended to these basic options. The commitments could be binding or non-binding. Safety valves in the form of capped prices for emission allowances could help address the problem of

9 For a discussion of intensity targets, see Philibert *et al.* (2003); Tol (2005). For a discussion on the need for per capita targets, see Agarwal and Narain (1991).

10 For example, if GDP stagnates without commensurate emission reductions, emission intensities (in the form of emissions/GDP) will rise and may exceed a target at the same time as economic conditions in the country worsen and innovation and investment (presumably) slow down. Pizer (2005); Dudek and Golub (2003).

price uncertainty of fixed emissions targets, and trading systems for emissions and credits (such as the existing CDM, JI and IET) could provide cost effectiveness. It has also been suggested that targets could be expressed as a quantity of emission reductions (expressed as a negotiated percentage of actual emissions during the compliance period), yielding a more flexible approach in the face of uncertainty about GDP growth (Baumert and Goldberg, *forthcoming*). Either emissions or intensity targets could be part of a hybrid approach that has differentiated approaches to commitments; this sort of approach would work to address differences in national circumstances.[11] And any of the three types of targets could be expressed as short-term or long-term commitments.

Market mechanisms:[12] Market-based mechanisms will be a key part of any approach to ensuring economic prosperity while achieving necessarily deep cuts in emissions. Both the G8 political leaders and leaders from industry recently affirmed their strong support for using market-based policies to address climate change (G8 2005; WEF G8 Climate Change Roundtable 2005). The main advantage of such policies is that they allow for environmental goals to be achieved at the lowest cost, by providing flexibility in how reductions can best be achieved.[13] They can also provide an international framework to help mobilize finance for clean technologies in major infrastructure investments. The challenge in adopting such approaches will be to design regimes to which they are amenable. Fixed targets are easily amenable to a market-based approach, as are certain types of sectoral approaches. The most commonly proposed formulations of other approaches do not lend themselves to market mechanisms as easily.[14]

Apart from the economic efficiency arguments for market-based approaches, there is also an argument for a regime that offers some continuity with the Kyoto mechanisms, in which a host of private investors have invested heavily. On the other hand, there will be reluctance in many countries to make heavy use of mechanisms that are seen as simple transfer payments with few tangible environmental results. If such an outcome were to be agreed, there would likely be a need to "green" those mechanisms—in particular, international emissions trading—to help them meet the test of political acceptability.[15]

There's a range of market-based policies available for addressing climate change, but a specific emphasis has been given to mechanisms that create an international carbon market. For this to exist, some sub-set of states will have to take on some sort of binding quantitative commitments. That is, to have market mechanisms that use a carbon market, we will need a policy framework that somehow gives value to carbon in the way the Kyoto targets do.

Technology agreements:[16] As an alternative to, or complement to, quantitative commitments, countries could pursue technology agreements.[17] Such an approach could be pursued by groups of countries—perhaps relying on those few that would cover a large share of global use of a given technology. The agreements would spell out coordinated international approaches to funding research and development, support for market development (such as subsidies, assured market shares), regulatory reform to facilitate uptake and demonstration projects in sectors that have high potential for low-cost, high-impact solutions. Candidate sectors include hydrogen, fuel cells, nuclear fusion, large-scale solar-based generation, biomass fuels and carbon sequestration. Another approach to technology agreements would see countries commit to technology-related sectoral targets (e.g., zero-emission power generation by a certain date), and then cooperate toward such goals in the ways described above. A drawback of the technology approach is its inability to deliver predictable emission reductions. As such, it is—like many of the options surveyed here—most appropriate as part of a broader mix of approaches.

A focus on developing new technologies, by harnessing the transformative power of innovation, offers the potential for emissions reduction on a grand scale. But it is for the most part a long-term approach. Such a far-sighted vision is needed; as challenging as the cuts in the next 20 years will be, there will be a need for an

11 This point is made in paper 3, starting on page 41. For a survey of possible permutations, see Bodansky (2004). Bell *et al.* (2005) assess the various options on the basis of a number of criteria.

12 Paper 3 goes into much greater depth on the nature of market-based approaches to climate change mitigation.

13 For a synthesis of the literature on this question, see IPCC, (2001b): Sections 7.3, 8.3, 9.2 and 10.2.

14 In the end, any approach that sets binding quantitative targets of some sort can be amenable to market approaches.

15 See Moe, Tangen *et al.* (2001); World Bank (2004).

16 Paper 2 goes into much greater depth on the options for a technology approach to climate change mitigation.

17 The recently-announced Asia-Pacific Partnership on Clean Development and Climate is one example of this sort of approach.

even more ambitious effort thereafter. A number of countries have called for emission cuts by 2050 of 60–80 per cent. This underscores the urgent need for a focus on the next generation of carbon-free technologies—on the necessary research, development, demonstration, deployment and diffusion—as a complement to short-term efforts to achieve reductions (Sanden and Azar 2005). These sorts of investments, undertaken now and bearing fruit in the longer term, will avoid massive costs down the road in achieving deep emission reductions while using old-generation or marginally improved technology. Complementary short-term efforts such as quantitative commitments and market mechanisms both add to the incentives for technology development and, by altering the current emissions scenario, alleviate the immense pressure on future technologies to deliver cuts.

Sectoral approaches: Most permutations of technology agreements involve a sectoral approach. Another type of sectoral approach would be to set absolute (emission-based) or relative (intensity-based) targets by sector for the major sectors of concern. The former could involve reduced emissions, or even a long-range zero-emissions commitment in a given sector. The latter could be based on intensity of production (GHGs per MW of electricity produced), or on a performance standard (GHG produced per kilometre by automobiles). The targets could be differentiated according to national circumstance, either according to the state of the sector, or according to non-sector-related criteria such as level of development, per capita emissions, etc. Another form of sectoral approach would be policy-based, with pledges by countries to adopt and implement specified policies in the sectors covered. Under any sectoral approach, the regime would have to be tailored somewhat differently for each sector, according to its specific circumstances (levels of trade, state of technology vs. state of equipment, levels of emissions, etc.) (Bosi and Ellis 2005). Sectoral approaches could conceivably be amenable to a crediting/trading mechanism that rewarded those countries that bettered their targets—a key feature not shared by most formulations of technology and policy-based approaches.[18]

Unlike technology approaches, some sectoral approaches have the advantage of being able to deliver a more or less predictable environmental outcome. It is not too difficult, for example, to estimate the impacts of a zero-emissions scenario in the electricity sector, or of improved fuel efficiency in the automotive sector. On the other hand, because they may limit overall coverage and thereby miss opportunities for cost-effective actions, sectoral approaches could be more costly if not complemented by other approaches.

Sectoral approaches might also be implemented globally, by industry associations as opposed to governments, or by governments negotiating with a sector at the international level. One difficulty here would be in coordinating action and ensuring compliance in those sectors where there are many dispersed actors. Another would be determining how government and industry actions would relate to the multilateral regime established under the UNFCCC; how would global commitments by industry be reconciled with national commitments by governments?

A key issue is how many sectors to cover under such an approach. It would obviously be simpler to negotiate only a few key sectors with the right characteristics (such as a few key players, a comprehensive industry association, or available clean technologies). On the other hand, such an approach could give rise to undesirable competitiveness impacts between covered and non-covered competing sectors, and between countries in whose economies the covered sectors feature more or less strongly. From this perspective, a larger number of covered sectors would be better.

Conversely, a sectoral approach might yield fewer competitive concerns than an economy-wide target approach under which national governments are free to allocate the responsibilities for emissions reduction across sectors. Such approaches can give rise to governments shielding particular sectors, and thereby granting them advantages over their competitors in other countries that do not follow suit (Cosbey 2005; Bodansky, Diringer and Wang 2005).

For developing countries, a sectoral approach involving dynamic crediting baselines can allow countries to focus on their key sectors—for example, those where inward investment is needed—that serves the dual purpose of sustainable development and emission reductions.

Policies and measures: A "bottom-up" approach, this would involve pledges by national governments to implement certain types of GHG-reducing policies and measures. Ideally, these would be part of broader

18 Crediting/trading for sectoral efforts, however, faces some significant methodological and data-related obstacles. See Bosi and Ellis (2005).

commitments to development goals that would yield both climate-related and other benefits. For example, governments might commit to an improved transportation infrastructure, including in the plan such GHG-reducing elements as public transportation, fuel efficiency, technology standards and so on. The co-benefits would include improved air quality, improved transportation services, a more attractive investment climate, among others. The result would be a mainstreaming of climate-related objectives in national development policies in areas such as energy, agriculture, manufacturing and transportation.

From a cost-effectiveness perspective, this kind of mainstreaming is desirable as it achieves synergies that reduce the overall costs of achieving the chosen objectives. It also fits well with the pursuit of a broad sustainable development approach to addressing climate change.

There are several permutations of this approach. One would apply only to developing countries, constituting all or part of their involvement in a broader regime. Multilateral sources of funding might support their policy efforts. In another variation, a crediting mechanism might accord credit for the GHG reductions made by policies and measures that were deemed "additional"—those that went beyond what would be considered regulatory business as usual. Both such approaches have the advantage of helping developing countries substantively engage in the regime with low impacts on their pursuit of economic prosperity. Neither approach on its own, however, can guarantee a desired environmental outcome.

Apart from the notion of a separate "policies and measures approach," it is obvious that policies and measures will play an integral part in all approaches. For example, an international carbon market requires enabling domestic policies to link actions by a country's private sector to the market. Or, in the instance of a country taking on a crediting baseline for a sector, domestic policies and measures would be the means to ensure the overall sector beats the baseline so that individual investments are able to get credits.

Selected assistance: It will be particularly difficult in some countries to ensure economic prosperity in the face of international and domestic action to combat climate change. Such actions, if they are successful, will result in some degree of creative economic destruction, posing special challenges for economies that rely heavily on declining sectors or, in general, whose terms of trade might deteriorate. Oil-exporting developing countries and least-developed countries that fit this mould may need targeted assistance to help diversify or restructure their economies. The advantage to a regime that involves such an approach, aside from its desirable economic outcome in the target states, is its greater political feasibility. Difficulties include establishing the criteria for and nature of assistance.

Adaptation: Even if the global community succeeds in the sort of ambitious action contemplated above, there will still be adverse effects from the current and future levels of GHG concentrations in the atmosphere (Yamin, Smith and Burton 2005). Some of the most severe impacts are predicted to fall on those countries least able to cope, and with the lowest GHG emissions. In all countries, the marginalized are likely to be more vulnerable and disproportionately affected. In the end, however, we will all bear the costs of a changing climate; estimates of just insurance-related damages in OECD countries from unchecked climate change are in the hundreds of billions of dollars annually (Association of British Insurers 2005). Any international policy framework must consider how to approach the task of adapting societies, economies and infrastructure—particularly, but not exclusively, in least-developed countries—to reduce vulnerability and lessen any adverse impacts.

3.2 Timing Considerations

How can timelines for setting climate goals be adapted to the competing demands of rapid emission reduction and the longer timelines that can underpin economic and investment planning? Determining an appropriate policy response is inherently challenging. The basic problem is that while climate change and its related impacts will unfold over several decades, stretching into centuries, it requires a policy response that is, to a large degree, guided by current political realities. The fact of cumulative emissions (CO_2, for example, remains in the atmosphere for approximately 100 years after it has been emitted) means that nations must respond today to this very real and ever-growing threat. The challenge is not to find the best policy today for the next 100 years, but rather to select near-term and long-term strategies that do not compromise future options, are economically and socially manageable in current circumstances, and can be adjusted over time in light of new information.

That challenge is intimately related to cost considerations. The basic tension is that early action is inherently costly since it may force an early turnover of capital stock—a particular concern in sectors where investments

are long-lived and costly.[19] As well, later action can take advantage of superior, lower-cost technologies not available to today's investors. On the other hand, early action may help to induce technological change through the price signals it sends and any incentives it involves, bringing new cost-saving technologies on board more quickly (Goulder 2004). As well, early action provides a hedge against uncertainty; if countries decide in several years that they need even more demanding targets, a decision today to take later action would mean much greater costs incurred than under an early action scenario (SEPA 2002). Finally, a decision to take later action assumes that the future generations onto which we "backload" the responsibility for deep cuts will actually be willing and able to make them.

Several guiding rules can help in coming to grips with timing considerations. First, any of the approaches described above should take explicit account of the economic realities in the affected sectors. Sectoral approaches, for example, might be tailored by sector to account for the age and expected lifetime of the existing and planned capital stock. As well, given the major investment expected in the next 25 years in the energy sector in developing countries, it may be desirable to elaborate mechanisms that facilitate adoption of best available technology in those countries. Otherwise, the up-front premium necessary for such investments may deter investors (even where there is an attractive payback time, if capital is scarce), and we will be locked into many decades of excess emissions from trillions of dollars worth of energy infrastructure.

Second, it was argued above that there is an urgent need for complementary actions aimed at both near-term and long-term results. A technology approach might be ideal as a longer-term strategy for addressing the need for deep cuts in emissions, but would need to be coupled with parallel strategies such as targets that will have impacts in the short-term.

Third, a framework involving the flexibilities of emissions trading and allowance banking provides timing alternatives that help to reduce costs that might otherwise occur if actions are forced—in location and time.

Finally, the most important element in any regime from an investment planning perspective is predictability. To return to a particularly salient example, given that many energy infrastructure investments have lifetimes that span decades, the massive significance of the energy sector to climate change efforts, and the US$16 trillion of investment needed over the next three decades in that sector (IEA 2003), it is critically important to send signals now about the type of regulatory and cost impacts any future climate regime will have. Clearly it is impossible to spell out the details of agreements that have yet to be negotiated, but to the extent it is possible to send signals, the result would be a better mesh of the short-term nature of negotiations with the long-term nature of investment planning. From this perspective, a regime that had no defined end date would be preferable. To preserve flexibility, however, such a regime would need to incorporate mechanisms for amendment and continual improvement.

3.3 Information and Communication

How might we better assess, communicate and take into account the economic and social risks of a changing climate; the cost to sustainable growth of not taking aggressive action; and the many non-climate-related environment and development benefits to be achieved by appropriate action?

Better assessment calls for either increased funding to the pursuit of climate-related science, or more efficient use of existing funding (or both). Better communication is a challenge at two levels: communicating to policy-makers, and communicating to the public at large.

Public awareness of climate change as an issue is key to enabling effective political action. The challenge is to reach a broad audience cost-effectively with a complex message. Useful lessons might be drawn in this regard from the expertise of the advertising industry worldwide, which has the benefit of years of experience honing its skills in communicating to mass audiences and changing consumer behaviour. International coordination of efforts would undoubtedly be productive.

Youth represent a key audience for this kind of education, being at once willing to learn, eager to make a difference, and able to influence family members that would be more difficult and costly to reach by other methods.

Communicating to decision-makers is a separate challenge: how can they be provided with the knowledge and tools they need to better integrate the climate change imperative into overall public policies? This kind of

19 Transport and energy infrastructure score highly on both categories.

integration at the national and sub-national levels will help determine the ultimate success of climate change efforts, climate change being so intimately tied to objectives in broader government policy-making (e.g., priorities in energy systems, natural resource investments, transportation and urban planning objectives, and national-level strategies to achieve the Millennium Development Goals.) Those states that have successfully established institutions of communication and integration might pool their experience in a survey of best practice, and funding might be made available to disseminate and act on the results.

4.0 Questions for Consideration

This paper is intended to serve as a platform for productive discussions on how to achieve necessarily deep cuts in emissions while still pursuing economic prosperity. It suggests a number of questions that will need to be considered in the process of elaborating a post-2012 regime for international action on climate change.

- What is the ideal mix of approaches, given the need for fundamental innovation in some sectors over the next 50 years, the simultaneous need for even more short-term emission reductions and the importance of addressing the long-term emission consequences of near-term investments?
- How should the international community differentiate the participation of nation states in a post-2012 regime? What mix of commitment types will be at once politically feasible, cost-effective and environmentally effective?
- What are the implications of the various post-2012 options for the nature and process of the negotiations? Given that some options dictate important differences in approach, and given the lack of consensus on the options to pursue, how do we proceed?
- How can we more effectively engage industry and the private sector in meeting the challenges?
- How can we ensure that countries with special challenges are assisted in their struggle to adapt to a carbon-constrained global economy?
- How can we give private investors the greatest possible degree of long-term certainty and predictability?
- How can we better communicate, to decision-makers as well as the general public, the urgency of the challenges presented by climate change?

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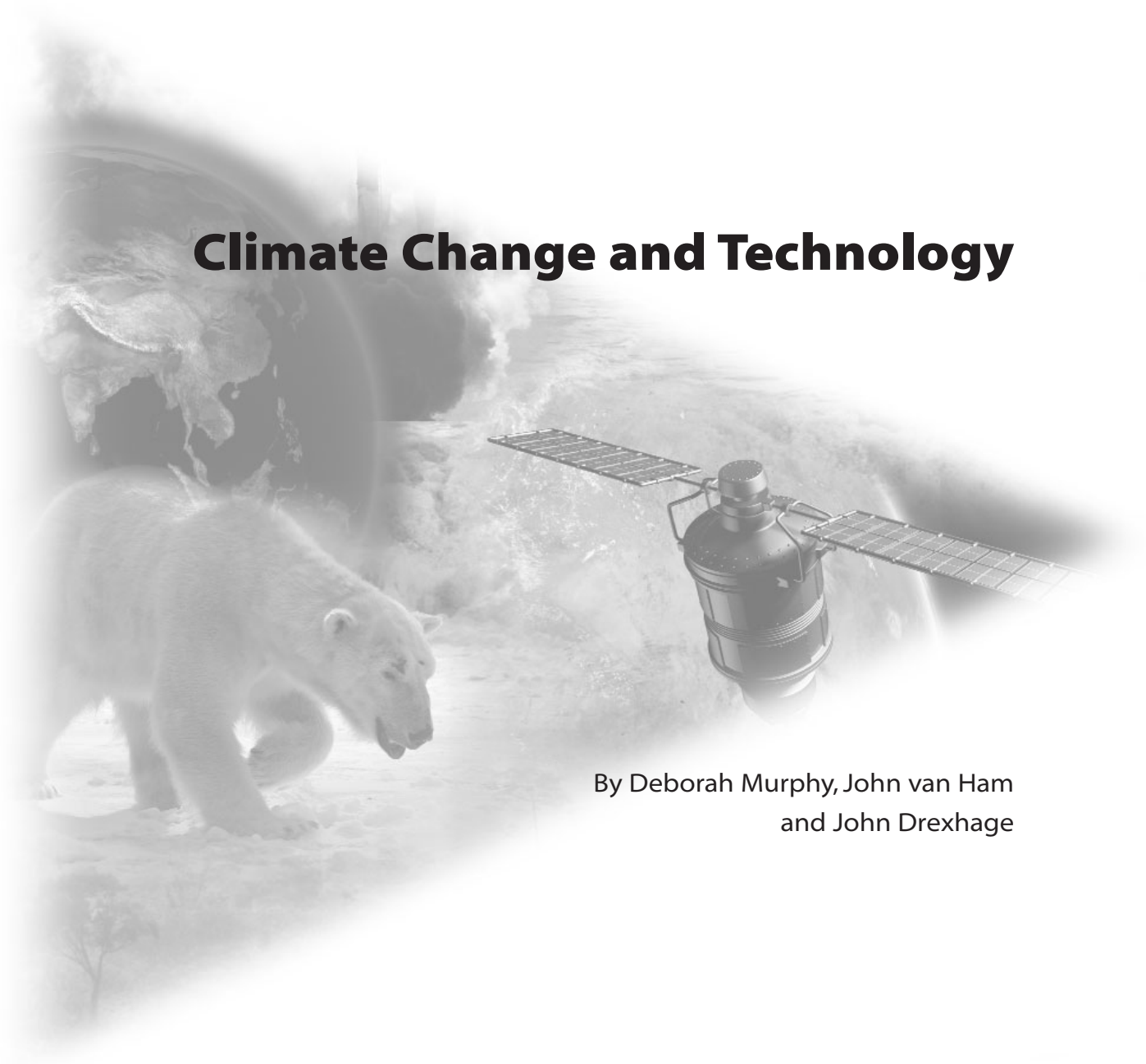

By Deborah Murphy, John van Ham
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1.0 Introduction

This paper examines how a global climate regime for post-2012 could more effectively promote the development, deployment and diffusion (DD&D) of appropriate technologies.

Technology is expected to play a critical role in the mitigation of and adaptation to climate change, and achieving the objective of the United Nations Framework Convention on Climate Change (UNFCCC) (Article 2) to stabilize "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." The Intergovernmental Panel on Climate Change (IPCC 2001) estimated that emission reductions of more than 60 per cent would be necessary to stabilize global concentrations at 2001 levels. Meeting the long-term objective of the UNFCCC will require, over decades or centuries, that society reduces GHG emissions to near zero. To achieve the required reductions will require a significant transformation of the conventional technology used to produce and distribute energy, manufacture goods and enable transportation (both the mode and fuel).

The deployment and diffusion of existing technologies, as well as the DD&D of new technologies, will be essential to stabilize anthropogenic GHG concentrations. Pacala and Socolow (2004) note that stabilizing emissions at 500 parts per million (ppm)[1] requires that emissions be held near the current level for the next 50 years, even though they are projected to more than double due to population growth, poor countries getting richer and the failure of wealthy countries to reduce greenhouse gases. There is widespread agreement (e.g., IPCC 2001; Pacala and Socolow 2004) that known technologies could reduce emissions significantly from the business-as-usual trends in the short term. For these technologies, development is not the issue. More critical are effective deployment and dissemination in all countries. Over the long term, the current portfolio of technologies is unlikely to reach the objective of the UNFCCC, indicating that increased technology DD&D is critical.

Article 4 of the UNFCCC states that Parties are committed to "Promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emission of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors." Technology transfer is defined by the IPCC (2000, section 1.4) as the:

> "broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organizations (NGOs) and research/education institutions.... The broad and inclusive term 'transfer' encompasses diffusion of technologies and technology cooperation across and within countries."

Much work has been undertaken to promote technology transfer within the UNFCCC regime, including the adoption of a framework on the transfer of technology, the establishment of an Expert Group on Technology Transfer (EGTT) that aims to enhance the technology transfer goals of the UNFCCC and the establishment of the Special Climate Change Fund (SCCF) that is intended to support activities in the areas of, *inter alia*, adaptation and the transfer of technologies.

In the context of the UNFCCC, technology transfer has generally referred to the transfer of technologies from developed to developing countries, despite the definition in the IPCC special report, which also correctly points to the potential of technology transfer on a South-South basis or between industrialized countries. Rolfe (2000) notes that most funding under the UNFCCC has focused on needs assessments, barriers to the transfer and dissemination of environmentally-sound technologies, and capacity building. In practical terms, very little transfer of hard technologies has taken place, certainly not enough to begin decreasing carbon emission trends. The lack of progress within the international negotiations has certainly contributed to this state of affairs. The controversy stems from the differing perceptions of technology transfer: developing counties have wanted developed countries to facilitate technology transfer through increased financial and technical support; while developed countries have expressed an unwillingness to share their technologies without commercial benefit and have pointed to the need for incentives for private companies that own the technologies.

1 Proposals to limit atmospheric carbon dioxide to a concentration that would prevent the most damaging impacts of climate change have focused on a goal of 500 ± 50 ppm, or less than double the pre-industrial concentration of 280 ppm. The current concentration is ~375 ppm (Pacala and Socolow 2004: 968).

To be effective, a future international climate regime will need to find ways to encourage and enhance technology DD&D. Technology development could be encouraged through research programs and partnerships; deployment efforts could assist in creating the necessary market transformation to support the uptake of new technologies; and technology diffusion, the successful market penetration of technologies in both developed and developing countries, could be supported through the dissemination of technical information and know-how to encourage the subsequent adoption of new technologies and techniques. Technology cooperation—those efforts made to share technology research, development and diffusion, including goods and knowledge—and technology transfer are means to support the DD&D of climate-friendly technologies. Nor should the prospects for South-South technology transfer be understated—often times, more similar socio-economic circumstances between developing countries might mean better prospects for sustainable technology transfer in those regions. Biofuels in transportation are but one example to consider in this regard.

Fully effective technology DD&D will include the creation of incentives for developed countries to expand markets and share their technologies by encouraging and supporting commercial benefits, while assisting developing countries that are unable to pay the extra price required to deploy these technologies. Not a small order and not one for which there is a single or simple immediate solution. While a variety of technology DD&D approaches can be encouraged, the challenge is to identify and design approaches that will be most effective under the UNFCCC, as well as to encourage complementary initiatives (e.g., international technology research partnerships and Official Development Assistance (ODA)) to support the goal of the Convention. Technology DD&D occurs both within and outside of the UNFCCC, thus effective technology DD&D in a post-2012 regime will need to be defined in a manner that leverages, rather than duplicates, existing mechanisms.

It is also becoming increasingly apparent that diversifying power fuel sources beyond traditional fossil fuels is an increasingly attractive option from an energy security perspective—non-fossil fuel sources, including renewables and nuclear, can make a constructive contribution to this process.

This paper examines the contribution of technology DD&D in building the post-2012 climate regime and the role of the UNFCCC in promoting DD&D initiatives that will assist in stabilizing GHG atmospheric concentrations. Section 2 provides the background and context for the discussion by providing information on the technology challenge. The section also includes a brief review of technology cooperation and transfer activities in and outside of the UNFCCC. Section 3 reviews the barriers to successful technology DD&D, as well as strategies to overcome those barriers. Section 4 examines options for enhancing technology DD&D in a post-2012 regime and Section 5 puts forward key questions for discussion and moving forward.

2.0 Climate Change and Technology – An Overview

The goal of stabilizing atmospheric concentrations of GHGs poses a large technological challenge as world energy demand is projected to rise and new technologies will be required to meet this demand. For example, the IEA's *World Energy Outlook 2004* estimates that up to US$16 trillion will be invested in the energy sector up to 2030. The IEA estimates that total energy demand, under a business-as-usual scenario, will increase by more that 50 per cent between 2000 and 2030, with developing countries expected to account for 70 per cent of the growth in global energy demand and two-thirds of the growth in global GHG emissions. Fossil fuels are expected to remain the primary source of energy and will meet more than 90 per cent of the projected increase in demand (IEA 2004b).

2.1 Mitigation Technologies

"Mitigation technologies" are those technologies that reduce the levels of GHG emissions, covering short-, medium- or long-term periods. Many of the mitigation technologies focus on reducing carbon dioxide emissions from fossil fuel combustion as they form the largest share of overall GHG emissions. Commercially available technologies can play a large role in meeting the short-term goals of the Kyoto Protocol, as well as the goal of the UNFCCC over the medium term. For example, Pacala and Socolow (2004) have outlined a portfolio of existing technologies in the form of "stabilization wedges" that could solve the climate change problem for the next 50 years.

The wedges focus on technologies that have the potential to produce a material difference by 2054, and include efforts beyond business-as-usual in the areas of carbon dioxide capture and storage (CCS); renewable energy (e.g., wind, solar and biomass fuel); energy efficiency and conservation (e.g., efficient vehicles and buildings); fuel switching; nuclear fission; forest management; and agricultural soils management. Many of these available technologies are not yet fully competitive under current policies and markets.

There is a significant potential for new investments in the short term to utilize more efficient demand-side technology as energy efficiency gains translate into absolute reductions as well as a reduction in the carbon dioxide intensity of economies. Advances in energy efficiency and renewable energy technologies are required to enhance energy security, an increasingly important issue. This is a critical issue for many least-developed nations that are dependent on imported oil for their energy needs, and access to energy is a key consideration for economic development and poverty alleviation in most developing countries. Energy security is also important for many developed nations, especially those that are net importers of oil and gas and reliant on supplies from around the world. Disruptions in the energy supply could have serious impacts on the economy and security of a nation.

Finance portfolio theory is now being used to show that diversifying the electricity generation mix at the national level to include, for example, renewable energy, can help deliver increased energy security by reducing the impact of fossil price volatility within the energy system, as well as reduced emissions. Renewable energy may have a higher capital cost, but it reduces overall system risk and cost, as its costs move independently of fossil fuel prices. Recent research by Awerbuch (2005) highlights an important alignment in many countries of the response to climate change and energy security (security and affordability of supply, role of national renewable energy resources and energy efficiency).

The production of renewable energy sources is expected to rise, but these sources are projected to meet only 2.5 per cent of overall global demand in 2030 under a business-as-usual scenario (IEA 2004). The potential market for renewable energy is impressive in developing countries because of climate, untapped potential, geographic size and undeveloped power infrastructure. Advanced renewable energy technologies, including those in the areas of small hydro, biomass and photovoltaic technologies, will be in high demand in all developing countries. The DD&D of renewable energy technologies can have significant economic, social and health benefits. The World Bank (2000) notes that the quality of energy is low for two billion people worldwide who are dependent on biofuels, and combustion of these fuels leads to poor indoor air quality. Decentralized electricity generation based on renewable energy supplies (e.g., wind, solar and biomass) can be a key complement to grid extension in socio-economic development and lead to improved local and indoor air quality with associated health benefits.

There are socio-economic and geographic considerations in regard to technology DD&D. For example, China and India have large coal reserves, and economic development and energy security priorities will ensure these two countries account for two-thirds of the increase in world coal demand over the next 30 years (EIA 2004). Given the size and projected growth rates of these two economies, clean coal technologies and carbon capture and storage (CCS) will be absolutely critical for limiting global GHG emissions.

Nuclear technologies can offer near-zero emission options, and China, Japan, Korea and India all plan to build more capacity. Most developed nations have not invested heavily in nuclear technologies since the 1970s, and public acceptability may inhibit their uptake in the short term (Planet Ark 2004).

Over the longer term, more advanced technologies will emerge that have the potential to further significantly reduce GHG emissions. Ultimately solving the climate problem will require the decarbonization of the world's energy supply, and many contend (e.g., Hoffert *et al.* (2002)) that revolutionary energy technologies will be needed, indicating that R&D investments are required now to ensure the necessary long-term technology DD&D. For example, technologies such as CCS, fuel cells, hydrogen systems, other renewables, biotechnology and advanced vehicles have the potential to be transformational technologies in future global energy systems if cost-effective technologies are available that meet other societal requirements including health, safety, reliability, other environmental concerns and cost. There is no one clear-cut technology option for moving forward and many areas of overlap exist among technology categories, where the success of one technology depends on the success of others.

DD&D is also required for technologies in other sectors that are important sources of GHG emissions. Forest management practices, afforestation and reforestation can increase the size of carbon sinks and enhance mitigation. Advanced technologies in the agricultural sector, such as aerobic composting of manure and the use of air seeders to reduce fertilizer use, can reduce methane and nitrous oxide emissions. Improvements in industrial processes can reduce non-energy-related emissions in such sectors as cement, iron, steel and aluminum. Landfill gas recovery and use technologies and recycling and waste containment programs can reduce methane emissions related to the disposal and treatment of industrial and municipal waste.

2.2 Technologies for Adaptation

Technologies for adaptation are those that "reduce the vulnerability, or enhance the resilience, of a natural or human system to the impacts of climate change" (Vladu 2005). Examples include agricultural and forestry practices, coastal zone management, watershed management, and disaster reduction and preparedness. This includes both "hard" (e.g., drought-resistant seeds and air conditioning) and "soft" technologies (e.g., insurance mechanism and hazard assessment). Technologies for adaptation will be required both in the short term as impacts of climate change are already being noted, and in the long term as the need to adapt will grow over the coming decades. Technologies for adaptation are particularly important for developing nations, where climate change will further pressure "survival" needs such as access to drinking water and food security, as well as pose a threat to environment and heath standards. The macroeconomic costs of climate change are uncertain, but have the potential to seriously threaten development in many countries.

Effective technology DD&D that leads to reduced GHG emissions and improved adaptation can lead to significant co-benefits and assist countries in meeting development goals. The health impacts of a changing climate are likely to be overwhelmingly negative, and are associated with extreme weather events (e.g., heat waves, smog, droughts, extreme rainfall), increased air pollution, and water- and food-borne enteric diseases. Technologies for adaptation can assist countries in coping with extreme weather events, and improved air quality, which results from decreased burning of fossil fuels, can reduce the cost of health care expenditures associated with air pollution-related illnesses. A report in the *Lancet* (Working Group on Public Health and Fossil Fuel Combustion 1997) estimated that strategic climate policies could prevent about eight million deaths globally that would occur between 2000 and 2020 in a business-as-usual scenario.

2.3 Overview of Activities to Support Technology Development, Deployment and Diffusion

A number of activities and initiatives have been undertaken to support technology DD&D in the area of climate change. While too numerous to mention all, key initiatives with linkages to the UNFCCC are listed in Annex A of this paper.

The salient point is that actions to date offer valuable lessons for the development of effective initiatives to enhance technology DD&D. Successful DD&D requires cooperation among stakeholders—including multilateral and bilateral development agencies, international and regional financial institutions, governments, research institutions and the private sector. The creation of an enabling environment (e.g., creating market conditions through policy and regulatory drivers, improved human resources and good governance) can assist in bringing together partners and creating the conditions for climate-friendly investments and focused initiatives to link climate change mitigation and adaptation with broader sustainable development goals. A key challenge for the post-2012 regime will be to identify and implement technology DD&D actions that build on current initiatives to ensure that climate change is a key consideration in investment decisions to allow for significant technology change over the medium to long term. This will require significant mobilization of public and private sector finance toward zero- and low-carbon technologies, including a determined shift toward demand- and supply-side energy efficiency.

3.0 Technology Development, Deployment and Diffusion: Barriers and Strategies

3.1 Barriers

A number of barriers must be overcome to enhance technology DD&D. The EGTT has undertaken extensive work in analyzing barriers to technology transfer, including hosting workshops on technology needs assessments, enabling environments and innovative financing. The issue was explored in the 1998 UNFCCC technical paper, *Barriers and opportunities related to the transfer of technology*. As well, a senior-level round table on enabling environments for technology transfer was held on December 8, 2003 in Milan, Italy at COP-9, where discussion highlighted, *inter alia*, different technology transfer experiences, including macro and micro barriers. The session (UNFCCC 2004a: 5) noted that "barriers exist at every state of the technology transfer process—technical, economic, political, cultural, social, behavioural and institutional." Challenges to the effective deployment and dissemination of technology in developing countries include the need to adapt technologies to local conditions, lack of supply chains, insufficient human capabilities and lack of integral institutional structures, such as stable grids and stable investment climates.

The UNFCCC workshop on enabling environments (as reported in IISD 2003) identified commonly encountered barriers to technology transfer, including failures in "reflecting economic and environmental costs in prices; enforcing regulations; ensuring awareness of relevant measures; and developing affordable cleaner technology" as well as the "high cost of patented technology, limited short-term profitability of some environmentally-sound technologies, limited finance, insufficient technological know-how, and inadequate institutional capability." The report on the UNFCCC workshop on innovative financing (UNFCCC 2004b) outlined the main barriers to accessing finance for technology transfer and noted that "many investors view renewable energy and GHG projects as compounding risk—combining risky sectors with risky markets with a risky commodity," and that future work should focus on removing the barriers in developed as well as developing countries.

The work of the EGTT has tended to focus on barriers to technology transfer between developed and developing countries. Barriers can also be looked at in a wider context when assessing technology DD&D, which takes place within countries and regions, between developed countries, between developing countries, and between developed and developing countries. For example, technology lock-in is a major barrier to the rapid uptake of new climate-friendly technology in all of the above circumstances. Established systems have market advantages arising from existing infrastructure, services and institutions. Fundamental shifts in technology take time, and DD&D can take decades before new technologies become widely accepted and economically competitive. Sanden and Azar (2005) note that escaping technology lock-in will be a slow process extending over decades, having to overcome such barriers as technology inter-relatedness, vested interests, legal frameworks that fit the use of historical and present technologies, and the limitations imposed by the evolved consensus over how technology should be designed limiting the vision of business and governments.

In developed countries, social and behavioural preferences for existing technologies and lifestyles at the household level are a major barrier, often reinforced by media and advertising. Within the business and industry sector, some may resist politically-driven technological change if there are insufficient incentives. Once built, large units of physical capital (i.e., factories, power generation plants and transportation infrastructure) can operate for many decades. In the near term, patterns of capital consumption are driven by factors largely unrelated to climate change, and will likely only use climate change as an investment decision factor when obligated to do by regulations (Lempert *et al*. 2002).

New technologies often face a major disadvantage when competing on a direct-cost basis with conventional technologies; they generate fewer environmental externalities than conventional technologies, a benefit which is typically not (or not fully) reflected in market prices. Thus, mechanisms (e.g., taxes and regulations) are required to provide the right signal about the full social costs of technology choices. Price signals that reflect the negative environmental and social externalities related to energy use can improve the DD&D of climate-friendly technologies, as well as influence the diffusion of energy-using technologies that are being innovated and commercialized at a rapid rate. Jaccard and Mao (2003) note that financial instruments (e.g., emission caps and market-share requirements) that change energy prices to reflect negative externalities are becoming increasing popular, and can be directed at "fuel choices, emission levels of each fuel, and at the amount of energy consumption to provide a given level of energy services." A key consideration is how to design an international framework that can encourage price signals of similar magnitude in developed and developing countries.

Neuhoff (2004) argues that an uneven playing field exists because of direct and indirect subsidies. He estimates that OECD countries spent US$20–30 billion on energy subsidies in 2002 and such subsidies may delay investment in energy efficiency and renewable energy provision. Traditional export credit guarantees by OECD countries benefit traditional energy technologies. In the late 1990s, Export Crediting Agencies (ECAs) facilitated a US$17 billion annual investment in fossil energy and only US$0.8 billion in renewables. Neuhoff notes the lock-in of technologies is exacerbated by the lower production costs for conventional technologies and the cost (including learning-by-doing) of adopting new, more efficient technologies.

Purvis (2004) notes that foreign ownership restrictions may restrict the diffusion of climate-friendly technologies. For example, China requires that all power investments over US$30 million be approved by the central government, and India caps foreign ownership on energy investments over US$350 million. Other barriers also impede technology DD&D, including informal administrative practices, bureaucratic red tape and corruption.

Weak intellectual property rights (IPR) regimes are often perceived as barriers to technology DD&D, as technology owners fear their technology may be stolen if they sell equipment without a license agreement.

Development of IPR regimes in developing countries can assist those countries in attracting private sector investment, as well as encouraging innovation and the development of indigenous technologies.

Many developing countries face additional challenges when trying to attract investment into the energy and infrastructure technologies needed for social development due to the perception of high risk and inadequate returns, alongside substantial transaction costs (van Aalst 2004). In addition, IEA's *World Energy Investment Outlook* notes: "Investing in energy projects in developing countries and the transition economies is generally riskier than in the OECD because of less well-developed institutional and organizational structures, lack of clear and transparent energy, legal and regulatory frameworks, and poorer political and economic management."

Exchange rate risks are also a factor in projects where revenue is generated in local currency but fuel must be bought in foreign currency. The resulting higher risk premium means returns have to be "significantly higher" than in OECD countries (IEA 2004b: 76). This highlights the importance, at the national level, of creating the right enabling environments—through political and regulatory reform, together with greater local capacity—to stimulate private capital to flow to those regions. Increases in the production of renewable energy sources can also mitigate the exchange rate risk by reducing the inputs of foreign fuel.

Developed and developing countries also face challenges in developing and attracting technologies for adaptation. Klein *et al.* (2005) note that the transfer of technologies for adaptation faces additional barriers when compared to mitigation technologies, in that the uptake of such technologies is dependent on the buy-in and involvement of an expanded stakeholder community, and there is unwillingness at present to provide the required funding for technologies for adaptation.

In summary, the DD&D of new technologies are processes that can take years, even decades. The identification of barriers, which vary from country to country, can assist with the identification of strategies and opportunities to overcome them. This will require a concerted effort, and the post-2012 framework could be designed to play an important role in encouraging appropriate strategies and initiatives.

3.2 Strategies

Much research has been undertaken on overcoming barriers and creating strategies to more broadly enhance technology DD&D. Technology "push" (e.g., incentives for investment and technology standards) and "pull" (e.g., R&D, regulations and fiscal instruments) options will be required to bring existing and emerging technologies into implementation. Many experts (e.g., Sanden and Azar 2005) note that carbon prices needed to meet the Kyoto Protocol will likely not be high enough to create the "pull" required to develop more advanced technologies in the short term. Thus, incentives will be required to support technology DD&D over both the short and longer term.

3.2.1 Innovative Financing Options

Innovative options are also required to attract financing for technology DD&D, and were addressed at the EGTT workshop on financing (UNFCCC 2004b). A key message was that risk sharing can increase financial investment and stimulate local private-sector participation. Governments have an essential role in risk management, including establishing priority investment areas, setting out framework conditions for transactions and shaping financial flows and providing a stable legislative and regulatory environment. Technology needs assessments can assist in identifying the key stakeholders and capacity building for local investors can assist in project preparation and development to improve access to finance. The workshop also emphasized the importance of seed capital (initial equity capital), as well as the need to develop a "common language" for ongoing dialogue between governments and the finance sector. An effective policy framework will be "loud, long and legal," to ensure the right signals attract capital; the rules and incentives are stable and sustained; and that the regulatory framework provides the basis for long-life capital-intensive investments.

3.2.2 Private Sector Investment

Encouraging private sector investment is critical for technology DD&D, as private markets have increasingly become the main avenue for the transfer of technology. Developing countries are expected to account for 70 per cent of the growth in global energy demand and two-thirds of the growth in GHG emissions. Foreign direct investment (FDI) is the largest component of external funding to developing countries, and is expected to be the major player in financing energy and transportation infrastructure in developed as well as developing countries.

As FDI accounted for 60–80 per cent of global financial flows in recent years (Violetti 2004), private sector investment should be viewed as one of the main vehicles for ensuring that technology DD&D contributes to short- and longer-term climate change mitigation and adaptation, despite the fact that private investment remains low in many developing countries.

In this context, there is a need to ensure that the financial markets and public finance institutions are mutually reinforcing efforts to more effectively support sustainable development if the world is to stabilize GHG emission reductions over the long term. Public-private partnerships are increasingly being used as an innovative means to promote private sector investment in climate-friendly technologies. For example, the UN Foundation (UNF) supports emerging climate change policies and promotes public-private partnerships with UN agencies that advance innovative sustainable energy programs, particularly in developing countries. UNF and the Shell Foundation have invested with UNEP in an initiative to accelerate the market for financing solar power in India by helping two commercial banks develop lending portfolios.

The private sector needs to be better engaged to support technology DD&D. Private sector involvement can be encouraged through the development of incentives for companies. For example, market information that includes information about new project opportunities, potential projects and financing for projects can assist private sector companies in making investment decisions. Pre-feasibility studies can be undertaken and the information provided to potential investors. The establishment of business networks and transparent competitive solicitation processes can also promote private sector investment. Reducing the risks of investing in projects in developing countries is essential; requiring improved institutional and organizational structures, transparent legal and regulatory frameworks, and improved economic management.

Improvements to IPR in developing countries can assist in encouraging private sector investment for technology DD&D, although Kim (2002) reports that the effects of IPR on technology transfer vary according to a country's level of development and the technological nature of economic activities. Effective IPR regimes are important for countries with accumulated indigenous capacity with science and technology infrastructure; yet IPR protection can hinder technology transfer in the early stages of industrialization. This suggests that strict IPR regimes are most likely to promote private sector investment in technology DD&D in more economically prosperous developing countries. While the protection of IPR is noted as a means to promote technology development, specific guarantees with investors may also offer a means to protect product, process and trade secrets and encourage private sector investment in climate-friendly technologies.

The promotion of technology DD&D to developing countries will require new and additional financial resources that can benefit both the technology provider and the technology recipient. Cost-sharing may be one means to increase private sector investment. Establishing the right price signals that account for negative externalities for could also assist in opening up markets for climate-friendly technologies, which are often not the lowest-cost option.

3.2.3 Multilateral Financial Institutions and Export Crediting Agencies

Multilateral financial institutions and Export Crediting Agencies (ECAs) leverage substantial private sector investments. ECAs invest or indirectly support development activities that are considered too risky for the private and/or public sector. Investments in climate-friendly technologies may be eligible for support from ECAs, and there is opportunity to encourage coherence of these activities with global climate change goals through selectivity in the projects they support, the use of common approaches for evaluating the environmental impacts of projects and the introduction of energy efficiency and carbon intensity standards. The International Finance Corporation, which is the private sector arm of the World Bank, is increasingly supporting regional environmental business facilities, particularly small- and medium-sized businesses that are active in the areas of energy efficiency and cleaner production methods, and other carbon finance opportunities.

3.2.4 Actions under the UNFCCC

Technology transfer between developed and developing nations has been an important topic within international climate change negotiations and some developing nations refused to sign the UNFCCC and Agenda 21 until developed countries more clearly committed to supporting technology transfer. Thus, technology transfer has been an incentive for developing country participation in the UNFCCC, and increased access to technology will continue to play that role in a post-2012 world.

The EGTT has identified and is working to improve technology transfer, and developed countries have supported technology transfer activities through both multilateral and bilateral channels. GEF support has been provided for capacity-building, technology needs assessments and technology transfer, including projects activities in the areas of renewable energy, energy efficiency and energy conservation. At COP-10, developed countries pledged US$34.7 million to the SCCF to finance projects relating to adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification.

3.2.5 Policies and Programs at the National Level

The IPCC (2001) notes that a comprehensive set of actions is needed to promote technology innovation, development and deployment. Policies and programs at the national level can enhance technology DD&D, and national governments can use fiscal measures; regulatory policies; and information, labelling, voluntary and other assistance programs to enhance technology DD&D. Lempert *et al.* (2002) argue that government-funded research plays an essential role in developing new technologies and advancing new technologies to market readiness through such policies as tax credits, appreciated deceleration of investments reducing GHG emissions and government procurement of low-emitting technologies. Government policies can assist in reducing firms' uncertainty about new technologies and should be designed to enhance "learning by doing" to increase the likelihood that new technologies will be deployed during times of rapid capital turnover. Governments can also induce firms to retire old technologies through regulatory reform, infrastructure policies, and promoting information dissemination programs that encourage environmentally-conscious consumer demand.

The OECD and IEA (2003: 19-20) promote these and other policy tools, such as cooperating with the private sector to develop and diffuse new technologies, facilitating public-private and inter-firm collaboration, seeking out opportunities for international collaboration and providing access to "learning opportunities" (e.g., protected niche markets). To ensure the involvement of the private sector in technology DD&D in developing countries, activities such as fair trade policies, protecting IPR, diversifying forms of assurance mechanisms, reducing transaction costs of collaboration and increasing public access to information about technologies are necessary. Flannery noted key roles for the public and private sectors at the 2004 *IPCC Expert Meeting on Industrial Technology Development, Transfer and Diffusion* (IPCC, 2004: 7). He stressed the need for governments to establish enabling frameworks (including rule of law, protection of intellectual property and safe and secure environment for workers and communities) to allow the private sector to bear the risks and capture the rewards of deploying technologies.

3.2.6 Official Development Assistance

The issue of climate change would significantly benefit from a fuller integration into the mainstream activities of development agencies. While a number of focused activities have assisted countries with National Communications and National Adaptation strategies, linkages between climate change and poverty alleviation are still not fully appreciated. This is beginning to change and increasingly initiatives of development agencies support the mitigation of and adaptation to climate change. There is substantial room for ODA to contribute to technology DD&D through projects in the areas of energy infrastructure (including renewable energy), energy efficiency, transportation infrastructure, agriculture and forestry. ODA is particularly well positioned to assist in technology DD&D in areas where the private sector is not active, such as adaptation or in gaps in the financing supply chain that create blockages to the development of commercial operations. ODA can also be used to enhance enabling environments and provide capacity building to create the necessary foundation and absorptive capacity for successful technology DD&D. Capacity building can also assist countries in identifying new technologies for their specific needs and the benefits associated with new technologies, such as improved productivity, cleaner air and water and related health benefits. For technology DD&D to be effective, it must address broader economic development and quality of life concerns. Many countries are facing increased problems with environmental degradation (e.g., air pollution) and clean technologies could help to improve health conditions.

Consistent with the approaches discussed in the *Climate Change and Adaptation* paper (see page 57), technologies for adaptations are required that are appropriate to local circumstances. Strategies to support the DD&D of technologies for adaptation should be integrated with national plans to promote sustainable development, poverty alleviation and the Millennium Development Goals. The DD&D of technologies should

account for activities in various multilateral and bilateral frameworks to ensure that synergies are exploited. As well, many technologies for adaptation are or will be developed for tropical climates (e.g., agriculture and forestry techniques), indicating that opportunities for South-South cooperation should be identified and encouraged.

3.2.7 Summary

In summary, a number of strategies involving a variety of stakeholders can be used to promote technology DD&D. Successful mitigation of and adaptation to climate change will require linking technology DD&D with investment cycles and integrating climate-friendly technology options in ongoing investments. Such actions can be instrumental in inducing "leapfrogging" to best available technologies in developing countries to assist them in avoiding the polluting technologies of the past. This will require the establishment of an enabling environment that directs market forces to sustainable investment choices, which includes an appropriate mix of policy tools, human and institutional capacity, technology absorptive capacity and financing. Integrating new technologies through policy and practice is extremely important to induce staying power and move beyond a project mentality. Technology DD&D that builds on and complements the technology transfer work underway, could be encouraged under the post-2012 climate regime.

4.0 Options for Technology Development, Deployment and Diffusion in a Post-2012 Regime

A number of options for enhancing technology DD&D in a post-2012 regime have been put forward. This section includes a review of the literature regarding these options and presents a menu of options for technology DD&D both within the UNFCCC and beyond, but complementary to and supportive of, the objectives the Convention.

There is no one technology or action that will induce the required emission reductions to meet the goal of the UNFCCC, but rather a suite of actions is required—of which technology DD&D will be one component. It is important to note that the UNFCCC is only one of a number of actors promoting technology DD&D, which is a broad issue that encompasses not only climate change, but also economic development, poverty alleviation, sustainable development and energy security.

Philibert (2004:12) explains that actions to promote technology DD&D have the potential to ease barriers to strengthened emissions mitigation cooperation by promoting a deeper understanding of difficulties faced by countries, building confidence between countries, increasing the relationships between stakeholders in and between the various countries, and remaining engaged on common mitigation action even though countries may have difficulties agreeing on a global framework. Many experts (e.g., Sanden and Azar 2005; Buchner and Carraro 2005; Benedick 2001; Philibert 2004) agree that actions to promote technology DD&D will be most effective if they are a complement to a credible, global commitment to limit GHG concentrations. An exclusively technology-focused approach is unlikely to provide the emission reductions required, but should be considered as one component of a future climate regime.

4.1 Technology Agreements

Technology agreements and protocols are one option for promoting the DD&D of climate-friendly technologies. International commitments may relate to the use of common technology standards, such as energy efficiency standards for appliances, the prescribed use of low or zero-carbon technologies (e.g., minimum shares of renewable energy in energy production) or minimum standards for the energy efficiency of industrial processes or power plants. A number of proposals that could be developed under or outside the UNFCCC negotiating umbrella have been put forward regarding technology agreements and protocols. The main elements of key proposals are set out below.

4.1.1 Agreements for Technology Deployment and Diffusion

Barrett (2001) argues that common technology standards will provide incentives for investments in climate technology, as well as provide incentives for compliance and participation. He suggests that technology standards will be largely self-enforcing because if enough countries adopt the standards, other countries will follow common standards because of economies of scale in production and network effects. The most attractive approach would be to establish technology protocols in such areas as the use of hybrid engines, fuel cells or

standards for fossil fuel power plants to capture and store carbon. Barrett's proposal would have developing countries be bound by technology standards set out in separate protocols, but the diffusion of required technologies would be financed by developed countries, with contributions based on ability and willingness to pay as determined by the UN's scale of assessments.

Benedick (2001) proposes a portfolio approach that emphasizes long-term international standards and incentives for technology development and deployment that aims to promote a technological revolution in energy production and consumption. The approach includes the adoption of a portfolio of policies that would be coordinated with like-minded nations and include technology targets for power generation and fuel efficiency standards for automobiles. The portfolio would include a carbon tax to fund new technology research and a program funded by developed countries to promote technology transfer to developing countries.

Edmonds (1999) and Edmonds and Wise (1998) put forward a proposal for a technology backstop protocol, that would serve as a backstop in the event that other options (such as tradable permits) failed. A technology-based protocol would set out medium- to long-term international technology targets and/or standards for new fossil-fuel electric power plants and synthetic fuel plants installed in industrialized countries after 2020. Developing countries would be required to do the same upon reaching identified levels of development, defined as when their per capita income has risen to the average 2020 income level for industrialized countries in purchasing power parity terms.

Tol (2002) proposes a technology protocol that would specify the speed at which Best Available Technologies (BAT) standards would progress, with standards only applying to developed countries.

Ninomiya (2003) proposes an international agreement on energy efficiency levels in major emitting industries and energy efficiency standards for major appliances in the residential and transportation sectors. The proposed agreement would complement the Kyoto Protocol and aim at participation by developed and major developing (e.g., China, India and Brazil) countries. He suggests that a global R&D fund should be considered to support the development of appropriate technologies.

Sugiyama *et al.* (2003) suggest an orchestra of treaties, including three that are outside of the UNFCCC: a group of emissions markets to include countries with domestic emissions trading systems; a zero-emissions technology treaty (ZETT) to foster long-term technological change; and a climate-wise development treaty (CDT) to promote development, technology transfer and adaptation. The fourth block, which would be within the UNFCCC, includes protocols for emissions monitoring and information exchange and the establishment of a fund for capacity building for least-development countries and small island states. The ZETT is expected to include funding commitments for R&D, with a focus on zero-emitting technologies, while the CDT would modify flows of financial assistance to developing countries to ensure that climate issues are accounted for in development policy.

In summary, the proposed agreements for technology deployment and diffusion offer flexibility in the design of a post-2012 climate regime as such agreements could be undertaken under the UNFCCC or as a separate regime. Technology agreements could build on current initiatives such as the IEA implementing agreements or programs of the GEF, be developed between like-minded countries, or be set up to promote technology cooperation between developed and developing nations. Den Elzen and Berk (2005) note that technology agreements are easy to monitor, enhance technology spill-over and transfer, and encourage compliance through market forces. Weaknesses of this approach include uncertainty on environmental effectiveness, difficult negotiations, technology lock-in and the possibility of reduced incentive for technology innovation.

4.1.2 Technology Research and Development Agreements

Many experts have indicated that increases in R&D are critical to develop new technologies for a carbon-constrained future. Technology R&D agreements can be useful components of a future climate regime by enhancing the long-term perspective and effectiveness, and making use of market forces. Cooperation on R&D can allow participants to benefit from each others' efforts, help disseminate technologies, and reduce the costs of such efforts by sharing results and preventing duplication of efforts.

Barrett (2001) has proposed an international agreement on R&D funding as the "push" component to his proposal for agreements on technology standards. He proposes common research efforts for the development of climate-friendly technologies, whereby countries make a financial commitment to research programs based on ability and willingness to pay. Incentives for participation would include the sharing of R&D results among

participating countries only (e.g., through shared patents). Barrett proposes a research emphasis on electric power and transportation. Sanden and Azar (2005) put forward a similar proposal whereby R&D is supported through an R&D carbon levy of US$1 per tonne of carbon to raise revenues.

Similar to technology agreements to promote deployment and diffusion, R&D agreements offer potential flexibility in the design of a post-2012 climate framework as such agreements could be undertaken under the UNFCCC or as a separate regime. The strengths of R&D agreements, as noted by den Elzen and Berk (2005), include an enhanced long-term perspective and enhanced technological capacity in participating countries. The weaknesses include uncertainty on environmental effectiveness, lack of market incentives to apply technologies (indicating a need for deployment agreements) and the risk of selecting and promoting less effective technologies.

4.2 Sectoral Agreements

National or regional sectoral agreements could be related to limitation or reduction commitments for levels of GHG emissions or energy use. Watson *et al.* (2005) note that sectoral agreements could be designed to encourage climate-friendly investments in certain sectors, or to encourage the adoption of climate-friendly policies in a sector through taxes, standards or other regulation. Schmidt *et al.* (2005) explain that sector-based approaches can be developed in a variety of forms, such as "fixed-based limits, dynamic targets, benchmarked-based, harmonized policies and measures or combinations." Sectoral agreements could be global, defining commitments or targets for specific sectors such as cement or steel production. These types of targets could work for internationally-oriented sectors with a fairly limited number of actors, and the commitments could consist of emission limitations or reduction targets for the entire sector, or process-related targets such as the use of low-emission technologies. As well, country-wide sector targets could also be negotiated and, as an intermediate step in establishing sectoral targets, best practices with existing technologies could be used as a benchmark.

Jaccard and Mao (2002) provide examples of successful sectoral agreements, including the Renewable Portfolio Standard in electricity that requires electricity providers to ensure that a minimum percentage of electricity sold in the market is produced by wind, solar, biomass, small hydro or other designated renewables. The policy originated in the state of California and has been adopted by a number of jurisdictions in developed countries (Europe, North America and Australia). The Vehicle Emission Standard is focused on technologies and requires automobile manufacturers to guarantee that a minimum percentage of vehicle sales meet different categories of maximum emission levels.

Sectoral targets and commitments offer advantages when viewed in an international climate regime. Such agreements could be undertaken under the UNFCCC or as a separate regime, and could be voluntary or mandatory. Sectoral agreements may be easier to negotiate than other technology agreements, as they help to create a level playing field for international sectors, and could enhance technology spill-over and transfer. They are also suitable for developing countries as it allows them to address GHG emissions in a step-by-step manner. Weaknesses include the potential for carbon leakage to other sectors without targets if substitutes to the products are available (Aldy *et al.* 2003), and standards run the risk of being either unambitious or unachievable because regulators do not know the exact amount of improvement that is feasible.

4.3 Regional/Bilateral Technology Initiatives

Agreements to cooperate on climate technology are taking place outside of the UNFCCC, and a number of countries have signed bilateral agreements on technology and scientific cooperation. Buchner and Carraro (2005) note that the European Union cooperates on international science policy with more than 30 countries and is engaged in a number of technology agreements aimed at the improvement of energy technologies and climate-friendly production processes; the United States has signed various bilateral climate technology agreements (e.g., with Australia, Japan, Russia, Italy, India and China); and Japan has strengthened its role in climate cooperation with Asia, including a joint research initiative with seven developing nations aimed at providing technological assistance to these countries to reduce their GHGs in exchange for carbon dioxide emission credits.

The Asia-Pacific Partnership on Clean Development and Climate (signed by Australia, China, India, Japan, Korea and the USA in July 2005) aims to promote the development, diffusion, deployment and transfer of existing and emerging cost-effective cleaner technology and practices. This partnership is to be consistent with and contribute to efforts under the UNFCCC and will complement the Kyoto Protocol.

Regional and bilateral initiatives can promote technology DD&D between developed countries, between developed and developing countries and between developing countries. Support for South-South cooperation can be a cost-effective means of assisting developing nations. For example, considerable expertise in the area of bioenergy exists in developing countries and would be much more easily transferable than Northern solutions. Bilateral and regional technology agreements most likely would be complementary to the UNFCCC process, but proper reporting processes could ensure that the UNFCCC Secretariat or the EGTT is informed of activities and able to fulfil a coordination role to prevent duplication of efforts and encourage sharing of information and lessons learned.

4.4 Flexibility Mechanisms under the Kyoto Protocol

Technology deployment mechanisms exist under the Kyoto Protocol, including the CDM. Suggested enhancements to the CDM to encourage technology diffusion include an expansion to include policy-based CDM, sectoral crediting mechanisms, and the Japanese proposal regarding credits for technology. Sectoral crediting mechanisms would provide incentives for developing countries to develop national, regional or sectoral projects, based on the adoption of policies and measures, rather than project-based investments, to achieve emission reductions. Examples include the modernization of country's cement sector or reduction of emissions in the transportation sector. Policy-based CDM would grant credits to governments that enacted GHG-reducing policy reforms. A government might, for example, adopt a particularly strong efficiency standard in its building code, saving on the energy used in heating and cooling. The resulting emission reduction (or some portion of it) would be credited to the government. Japan plans to present a proposal at COP-11/MOP-1 in which industrialized nations would be able to transfer energy-saving technologies to developing nations as part of emissions quota transactions. The details of this proposal are not yet clear, but Japan is attempting to estimate the amount of credits that could be gained from technology transfer.

Joint Implementation (JI) also offers opportunities to encourage technology deployment between developed nations and economies in transition. Many Eastern European nations and former Soviet states view JI as a means to attract investment from OECD nations, as well as fulfil international commitments under the UNFCCC as they anticipate that their own countries and firms will be able to use part of the reductions to help fulfil their commitments. Many of the economies in transition aim to increase energy efficiency and reduce the environmental impacts of energy production and consumption, as many of these countries have severe problems with acid rain, urban smog and the health impacts of air pollution. JI may be able to assist with technology DD&D by encouraging projects in areas that may be difficult to secure financing (such as renewable energy and energy efficiency), and assisting in attracting private capital.

International Emissions Trading (IET) could also stimulate technology cooperation with and technology transfer to developing countries. Egenhofer and Fujiwara (2003: 53) argue that developing countries could import advanced technology on favourable terms if they agree to discount prices of emission allowances on sale. Hence an equal per capita emissions approach linked with IET could help developing countries strengthen their technical base. However, this kind of package would not benefit countries without excess emission allowances to sell or only with small emission allowances. Green Investment Schemes (GIS) also offer opportunities to encourage technology cooperation. These schemes could ensure that purchases of surplus emission allowances are directly linked to projects that generate real reductions. The idea behind GIS is relatively simple—revenues collected through IET could be earmarked for environmental purposes in the seller country, and the purchasing country could use it to promote appropriate climate-friendly technologies.

4.5 Technology Transfer

Technology DD&D could be encouraged through increased support for the framework for technology transfer established under the UNFCCC. This could assist in technology development and deployment in developed and developing countries by building on the work led by the EGTT in the areas of technology needs assessments, technology information, enabling environments, capacity building and mechanisms for technology transfer. Important work has been undertaken to identify technology needs and key stakeholders in the technology transfer process, develop a technology information system (TT:CLEAR), identify barriers and develop strategies for governments to overcome barriers, and build capacity to identify appropriate technologies for local conditions. These actions lay the groundwork for broader technology DD&D, including attracting private-sector investment.

Even if an international technology cooperation agreement were adopted, a large technology transfer role would remain, both to fulfil developed country obligations under Article 4.5 and to provide advice and support to developing nations in need, particularly the least-developed nations which are not well-positioned to attract private investment. Actions to promote technology DD&D that involve developing countries, such as international technology cooperation agreements, should build on the work of the EGTT.

4.6 Support for Technologies for Adaptation

While technologies for adaptation could be, and should be, included under broader technology agreements and in technology transfer efforts, specific actions have been recommended to support the DD&D of technologies for adaptation in a post-2012 regime. These options are described in Section 6.1 *Climate Change and Adaptation* (see page 57), and include:

- *Three Track Global Framework proposal* – includes an adaptation track that would build upon the Marrakesh Funds, be funded by industrialized countries and include compensation for damages;
- *Global Climate Agreement* – includes funding provided by Annex I Parties for building the adaptive capacity of vulnerable countries in line with the "polluter-pay" principle of the UNFCCC; support for capacity building in developing countries in areas such as development of sector-specific adaptation strategies; modification of GEF rules to better facilitate adaptation projects that provide local benefits and increase capacity to access to funding; and innovative insurance schemes; and
- *Broadening the Climate Regime* – puts forward an Adaptation Protocol designed to secure the transfer of funds and technology to those countries most vulnerable to the impacts of climate change.

4.7 Review of Options

The preceding discussion put forward a menu of options related to how the global climate regime can more strongly promote technology DD&D. Technology cooperation to support DD&D will be a long-term approach, but in the short term it may serve as a complement to other efforts to reduce emissions and adapt to the impacts of climate change. To create the required long-term effects, it will be necessary to start directing investment toward climate-friendly technologies in the short term and to persist with these investments thereafter. Moving forward in this regard could include a combination of approaches, as well as identifying options to build on work completed to date by building synergies with existing programs and institutions.

Technology agreements will be a critical component of any future climate regime if it is to be effective, irrespective of whether or not such agreements are better negotiated within or outside the formal parameters of the UNFCCC. Clearly, outside efforts are playing an increasingly important role: witness the many ongoing efforts, including: the G8 Action Plan on Climate Change; Clean Energy and Sustainable Development; the Asia-Pacific Partnership on Clean Development and Climate; implementing agreements of the IEA; and the Methane to Markets partnership. There is opportunity for technology agreements among regional or like-minded partners to create niche markets, which in turn can bring costs down and assist in diffusion to the rest of the world. A global framework under the UNFCCC that recognizes a variety of technology agreements could assist in legitimizing their activities and ensure recognition of DD&D actions under the agreements.

The most likely approach for the post-2012 regime to encourage technology DD&D would be the development of a technology agreement that includes developed countries in the short term, with economies in transition and developing countries having to satisfy the same obligations when they meet a certain level of development (e.g., per capita welfare as measured by purchasing power parity as set out by Edmonds and Wise 1998). For example, if developed countries adopted a technology agreement on stationary source standards commitments or a minimum share of renewable energy in energy production, it could create the critical mass to encourage global diffusion of technologies. Such a technology agreement could consider obligations for new investments in the medium term (up to 2020) and over the longer term (up to 2050).

A second viable option for the post-2012 regime would be an international R&D technology agreement, whereby developed nations commit to increase R&D spending and work in partnership with developing countries (an example is the Canadian government proposal that five per cent of R&D programs be done in partnership with developing nations (Anderson 2004)). Sectoral, technology cooperation and R&D agreements could be negotiated as an amendment to the UNFCCC, or alternatively be negotiated beyond the UNFCCC between like-minded countries as a demonstration of commitment to action to increase technology DD&D.

Technology DD&D is inherently a long-term approach, yet there are actions that can be undertaken in the short term. In particular, a viable alternative might be to seek agreement at COP-11/MOP-1 on the need to begin discussions on an agreement to promote technology DD&D and how such actions can be meaningfully reflected as part of the broader commitments in the post-2012 regime.

5.0 Key Questions for Discussion

Technology DD&D has the potential to assist in meeting the objective of the UNFCCC. A number of proposals and ideas have been put forward that could be further developed both within and outside of the Convention. To move forward on enhanced technology DD&D in a post-2012 climate regime, a number of key questions need to be considered:

- What is the best way to ensure that climate-friendly technology efforts are effectively complemented within and outside the formal UNFCCC negotiations?
- In that context, is there a more defined role for the UNFCCC in enhancing technology DD&D?
- What are the realistic elements of a technology approach? Is it a necessary but insufficient condition for developing an effective future regime on climate change?
- How can technology DD&D programs be integrated into, or designed to support, the UNFCCC, and where in the UNFCCC should this discussion take place?
- What international architecture would correct externality costs and account for the risks of GHG emissions to allow technology DD&D to take place on a global scale?
- How can technology agreements to promote DD&D be designed to best allow for the involvement of developing countries?
- Is there a role for technology cooperation beyond the UNFCCC, e.g., in the form of bilateral/regional initiatives or in the form of separate multilateral agreements?
- Would it be helpful as well to bring together the current international technology initiatives outside the UNFCCC under a technology umbrella? How do we ensure a source of funds for these initiatives?
- Is there a role for the WTO, regional agreements (e.g., NAFTA, ASEAN and EU) or multilateral institutions in actively supporting market-based policy frameworks (e.g., intellectual property protection and removal of foreign investment restrictions) that would encourage technology diffusion?
- Would a global fund to promote technology R&D with shared IPR be helpful in meeting technology DD&D goals?
- How can the human health benefits of new GHG technologies be used to promote international technology DD&D while potential health risks are minimized?
- How do we enhance and focus efforts on technology efforts related to adaptation?

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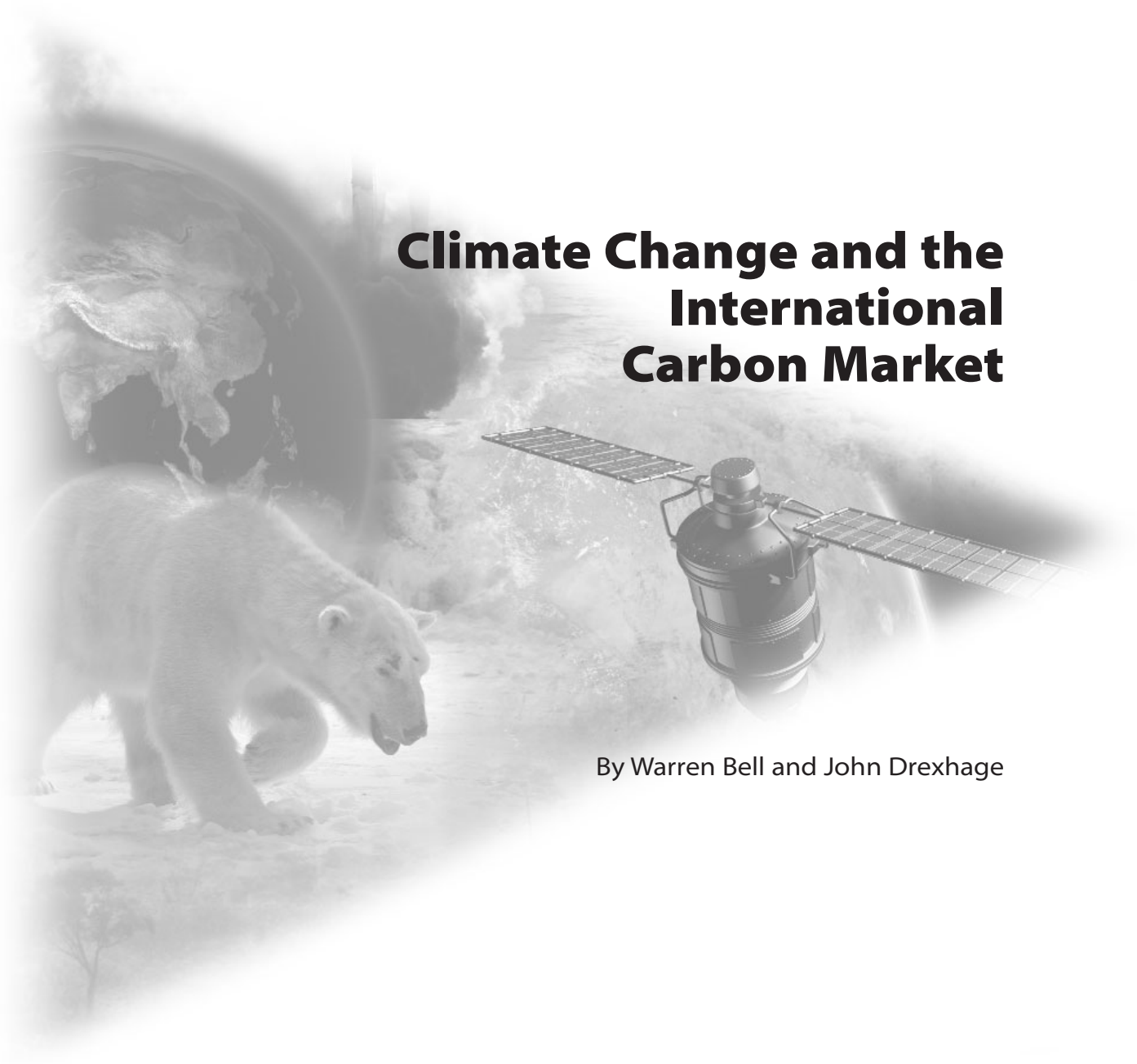
Annex A: Overview of Activities to Support Technology Development, Deployment and Diffusion

- Expert Group on Technology Transfer (EGTT) – established by the COP to enhance Article 4.5 of the Convention. The work focuses on five themes that are intended to be part of a strategy to create conditions for private and public technology transfer: technology needs assessments; technology information; enabling environments; capacity building; and mechanisms for technology transfer.
- Flexibility mechanisms of the Kyoto Protocol – can contribute to technology dissemination and transfer, with the Clean Development Mechanism (CDM) expected to assist with technology transfer to developing countries, and Joint Implementation (JI) expected to encourage technology deployment and diffusion between Annex I countries.
- Climate Change Fund, Adaptation Fund and Least Developed Countries Fund under the Marrakesh Accords – provide additional assistance for adaptation, technology transfer, energy, transport, industry, agriculture, forestry, waste management and broad-based economic diversification. These funds were designed to create conditions and leverage for private financing.
- Global Environment Facility (GEF) – as the financial mechanism for the UNFCCC, the GEF has given over US$1 billion for climate change projects, and its operating program No. 7 has as one of its objectives to reduce the costs of low GHG-emitting technologies by increasing their market share. The technologies emphasized in this program include photovoltaics, advanced biomass power, solar technologies, wind power, fuel cells, and advanced fossil fuel gasification and power generation technologies.
- IEA's implementing agreements (IEA) – includes more than 40 international collaborative energy research, development and demonstration projects (including technologies in the areas of energy end-use, renewable energy, nuclear fusion and fossil fuels, and agreements devoted to the dissemination of information).
- Climate Technology Initiative (CTI) – an implementing agreement under the IEA, the CTI was launched by OECD countries and the EU at COP-1 to accelerate the development, application and diffusion of climate-friendly technologies and practices, with an emphasis on technology transfer. Its work is closely linked to the UNFCCC process, and it is an important institutional means of implementing the work of the EGTT, including supporting technical capacity building in developing countries.
- G8 Agreement and Gleneagles Plan of Action on Climate Change, Clean Energy and Sustainable Development – reaffirms commitment to the UNFCCC and includes actions to promote the deployment of cleaner technologies and to work with developing countries to enhance private investment and transfer of technologies.
- G8 Action Plan on Science and Technology – includes a substantive section aimed at accelerating the research, development and diffusion of energy technologies.
- Renewable Energy and Energy Efficiency Partnership (REEEP) – is an international NGO organized as a private-public partnership that actively structures policy initiatives for clean energy markets and facilitates financing mechanisms for sustainable energy projects.
- UN agencies, including UNDP, UNEP and UNIDO – support technology transfer programs. Examples include UNEP's Global Network on Energy for Sustainable Development and the UNDP-GEF Technology Transfer Network.
- Multilateral institutions such as the World Bank, Asian Development Bank, OECD and others – develop and implement international technology cooperation programs.
- Bilateral programs on international technology cooperation – many are listed in national communications of the UNFCCC and include such initiatives as Canada Climate Change Development Fund, the US Climate Technology Partnership and the Netherlands' Miliev Programme that facilitates the purchase of climate-friendly technologies in developing countries by subsidizing a portion of the cost.

- Cooperation between like-minded nations – includes the International Partnership for the Hydrogen Economy; the Carbon Leadership Sequestration Forum; the International Thermonuclear Experimental Reactor; and the Methane to Markets Partnership. Many of these plurilateral initiatives are relatively new and have not demonstrated substantial outcomes to-date, often because they have not secured a permanent source of funding.
- The Asia-Pacific Partnership on Clean Development and Climate – signed in July 2005, this initiative (between Australia, China, India, Japan, the Republic of Korea and the United States) aims to create a partnership to develop, deploy and transfer cleaner, more efficient technologies and to meet national pollution reduction, energy security and climate change concerns, consistent with the principles of the UNFCCC. The partnership is intended to be a complement to the Kyoto Protocol.



Climate Change and the International Carbon Market

By Warren Bell and John Drexhage

1.0 Introduction

Political and business leaders have affirmed that an efficient and effective carbon market will be a critical element of the global climate regime.

In the Gleneagles Plan of Action on Climate Change, Clean Energy and Sustainable Development, G8 leaders supported a market-based approach to finance the transition to cleaner energy. The policy approach for reductions in greenhouse gas (GHG) emissions specifically flagged for further attention was "tradable certificates and trading of credits." Also given special mention were "project-based and voluntary offset mechanisms" (G8 2005).

In a statement just prior to the Gleneagles summit, the World Economic Forum's (WEF) G8 Climate Change Roundtable argued that "policy frameworks that use market-based mechanisms to set clear, transparent and consistent price signals over the long term offer the best hope for unleashing needed innovation and competition" (WEF 2005). The WEF Roundtable urged G8 governments to "establish a long-term, market-based policy framework extending out to 2030...." and "define greenhouse gas emissions rights through a cap-and-trade system or other market-based mechanisms...."

Why have market-based mechanisms, and emissions trading in particular, been singled out? Market-based approaches can enable governments to put in place systems to encourage innovation in industry while at the same time providing environmental certainty, credibility and cost-efficiency in meeting reduction targets. Under a global climate regime, market-based approaches have the potential to significantly reduce the costs and increase the feasibility of achieving the deep, long-term reductions required to address the risks of climate change. These approaches can also provide incentives for the development and deployment of low-carbon energy technologies and promote technology transfer to less-developed countries.

This paper examines how a future global climate regime might make the most effective use of market forces, including encouraging a robust and efficient international carbon market. While an efficient market offers a number of potential benefits, realizing these benefits will require countries to consider some key questions:

1. How can a long-term price signal be provided? Clear policy signals on the future of the climate regime are critical to maintaining a value for greenhouse gas (GHG) emission reductions and providing incentives to industry to invest in technologies and other reduction measures. The carbon market will significantly impact investment decisions only when a clear incentive for long-term action is established.
2. How can broader coverage and participation in the carbon market be achieved? How can the private sector be more fully engaged? The more sources included in the carbon market, the more efficient and effective it will be in minimizing costs and mobilizing investment.
3. How can monitoring, reporting and review systems be enhanced, especially in developing countries and economies in transition? Transparent, credible and efficiently-administered systems are essential for determining eligibility and compliance.

The measure of success for a global climate regime is not the existence of a carbon market, *per se*. The carbon market is a means rather than an end, and its success will be measured by how it assists countries in meeting their climate change and sustainable development commitments and priorities. For some, efficiency and cost minimization will be critical. For others, it will be equally important how the international carbon market helps to mobilize financing for clean technologies worldwide. This is especially important in major infrastructure investments that have long-lived emissions consequences.

2.0 Background

Market-based approaches, and especially emissions trading, have been central to the development of the global climate regime to date.

Two aspects of the climate change problem favour the use of market-based approaches such as emissions trading as a policy: First, GHGs mix uniformly in the atmosphere so that the location of emission reductions does not matter. Second, lowering the costs of emission reductions is extremely important, given the scale of global reductions likely needed to meet the ultimate objective of the UNFCCC. Market-based approaches recognize that con-

trolling emission sources, even within the same country or company, can have different costs. Emissions trading provides affected sources with flexibility and a choice of options for meeting their targets cost-effectively. This could entail implementing energy efficiency measures, adopting better control technologies or purchasing "reductions" from a source whose costs of reducing emissions are lower. Emissions trading encourages reductions to take place where they are the least costly, and offers the potential to significantly reduce the overall costs of meeting climate goals.

Emissions trading also supports the adoption of low-carbon technologies. The development, deployment and dissemination of technology are critical to achieving climate goals. Emissions trading can provide a market price incentive for the introduction of technologies that reduce emissions, and offers an important complement to other policies that promote technology development and transfer.

The emergence of international and domestic carbon markets in the past few years has mainly resulted from the framework established under the Kyoto Protocol (Protocol). The Protocol introduced three market-based mechanisms—international emissions trading (IET), Joint Implementation (JI) and the Clean Development Mechanism (CDM). The inclusion of these mechanisms played a significant role in the ability of Parties to ratify the Protocol and have become a key component for many countries in designing policy packages to meet their targets.

These mechanisms are also widely credited with helping to create a market value for GHG emission reductions and creating new markets and investment opportunities, even before the Protocol entered into force. This feature has been referred to as the "genius" of Kyoto (Cutajar 2004). The carbon constraints derived from the Protocol have resulted in the establishment of national and international trading schemes for private sector entities, such as the EU Emissions Trading Scheme (EU ETS). Other countries plan to implement such schemes in the coming years and means to link them are being considered. Separate from schemes that directly engage private sector entities, governments of Annex B countries that have ratified the Protocol are also active "buyers" in project-based activities under its CDM and JI mechanisms.

The new markets created by these international and domestic schemes are helping to mobilize public and private resources for investments in GHG mitigation.

3.0 The Emerging International Carbon Market

The current emerging international carbon market is not one market, but rather a mosaic of markets that includes allowance-based markets from international and domestic emissions trading schemes; credit-based markets related to the project-based mechanisms; and voluntary and sub-national trading markets. Many of these policies are at early stages of implementation. The different policy settings creating these markets and the outlook to 2012 are discussed below.

One common element across these differing markets is the unit of measure for the tradable commodity, with one unit being equal to one tonne of greenhouse gases measured in CO_2 equivalent. However, although the unit of measure is the same, the price of a tonne of CO_2 may vary considerably across different markets that are not directly linked, due to differences in supply, demand, compliance requirements and the nature of the commodity being traded. In markets where there is greater certainty about compliance requirements and allowance allocations (such as the EU ETS), the price of the commodity tends to be higher than for reductions from CDM and JI projects or in voluntary trading schemes. For example, the carbon price for an EU allowance in the first phase of the EU ETS (2005–2007) is now regularly around or over €20 per tonne CO_2.[1] However, prices in CDM and JI markets are generally quite a bit lower. This is in part because participants in these markets are engaging in forward transactions that entail assuming risks related to project viability and delivery. For example, ERUs from JI projects will not be physically available in the marketplace until at least 2008, and only if the host Party meets the eligibility requirements for trading. While the CDM will generate CERs before 2008, the first CERs were only issued in October 2005, and most transactions will continue to be for forward delivery. As more certainty evolves around JI and the CDM, and in particular the emission reductions associated with these projects, this is likely to be reflected in the price at which they are contracted and/or traded.

1 And has been as high as €29 per tonne CO_2.

The international trading system established by the Protocol will by and large remain dormant until 2008, the earliest date at which the trading of AAUs can occur. Over the next couple of years, the necessary infrastructure to support the market will need to be put into place. A number of the required bodies (the expert teams that will review countries' national inventory and registry systems as well as the facilitative and enforcement branches of the compliance committee) have yet to be established and countries must still put in place their national systems to meet the eligibility requirements for trading. The only component of the overall Kyoto "mechanisms" system currently functioning is the CDM which began operation in December 2001 (see discussion below). Because the CDM was the first Kyoto mechanism to be activated it has been the primary focus of many governments, industry and non-governmental organizations.

Although the Protocol system for trading AAUs and ERUs is not yet in place, an active international carbon market has emerged, particularly in Europe.

3.1 European Union Emissions Trading Scheme

The international carbon market is currently dominated by the EU ETS which began on January 1, 2005. This scheme is mandatory for all 25 EU member states. In a way, it can be seen as 25 fully-linked domestic emissions trading schemes with a common design and central coordination on some key aspects by the European Commission (EC). Countries likely to, or who are expected to, accede into the EU (e.g., Romania) will also be required to implement domestic trading schemes under the EU ETS. The EU ETS could also include European EFTA countries (Norway, Iceland and Lichtenstein). Norway has developed an emissions trading scheme compatible to the EU ETS and is in discussions with the EU on possible linkages.

In its first phase lasting through 2007, the EU ETS covers six sectors: electricity generation heat and steam production; mineral oil refineries; processing and production of ferrous metals; cement; bricks and ceramics manufacturing; and pulp and paper. Emission allowances are allocated by national governments to energy-intensive plants and installations based on a plan approved by the EC. In total, around 12,700 EU installations are to be covered by the scheme (representing approximately 40 per cent of EU CO_2 emissions). From 2008, the scheme will coincide with the Protocol's first commitment period, and will continue thereafter in five-year intervals.

The EU ETS, as currently defined, is an international emissions trading system but not a Kyoto Protocol trading system. Compliance units are EU allowances (EUAs), not AAUs.[2] Consequently, linkages have to be defined separate from the Protocol to allow the use of international units. Linkages to the Protocol's project-based mechanisms (JI and CDM) have already been established; CERs can be used from 2005 and ERUs from 2008.[3] The EU ETS also provides the possibility of linking with other trading schemes through negotiated agreements. Other linkages could potentially be made to allow "greened" and other AAUs as well as compliance units from domestic emissions trading systems in other jurisdictions into the EU ETS.

The EU ETS is a policy tool for managing emissions of firms in key industrial sectors. It does not control the possible buying and selling of allowances by individual EU Member States as they manage their compliance for 2008–2102 under the Protocol. The EU ETS is therefore only part of the overall international carbon market emerging in Europe. For example, a number of European countries are very active in pursuing credits from CDM and JI projects. They are also free to buy AAUs as well as units derived from land-use change and forestry activities even if private sector participants in the EU ETS cannot use them for compliance purposes.

3.2 Green Investment Schemes

Proposals for "greening AAUs" (also known as Green Investment Schemes or GIS) have emerged as a result of a desire on the part of some Annex I countries (primarily the EU, Canada and Japan) to enhance the political acceptability of purchasing AAUs from certain EIT countries when these are seen as deriving from the decline of their economies subsequent to the Kyoto target base year. Although there has been significant interest in GIS, the concept is not yet well-defined and, as yet, there is no real market for greened AAUs.

2 However from 2008, EUAs are also EU AAUs at the electronic serial number and registries level of detail. This means that the unit traded will have markers that identify both its EUA and AAU status. This will ensure easy tradability under the Kyoto Protocol if the political/policy framework is in place at the domestic level.

3 There are some limits on the types of credits that can be brought into the EU ETS. CERs from land-use change and forestry projects are not eligible for entry during the first trading phase, but CERs and ERUs from these projects may be eligible in the 2008–2012 period.

In simple terms, GIS involves ensuring that revenues from the purchases of surplus AAUs are directed to projects that generate real environmental benefits. Green Investment Schemes are not a defined element of the Kyoto Protocol, but are a preference on the part of buyers and, consequently, there is no formal or widely agreed definition of "green credits." A distinction is sometimes made between "hard" greening, defined to include only activities or projects that lead to GHG emission reductions that can be directly quantified, and "soft" greening, which includes activities for which GHG emission reductions are not easily quantified.

In the "hard" greening scenario, there is a direct relationship between the quantity of emission reductions generated by the activity and the corresponding number of AAUs that are greened. The project-based nature of hard greening means that monitoring, reporting and verification processes similar to those introduced for JI or the CDM would be required.

So-called "soft" greening includes a wide range of policy, program, technology and capacity-building initiatives that are not easily quantified in terms of emission reductions, but which may contribute significantly to action on climate change in the host country.

A greened AAU transaction also allows for considerable flexibility in the timing of the exchange of AAUs, the disbursement of funds and the resulting emission reductions. This means that it is possible to target activities that may not necessarily achieve near-term measurable reductions, but which make significant contributions in the medium or longer term.

A key requirement of any greening scheme will be strong oversight and administration to ensure that the proceeds of AAU transactions are invested in projects that reduce emissions.

3.3 Joint Implementation (JI)

Trading under JI does not formally begin until 2008, although JI projects could have begun in 2000. Some JI projects are already under development and a forward market for Emission Reduction Units (ERUs) from JI projects is emerging. The main buyers are governments in the EU and Japan; carbon funds such as those under the World Bank; and private entities covered by the EU ETS, which allows ERUs to be used for compliance beginning in 2008.

JI has two "tracks." Where a host country has met all of the requirements for eligibility to participate in international emissions trading, trades under Track 1 JI are possible. Under Track 1, the decision about how many ERUs a project has generated is the responsibility of the countries involved. If only a smaller subset of the eligibility requirements are met, the project has to go through Track 2 JI, a process somewhat akin to the CDM, and the number of ERUs generated will be verified through this process.

Some countries are focusing their attention on meeting the requirements for full mechanisms eligibility; others are choosing first to prepare for Track 2 JI. Eligibility for Track 2 JI will be easier to reach, and will allow countries to engage in some trading while completing the requirements for full eligibility.

3.4 The Clean Development Mechanism (CDM)

In the three-and-a-half years since the adoption of the Marrakesh Accords in 2001, the majority of experience with the Kyoto mechanisms has been gained in the CDM. This experience relates to project development and the regulatory processes required for registration as CDM project activities, such as the methodology approval process, accreditation of Designated Operational Entities (DOEs) and the project registration process.[4] In October 2005, the final phase of the CDM project cycle, verification of emission reductions and issuance of CERs, became operational.

Important financial flows into host countries are expected to take place as a result of CDM activities; to date more than US$800 million has been allocated to carbon funds or CDM/JI programs. Together with private and other sources of funding, the OECD conservatively estimates financing for CER purchases under the CDM to 2012 at roughly US$1 billion (Ellis *et al.* 2004).

The CDM is the most fully developed of the three mechanisms and the most complex. While the mechanism has made considerable progress since its inception, stakeholders in the CDM have raised concerns over the

4 The first methodology was approved in September 2003. The accreditation procedures were adopted in January 2003.

efficiency and cost of the process. However, given the project-specific nature of the CDM, the necessity to ensure environmental integrity of the system and a steep learning curve by all stakeholders, a rigorous process has been needed. It is also important to note that the Executive Board has instituted measures designed to speed up decisions and reduce their backlog of work.

The CDM has also been burdened by potentially unrealistic expectations about what it can deliver, in terms of the potential size of the market and the ability to bring about major changes in developing countries. Project-based mechanisms are, by their nature, more administratively demanding and costly than cap-and-trade. These limitations, in turn, restrict the ability of project–based mechanisms to effect the types of infrastructure change and technology shifts that many non-Annex I countries, in particular, had hoped to achieve through the CDM.

In the current carbon market, prices for emission reductions from CDM projects are influenced by expectations about the ability of projects to attain status as CDM project activities and the future delivery of CERs. Because the emission reductions related to the projects are subject to a great deal of risk, namely that they have not undergone registration and verification procedures, these reductions tend to have a low purchase price. Of greater concern, however, is that without a clear signal from policy-makers on post-2012, the CDM will likely experience a loss of interest from carbon investors given the lead time required in developing and implementing a project. As a result, the CDM is expected to begin experiencing a significant slow down of activity in the near future.[5]

The majority of CDM issues facing Parties today relate to strengthening and streamlining the CDM over the next couple of years. The CDM Executive Board is also faced with addressing a number of issues with implications for the commitment period and the post-2012 period. This includes the type and scope of projects eligible under the CDM. Considerable interest has been expressed by stakeholders in developing projects based on either a policy initiative and/or a sectoral baseline, and the CDM Executive Board is in the process of examining a potential CDM project based on a policy initiative (a proposal by Ghana for generating certified emission reduction units (CERs) through a policy-based initiative focusing on energy efficiency standards). If projects such as these are deemed eligible by the Executive Board, then the CDM may be able to adapt to the needs of both developing countries and potential buyers of CERs without significant structural changes occurring through international negotiations. This will be key to the future success of the CDM. For the CDM to grow, both in its contributions to GHG reductions and to the development priorities of developing countries, it will need to broaden its scope beyond the current project-based framework.

3.5 Domestic Emissions Trading

While the Protocol establishes a framework that enables an international carbon market in general, and international emissions trading in particular, it is the domestic policies of countries that allow for the connection of their industries to this market. The EU ETS and its Linking Directive is the most striking example of this point. Domestic schemes can also be constructed to manage emissions without international linkages.[6] Generally, however, the larger and more interconnected the market is, the greater its efficiency and effectiveness in minimizing costs and mobilizing investment.

Domestic emissions trading systems of various forms are being implemented by a number of countries to help meet their Kyoto commitments. Each of these trading schemes will require decisions on the mechanism, if any, for linking with international and other domestic systems.

- The U.K. launched a GHG emissions trading scheme in 2002 as a main feature of its Climate Change Programme. This scheme had two key elements. The first provided an exemption to the climate change levy (tax) for firms adopting an intensity target. The second was a voluntary trading program open to all U.K.-based legal entities with direct or indirect GHG emissions not covered by other

5 Developing a CDM project activity requires at least a two-to-four-year lead time, and large infrastructure projects can take as long as three to seven years from identification of the project to issuance of CERs. According to the *State and Trends of the Carbon Market 2005*, this means the window of opportunity for most project types closes in 2006.

6 The viability, effectiveness and efficiency of these "closed" systems will depend largely on their scale and coverage. For example, an emissions trading scheme covering just the major power and industry sources in (some) individual U.S. states can be more effective than one covering all sources in some whole countries, albeit they may not signal the same carbon price.

agreements or directives. The targets under this second element were fixed. A unique "gateway" feature connected the two elements to manage concerns about the linking of fixed and intensity schemes. The U.K. scheme is now going through a rollover process to the EU ETS where the coverage of sources is the same.

- Canada's plans are for an emissions trading program that will cover GHGs from large industrial emitters responsible for approximately half of national emissions. The system is intensity-based, with an overall goal of improving carbon efficiency by 15 per cent. The government has also committed to provide a price assurance mechanism to ensure that large emitters will be able to meet their regulatory obligations at a cost of no more than CDN$15/tonne for the period 2008–2012. A unique element of the Canadian system is its large provision for domestic offsets.
- While Japan has yet to decide whether to implement emissions trading in its domestic policy mix, both the Japanese government and its major industries have been significant early participants in the CDM, GIS and JI credits market (as buyers).
- New Zealand has developed a domestic projects-based scheme using the incentive of internationally tradable Kyoto units (AAUs or ERUs) for reductions that will lower its emissions in the 2008–2012 period. Kyoto-style trading flexibilities are also provided to competitiveness-at-risk emissions-intensive firms that take on best-practice-based emissions baselines and thereby get an exemption from a carbon charge. From 2008, these flexibilities include trading in Kyoto units. New Zealand has also flagged that it may move to a fuller domestic emissions trading scheme instead of the carbon charge.
- Switzerland has legislation in place that allows emissions trading by large industries beginning in 2008.

GHG emissions trading systems unrelated to the Protocol are also emerging:

- In the U.S., under a Regional Greenhouse Gas Initiative, 11 northeast states are heading towards an emissions trading system to manage CO_2 emissions in the power sector. There are also markets for carbon offset credits that derive from utility regulatory requirements in some states (e.g., the approval of new fossil-based power plants). The Chicago Climate Exchange (CCX) is a voluntary industry GHG trading pilot program for emission sources and offset projects in the United States, Canada, Mexico and Brazil.
- In Australia, state governments have recently announced their intention to establish a state level-driven national emissions trading program covering major power generation and industry sources. New South Wales already has a "baseline and credit" carbon trading market for electricity retailers under the Greenhouse Benchmark Scheme.
- To cater to the interest in "carbon offsets" of a growing number of corporate and government buyers worldwide (in both compliance and non-compliance markets), a number of international organizations offer carbon offsets from project-based forestry and/or energy initiatives.

3.6 Carbon Market Prospects to 2012

Several key messages can be drawn from the foregoing discussion on the current and emerging international carbon market:

- Rather than a single carbon market there is a number of markets that differ in timing, location, relationship to the Protocol and their compliance-based versus voluntary nature. While the underlying commodity may seem the same (e.g., tonne of CO_2 equivalent), the buyers, sellers and carbon prices can be quite different. The dominant market is that created by the EU ETS, which from 2008 is also connected to Kyoto compliance. There is also an active Kyoto compliance market now, mostly involving the governments of Annex B countries (as buyers) through the CDM and JI project-based mechanisms
- Whether and how any of these markets begin to merge depends on whether linkages are forged through international and domestic policies. Some connections have occurred through the Kyoto Protocol and the Linking Directive of the EU ETS. But there are gaps; for example, the EU has yet to establish links that allow the private sector entities in the EU ETS to directly participate in international emissions trading, as defined under Article 17 of the Kyoto Protocol.

- Only a relatively small percentage of GHG emission sources in industrialized countries are covered by a trading-based market mechanism linking them to a common international carbon market. While some regional initiatives in the U.S. and Australia are emerging, no U.S. or Australian emissions are currently linked. The EU ETS and Norwegian emissions trading scheme covers CO_2 only, but not the transport sector or LULUCF (sinks or sources). In 2006, the EU will consider whether to examine the scope of the EU ETS to include additional gases and sources. Other Annex B countries have yet to implement emissions trading schemes, although some plan to do so. The opportunity for achieving the potential efficiency (i.e., least cost) and effectiveness (e.g., mobilizing investment) attributes of a global trading scheme is, therefore, commensurately limited.
- Capacity-building efforts are likely needed to help some IET countries implement the necessary national inventory systems for eligibility to participate in the Kyoto mechanisms.
- The CDM is a critical first step and is the only Kyoto flexibility mechanism that engages developing countries. While there have been some start-up problems, most of these can be addressed prior to 2012. In the longer term, the CDM is somewhat constrained by its project-based framework. A broader scope and/or complementary approaches are likely to be needed for the carbon market to be effective in influencing large-scale capital infrastructure investments in developing countries over the next 20 years.
- Current carbon markets all suffer from the lack of certainty about the role of emissions trading-like market mechanisms in any international climate regime post-2012.

4.0 Beyond 2012 – Issues and Options

Within a short period of time, the international carbon market has started to take shape. As domestic and international trading schemes continue to come online, the market is likely to become more liquid and stable. However, if the carbon market is to play a significant role in helping to achieve the deeper reductions from current emission paths required over the next 20 years, decision-makers will need to consider how best to broaden and deepen the reach of the market. Experience to date and our understanding of the nature and limitations of emissions trading and project-based mechanisms suggest that several key issues will need to be addressed.

First, countries need to consider how to better engage developing countries in the carbon market in a way that supports the transfer of low-carbon technology and investments in sustainable energy and other sectors. In particular, the engagement of less advanced developing countries in the carbon market needs to be supported. The CDM is currently the only mechanism for developing country participation in the carbon market. Options could be explored to expand and complement the CDM in a way that recognizes the differing national circumstances of countries.

Second, the uncertain cost of emissions abatement presents a barrier to both broader participation and deeper reductions. Options to manage cost uncertainty without compromising long-term emission reduction goals should be examined.

Third, domestic policies such as domestic emissions trading systems or crediting mechanisms are needed to enhance the participation of the private sector in the international carbon market. These domestic systems or schemes also determine the extent of coverage of the carbon market and the number of sources that face a common price signal. The efficiency of the carbon market and the opportunity to minimize costs depend on linkages between these domestic trading systems. Countries need to consider how best to link systems while addressing national circumstances.

Fourth, in order for the carbon market to impact investment decisions, there must be some assurance that there will be a value for emission reductions beyond 2012. Since the value of the commodity traded in the international carbon market is entirely based on policies adopted by governments, the market requires a clear signal on the longevity of the limitation and reduction targets by policy-makers. These signals affect not only emissions trading schemes but also project-based mechanisms like the CDM. At this stage, aside from the EU's decision to continue the EU ETS beyond 2012, there is little certainty about the path that international climate change policies will take. Countries may want to consider whether and how an early signal might be provided.

4.1 Policy Options for the Post-2012 Carbon Market

The issues identified above suggest that there is a need for increased flexibility in the face of cost uncertainties and the requirement for broader participation and greater reductions. This section discusses a range of options to increase flexibility and address cost uncertainties: dynamic targets; time flexibility; non-binding targets; price caps; and sectoral approaches. These could modify or complement the current system of targets and mechanisms under the Kyoto Protocol.

Dynamic (intensity) targets

Dynamic or intensity targets are indexed to an agreed variable, such as actual economic growth. Assigned amounts would be adjusted up or down if growth is higher or lower than expected. Although sometimes proposed as a mechanism for accommodating growth, intensity targets and absolute targets can both be defined to address economic growth. Dynamic targets address uncertainty related to economic growth, but not uncertainty associated with other factors (Ellerman and Wing 2003; Pizer 2005; Dudek and Golub 2003). Whether or not intensity targets are more effective at reducing cost uncertainty than absolute targets is likely to vary among countries depending on the specific relationship between emissions and economic growth. Many of these concerns are particularly relevant to developing countries where wide fluctuations in GDP have occurred, and can be expected to occur, for macroeconomic reasons (e.g., exchange rate fluctuations, international market prices for agricultural goods, etc.) that do not have commensurate effects on emissions. Although assigned amounts are not known until after the end of the commitment period, dynamic targets can readily accommodate emissions trading. For countries, the true-up period provides an opportunity to adjust holdings of Kyoto compliance units.

Temporal flexibility

In addition to providing flexibility in the location of emission reductions, emissions trading can also provide significant temporal flexibility. Experience from some emission programs (e.g., California's RECLAIM) suggests that flexibility in timing can limit price spikes and reduce cost uncertainty (Egelston and Cohen 2005). The Protocol allows emissions to be averaged over a five-year period—essentially allowing banking and borrowing within the first commitment period. Compliance units can also be banked into (but not borrowed from) future compliance periods (Article 3.13). Increased temporal flexibility could be provided by longer compliance periods, but this advantage would need to be weighed against the risk of undermining the environmental objective if sources could defer abatement indefinitely. This risk is more severe in the international arena when participants are sovereign countries and compliance mechanisms correspondingly weaker. The ability to take advantage of flexibility in timing might also be enhanced by greater certainty about future commitment periods, for example by establishing a series of five-year commitment periods over a longer timeframe (e.g., 15–20 years).

Non-binding targets

Emissions do not actually need to be capped for trading to take place. Not all parties need to be potential buyers; some could be only potential sellers to the international carbon market. Potential sellers (developing countries) could adopt voluntary non-binding negotiated targets (also referred to as "no lose" targets) (Philibert 2000; Bodansky 2004; Grubb 2004; Philibert *et al.* 2003). Targets could be set at a national or sectoral level. Credits would be generated and sales would occur only if actual emissions were below the target. The risk of overselling could be limited by making countries responsible for buying back any allowances they had oversold at the end of the commitment period. A commitment period reserve could also be used to reduce the likelihood of overselling.

Non-binding targets directly address concerns about cost uncertainty and may enable countries to take on more ambitious targets. Non-binding targets could also provide incentives for developing country participation. In particular, non-binding country-specific sectoral baselines could be attractive to developing countries seeking to attract major investments in clean technology that fit with their sustainable development priorities, for sectors and sources where a project-based mechanism is less applicable.

Price caps (safety valves)

A safety valve mechanism involving a maximum price on allowances could limit costs and also cost uncertainty. Two approaches have been proposed:

- economic agents (or countries) buy allowances at a fixed maximum price from an international body; or
- economic agents within countries buy price-cap allowances from their own governments.

Issues and implications for emissions trading include the process for setting the price cap, how it links with regimes with different price caps and the disposition of revenues if an international body sells price cap allowances. Revenues could be used to fund adaptation or technology research and development.

Sectoral approaches

Sectoral approaches are the focus of growing international interest (Samaniego and Figueres 2002; Bosi and Ellis 2005; Watson *et al.* 2005). While broad coverage is important to maximize the efficiency of an emissions trading system, there are a number of reasons why an approach that focuses on a limited number of sectors may be appropriate for inclusion in a future climate regime. From a policy, institutional and economic standpoint, it may be more practical for many countries to start on a sectoral basis than through a national approach. Only a few key sectors (e.g., electricity production and land-use change and forestry) account for the majority of emissions in many countries. Building technical capacity and developing and collecting the necessary data (for inventories and projections) may be much more manageable at a sectoral level. At the same time, adoption of a sectoral approach could support the broader enhancement of emissions monitoring and reporting systems in developing countries.

Sectoral approaches could be fixed or dynamic, and binding or non-binding. Examples include:

- **Sectoral policy-based crediting** would generate credits for adopting and implementing climate-friendly policies in particular sectors. As already mentioned, a first step toward policy-based crediting has already been taken under the CDM. A project involving the introduction of energy efficiency standards in Ghana is under review. If successful, this could lead to a broad range of policy-based CDM projects. This approach also addresses concerns about possible policy disincentives created by the CDM.
- **Country-specific dynamic sectoral crediting baselines** could allow developing countries to focus attention on key sectors where investment is in tandem with priorities, e.g., financial assistance for clean technology in major infrastructure projects such as electricity generation and transport systems. This focus also extends to the monitoring and inventory systems needed to cover full sectors rather than individual projects, as with the CDM.
- **Transnational sectoral targets** could be developed for energy-intensive industries subject to international competition (e.g., aluminum, aviation, marine). This approach could be seen as a more effective way of controlling emissions of energy-intensive countries or countries with energy-intensive sectors while addressing competitiveness and leakage concerns. Transnational sectoral targets could co-exist with country-wide targets for some or most industrialized countries, in which case transnational obligations would substitute for allocation of national allowances to companies in that sector.

As noted above, these options are likely to complement or modify the existing Kyoto mechanisms. No matter how comprehensive the coverage of targets is in a future regime, there will likely be some countries, sectors and/or sources that are not covered but would be amenable to a project-based mechanism. The dual purpose of the CDM will likely continue to be very important as well, ensuring that CDM projects contribute to host country sustainable development. There may also be opportunities to expand the scope of the CDM. One option, policy-based crediting, is already being explored. If sectoral crediting baselines are included in a future climate regime, consideration will need to be given to whether the CDM or a new process is the appropriate vehicle for implementation. Another approach to broadening the CDM would be to allow wider scope for the inclusion of land use and land-use change activities; this could enable a larger number of countries to participate more actively in the CDM.

There may also continue to be a significant role for a second track JI-like mechanism post-2012 if some countries are unable to meet emissions trading eligibility requirements. The opportunity to link purchases to specific reduction or removal projects may also continue to be important to some buyers, especially if the domestic emissions trading system in the seller country is small or non-existent.

4.2 Linking Emissions Trading Systems

The development of a global emissions trading regime could result from future agreements within the UNFCCC or from the "bottom-up" linkage of several trading schemes, or a combination of the two. In general, a globally linked system of markets is desirable because it creates a larger, more liquid market and so should generate bigger cost savings

The Kyoto Protocol's national emission limits, emissions trading and project-based mechanisms provide a direct and relatively straightforward option for linking domestic systems, but other bilateral and multilateral approaches are also possible both within and outside the framework established by the Protocol. The EU Linking Directive has already established linkages between the EU ETS and CDM/JI and the possibility exists that further linkages may be established.

A future global climate regime may include a variety of different types of national and sectoral targets and crediting mechanisms, and this raises questions about the feasibility and desirability of linking different types of trading systems. Merging or linking systems with different types of targets is technically possible from an overall economic perspective, although there can be implications for output, overall emissions and thus, potentially, for environmental integrity. Difficulties can arise when linking an absolute and a rate-based permit trading regime, and also when linking trading regimes that have different monitoring, accounting and enforcement systems. If, for example, one regime does not include adequate monitoring of emissions, a source could sell unqualified allowances resulting from inaccurate GHG monitoring to others, undermining the environmental integrity of the regime. However, studies of the feasibility of linking trading programs generally find that it is technically possible to link programs with different designs. Only a few provisions have the potential to create problems (e.g., different safety valve prices) (Blythe and Bosi 2004; Baron and Bygrave 2005; Philibert and Reinaud 2004).

4.3 Possible Elements of a Framework

In order to have a robust and efficient post-2012 international carbon market that is able to deliver on world leaders' expectations and drive investment decisions, there must be demand. Fundamentally, this requires quantitative emission limits, in one form or another.

Related, and equally critical, is the role of participation. The greater the participation of countries and/or coverage of key sources and sectors, the more likely the framework will address competitiveness and leakage concerns. These concerns have contributed to the limited participation of countries in the Protocol's first commitment period. Participation also affects other important attributes of a successful climate regime: environmental effectiveness, cost-effectiveness and political acceptability.

The development of a wider array of options could allow different countries to adopt different policies to address their national circumstances. This could lead to a flexible international framework with a variety of elements linked through an international carbon market.

At an international level, elements in such a framework might include, for example:

- binding fixed emission limits for industrialized countries;
- for industrialized countries unable to agree to the above, binding fixed or dynamic emission limits for some sectors in some regional groupings—or possibly economy-wide binding dynamic emission limits;
- binding transnational sectoral emission limits (fixed or dynamic) for some key sectors represented by multinational "operators" such as cement, steel and aluminum;
- individually customized, voluntary, non-binding baselines for specific sectors to generate credits, while attracting investment in key sectors of developing countries; and
- a project-based crediting mechanism to provide coverage of emission reduction and sink enhancement activities not already covered by other market-based mechanisms.

These options are complementary rather than exclusive. They could be simultaneously implemented, with different countries selecting different policies according to their national circumstances. This would acknowledge a main lesson from the Kyoto process that countries around the world differ widely and may need different forms of commitments.

While an international framework is essential, the ability of the international carbon market to minimize costs and mobilize investment will also depend on private entity participation. Countries will need to consider how best to engage the private sector in the carbon market, for example through domestic emissions trading schemes or crediting mechanisms. Countries will also need to consider appropriate linkages to enable private entity involvement in the international carbon market.

4.4. The Need for an Early Signal

In order for the international carbon market to have an impact on investment decisions related to long-lived capital stock—energy and transportation systems—the price signal must extend beyond a few years. In particular, the flow of investments through the CDM is likely to diminish significantly over the next couple of years unless there is a clear signal that emission reductions will have value after 2012.

Clearly, it is difficult to provide much assurance at this stage concerning the form of any post-2012 climate regime. However, a clear indication of willingness by countries to work towards maintaining a functioning carbon market beyond 2012 will be an important first step.

Perhaps more important, individual countries that implement domestic emissions trading systems can send a clear signal through policy or legislation that the systems will continue beyond 2012. The EU has already signalled that its ETS will continue beyond 2012 and Canada has indicated its intent to establish longer-term targets for large emitters beyond 2012; other countries could follow.

4.5 Institutional and Capacity Needs

Broadening and deepening participation in the carbon market will also require that countries put in place the necessary infrastructure and institutions. The ability of economies in transition and developing countries to participate effectively in the international carbon market will depend to a great extent on building institutional capabilities to enable transparency, accurate monitoring and reporting, and legal systems. This is not an insignificant task, and some countries may be unable to put systems in place in time for eligibility to participate in international emissions trading at the beginning of the first commitment period. This challenge is likely to persist, and there is a clear case for capacity building being a focus of international collaboration with economies in transition and developing countries. Capacity building should address the wider set of institutional issues associated with GHG emissions management including, but not limited to, implementation of emissions trading.

The introduction of sector-based approaches, particularly in developing countries, may also support the enhancement of data collection and inventory systems for key sectors, but will certainly need to be complemented by additional capacity-building support.

5.0 Moving Forward

The last few years have seen the emergence of an entirely new market, one that creates value for GHG emission reductions. A robust and efficient carbon market can play a significant role in a future global climate regime by helping to minimize costs and mobilize worldwide investments in the low-carbon technologies needed to achieve deep long-term GHG reductions. Broadening and deepening the emerging carbon market to achieve these benefits may require countries to consider a range of market-based options to address differing national circumstances, support economic growth and minimize cost uncertainties. The effectiveness of the carbon market in mobilizing investments in long-lived capital stock also depends on policies that ensure long-term value for emission reductions. Countries will need to consider how best to provide an early signal that reductions beyond 2012 will have value.

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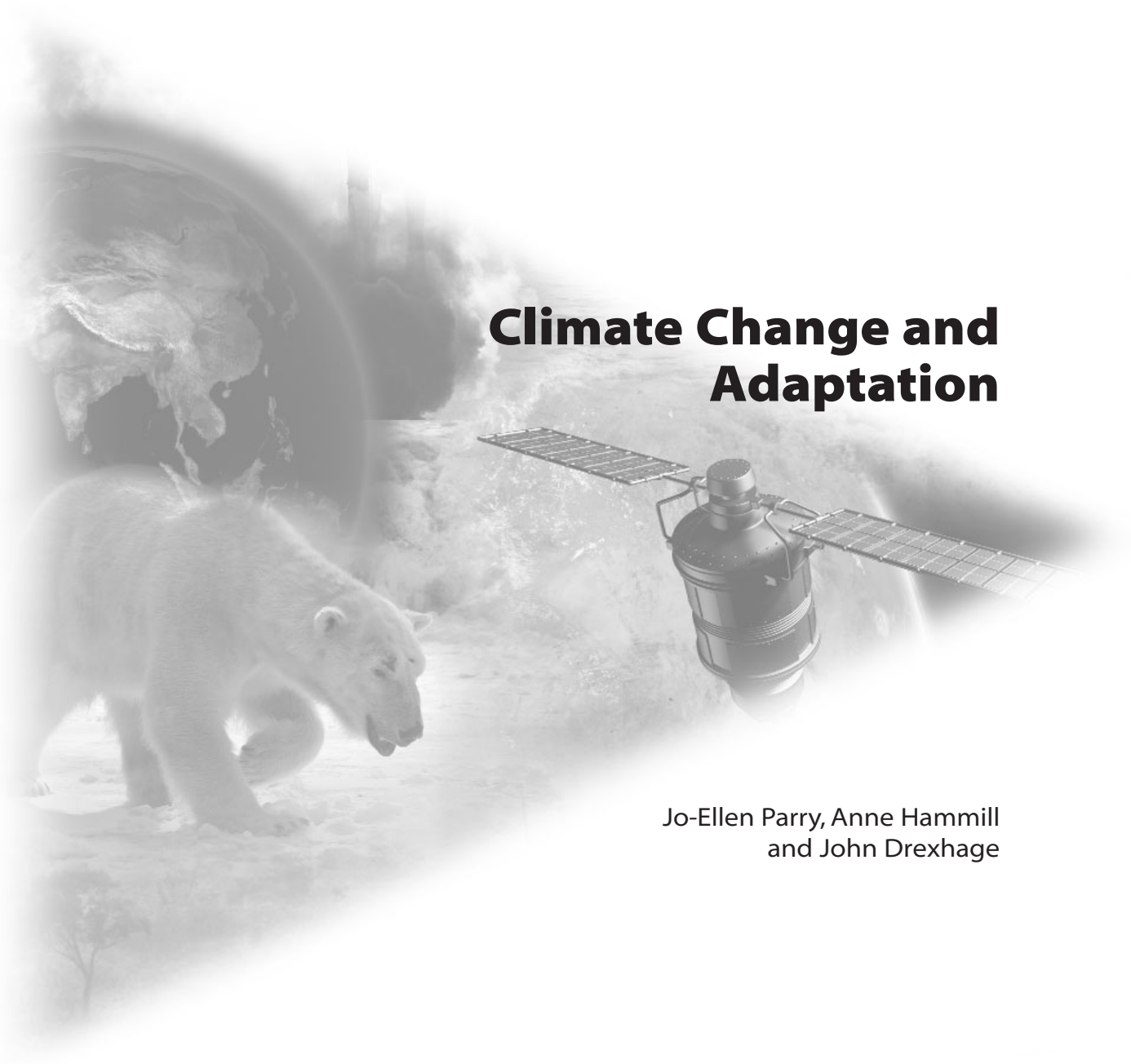

Climate Change and Adaptation

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1.0 Introduction

In preparation for its Presidency of the Eleventh Conference of the Parties (COP-11) to the United Nations Framework Convention on Climate Change (UNFCCC), the Government of Canada has identified four issues that should influence the creation of an effective and inclusive international climate regime over the long term. The fourth of these issues explores the following line of inquiry: How should adaptation to a changing climate be more fully integrated into development policies and funding instruments?

The adaptation line of inquiry reflects the international community's growing need to prepare for and respond to the impacts of climate change, and the corresponding recognition that any future global climate regime will need to address adaptation in a more prominent manner than in the past. It also reflects a growing international awareness that the most effective way to respond to the predicted impacts of climate change is to integrate adaptation considerations into core policy- and decision-making processes. Defining a new approach to addressing adaptation in a post-2012 regime will be challenging, in part because the international community is only beginning to understand how to effectively respond to the complex socio-economic and environmental impacts that will result from climate change. Adaptation to human-induced climate change is a new process for all countries—developing and developed—and concrete experience in applying an integrated approach to adaptation is limited.

The pages that follow provide a brief summary of research and policy developments relevant to determining a long-term, integrated approach to addressing adaptation. Section 2 provides an overview of some of the key factors and ideas influencing current approaches to climate change adaptation. It outlines present and anticipated physical and socio-economic impacts of climate change, the emergence of adaptation as an issue within the UNFCCC, and current conceptual understandings of adaptation. Section 3 focuses on the need to integrate adaptation into policy processes and describes the avenues through which this integration might take place, the supportive tools, approaches and technologies needed, and some of the challenges associated with an integrated approach to adaptation. Section 4 concentrates on how to mobilize the financial resources needed to support adaptation to climate change through avenues within and outside of the UNFCCC process. The paper concludes by examining priorities for future activity, laying out potential future options for addressing adaptation in an integrated manner.

2.0 The Adaptation Context

Climate change is one of humankind's most pressing integrated economic, social and environmental issues. While previously cast as a future condition to be avoided, there is mounting evidence that climate change is already happening and that its impacts are growing (IPCC 2001; ACIA 2004). These ongoing changes signal an urgent need to take action.

While human societies have always responded to environmental, social, economic and technological change, the potential rapidity of climate change could test the limits of our ability to adapt. Adaptation in the context of climate change consists of the actions that people take in response to, or in anticipation of, projected or actual changes in climate, to reduce adverse impacts or take advantage of the opportunities posed by climate change (Tompkins and Adger 2003). Adaptation to climate change can, therefore, be reactive—undertaken in response to impacts of current climate variability/climate change—or anticipatory—implemented before impacts are observed (Klein 2002). Planned adaptation achieved through deliberate policy decisions can support either reactive or anticipatory adaptation.

2.1 Present and Anticipated Impacts of Climate Change

According to the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC), the Earth's average surface temperature increased 0.6 ± 0.2°C in the 20th century. This trend is expected to persist, with an increase of 1.4 to 5.8°C by 2100. Even with "best case" mitigation efforts, some climate change cannot be avoided due to the inertia of the global climate system. Warming will vary by region and be accompanied by significant changes in precipitation patterns as well as changes in the frequency and intensity of some extreme events. Average global sea levels are projected to rise between nine and 88 cm by 2100, with implications for the 50 to 70 per cent of the world's population currently living in low-lying coastal areas (MSC 2002). The probability of large-scale and irreversible impacts, such as the collapse of the Greenland Ice

Sheet, are currently viewed as low,[1] but is expected to increase with the rate, magnitude and duration of climate change.

Regional impacts of climate change are already being observed. The TAR cites, among others, extended mid-to-high-latitude growing seasons, poleward and altitudinal shifts of plant and animal ranges, and earlier flowering of trees, emergence of insects and egg-laying in birds. The recently completed Arctic Climate Impact Assessment (ACIA) found that air temperatures in Alaska and Western Canada have increased as much as 3–4°C in the past 50 years. Other observations from this assessment include melting glaciers, reductions in the extent and thickness of sea ice, thawing permafrost and rising sea levels (ACIA 2004). Future impacts will likely be an extension of current observations of change.

In addition to altering biophysical systems, climate change will affect human health and socio-economic well-being. Recent increases in floods and droughts have already led to corresponding increases in damages and insurance impacts (IPCC 2001). In the future, even modest levels of warming are expected to increase the risks of hunger, disease and water shortages (Parry *et al.* 2001).[2]

Although climate change impacts will affect all countries, the poor in developing countries—primarily, but by no means, exclusively—will be disproportionately affected. Their reliance on local ecological resources, coupled with existing stresses on health and well-being (e.g., HIV/AIDS and illiteracy) and limited financial, institutional and human resources leave the poor most vulnerable and least able to adapt to the impacts of climate change (IPCC 2001). Consequently, there is growing recognition that climate change may undermine the ability of developing countries to meet the targets put forth in the Millennium Development Goals (MDGs) (AfDB *et al.* 2002).

Finally, it is important to note that climate change might also give rise to new opportunities. For example, changes in temperature and precipitation regimes might make it possible to grow food crops in new locations, potentially contributing to increased food security. In the Canadian Arctic, warmer winters and ocean waters could lengthen the summer ice-free season and potentially open the Northwest Passage, altering international trade routes and creating economic opportunities for northern communities (while simultaneously raising concerns about potential ramifications for northern ecosystems and traditional ways of life). As the process of global warming continues, it will be important to identify, assess and take advantage of new opportunities as they emerge.

2.2 The Emergence of Adaptation as a Policy Priority

Although mitigation and adaptation measures must both be pursued to effectively address climate change, negotiations under the UNFCCC have tended to focus primarily on efforts to reduce greenhouse gas (GHG) emissions. Sensitivity to the issue of adaptation has grown over the last five years, largely in response to the IPCC's TAR. The TAR confirmed that we are locked into a pattern of change, and that some adaptation is inevitable. Mitigation remains a priority for the international community since the degree of adaptation required is a function of a rise in global temperatures spurred by increased concentrations of GHGs in the Earth's atmosphere, and there are limits to the capacity of systems to adapt to change. However, adaptation has finally emerged as a legitimate—and, in some cases, urgent—policy priority, prompting action within and outside of the climate negotiations.

Within the UNFCCC process, the profile of adaptation noticeably increased at COP-7 with the establishment of the three "Marrakesh Funds"—the Special Climate Change Fund (SCCF), the Least Developed Countries Fund (LDCF) and the Adaptation Fund (AF). Attention to adaptation was further spurred at COP-8 with the Delhi Declaration, which reaffirmed economic and social development and poverty eradication as the first and overriding priorities of developing countries. Most recently, COP-10 produced the "Buenos Aires Programme of Work on Adaptation and Response Measures."[3]

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1 New research suggests there might be a higher probability of this event taking place. A recently completed study by the Southampton Oceanography Centre and the Tyndall Centre for Climate Change Research focused on improving estimates of the probable collapse of the thermohaline circulation system. Preliminary results suggest that the probability of this event happening is 10 times higher the originally predicted (Challenor *et al.* 2005).

2 Parry *et al.* (2001) predict that even at modest levels of global warming, by 2080, tens of millions of people worldwide will be put at additional risk of experiencing hunger and coastal flooding, hundreds of millions experiencing malaria and billions of people experiencing water shortage.

3 Decision 1/CP.10 builds upon earlier work on adaptation to the adverse impacts of climate change undertaken by the Subsidiary Body for Implementation (SBI) and the Subsidiary Body for Scientific and Technical Advice (SBSTA). It also initiates a process for the development of a new five-year structured work program within SBSTA on adaptation to the adverse effects of climate change that will address issues of importance to all Parties. The decision also includes a separate series of activities to address the economic impacts of "response measures" undertaken by Annex I Parties.

Outside the climate negotiations, there has been a veritable cascade of research and policy activity on adaptation. Apart from ongoing academic investigations into the characteristics, indicators and measurability of adaptation, the issue is being noticed by a variety of agencies. Initiatives such as the United Kingdom's Climate Impacts Program, Canada's Climate Change Impacts and Adaptation Program and the Caribbean Community Climate Change Centre have been established to continually increase national and regional understanding of adaptation concerns. Donor agencies have started to realize that their activities can both be affected by climate change impacts and influence capacities to cope with the impacts. The 2003 report of members of the Vulnerability and Adaptation Research Group (VARG), "Poverty and Climate Change," makes the case for integrating climate change concerns into development programming (AfDF *et al.* 2003). At the multilateral level, the Convention on Biological Diversity is examining the potential impacts of climate change on biodiversity and ecosystems, and identifying opportunities for adapting to climate change while enhancing conservation of biodiversity (CBD 2005).

Several environmental, conservation, development and humanitarian institutions have also established work programs on climate change adaptation. Conservation organizations such as The World Conservation Union and the World Wildlife Fund are highlighting the role of ecosystem management and restoration activities in building the adaptive capacity of vulnerable communities. International and local non-governmental development organizations (NGDOs) are similarly emphasizing the contribution of community development activities, such as microfinance, micro-insurance, income diversification, and education and training programs in reducing vulnerability to climate stress. Humanitarian organizations are using their hard-won expertise in disaster risk reduction and vulnerability and capacity assessments to inform emerging adaptation approaches, such as through the Red Cross/Red Crescent Climate Centre.

2.3 Understanding "Adaptation"

Conventional approaches to climate change adaptation have focused on future climate scenarios using General Circulation Models (GCMs), which help to identify and quantify potential impacts on different ecosystems and economic sectors. Based on these top-down, scenario-driven approaches, adaptation options are identified and, in some cases, prioritized. While these models are useful in depicting general trends and dynamic interactions between the atmosphere, biosphere, oceans, land and ice, low resolutions limit their ability to tell us about regional and local impacts of climate change. Nor is this scenario-driven approach intended to represent human interactions or local abilities to adapt, both of which are important for identifying appropriate adaptation strategies.

A new generation of research is now addressing adaptation by taking a bottom-up/vulnerability-driven approach to adaptation that usually involves assessing past and current climate vulnerability, existing coping strategies, and how these might be modified with climate change. "Vulnerability" in this context is defined as the degree to which a system is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability and extremes (IPCC 2001). Reducing vulnerability involves reducing exposure[4] through specific measures, or increasing adaptive capacity[5] through activities that are closely aligned with development priorities. The vulnerability approach overcomes uncertainties associated with GCMs and predicted impacts by increasing the capacity of communities and governments to cope and adapt to current climate variability and future climate change; resources spent on increasing adaptive capacity will not be wasted if actual climate change impacts are different from predicted impacts.

Top-down, scenario-driven adaptation approaches can provide policy-makers with information about the likely long-term impacts of climate change in different regions and at particular concentrations of atmospheric GHG emissions, and are useful in raising awareness, identifying key issues and supporting international processes (UNFCCC 2004). However, they do not provide local decision-makers with the detailed information required to develop adaptation strategies (Klein 2004). Bottom-up, vulnerability-driven approaches are more suited to developing adaptation strategies that meet localized needs (UNFCCC 2004). Top-down and bottom-up approaches are both useful, and can be used in a complementary fashion in formulating adaptation policy and practice.

4 Exposure in this context is defined as the degree of climate stress upon a particular unit of analysis; it may be represented as either long-term changes in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events (IPCC 2001).

5 The IPCC (2001) defines adaptive capacity as the ability of a system to adjust to climate change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Adaptation needs vary across geographical scales (local, national, regional and global) and temporal scales (coping with current impacts versus preparing for long-term change), and must be addressed in complex and uncertain circumstances. Responding to this process requires interdisciplinary and multiple expertise from the local to the international level. Researchers and practitioners in climatology, ecology, economics and the management of natural resources, including agriculture, forestry, watersheds and fisheries, will have to join forces with those from public health, engineering, business, disaster risk reduction, community development and social services.

The process of adaptation is made more challenging by the presence of additional stressors, such as HIV/AIDS and the impacts of trade liberalization on particularly sensitive domestic sectors. Climate change will impact systems that are already dealing with other shocks or global/regional trends. These shocks or trends also shape the vulnerability and adaptive capacity of human and biophysical systems, calling for the development of integrated options for adaptation.

3.0 Integration of Adaptation into Policy Processes

The global community has recently begun to develop and implement strategies and approaches for adapting to the ongoing process of climate change. Assessments of vulnerability to climate change have been completed and priority areas and options for enhancing adaptive capacity have been identified. However, this knowledge has thus far rarely led to the design of policies, programs or projects that bear these findings in mind in either developed or developing countries (EC 2005). For example, current documents that guide development strategies in developing countries, such as national development plans and Poverty Reduction Strategy Papers (PRSPs), pay negligible attention to climate change (Agrawala 2004). It is increasingly recognized that to effectively support adaptation to climate change and minimize the risks associated with predicted impacts, there is a great need to better integrate adaptation considerations into the center of decision-making and policy formation (Huq *et al.* 2003).

Accomplishing this objective requires an understanding of current and future climate risks. This understanding is then used to develop new measures or adjustments to policies, programs and projects so that risks are minimized and adaptive capacity is enhanced. This process can be referred to as "climate-proofing": the development of actions to protect infrastructure, systems and processes against climate impacts. Embedding climate change adaptation into sector policies and programs greatly expands the range of opportunities for reducing vulnerability to the impacts of climate change and builds into the system consideration of climate variability today as well as capacity to address changes in an uncertain future (OECD 2005; Smit and Benhin 2004). Integration also enables these impacts to be addressed in a more economically efficient manner (OECD 2005; EC 2005). As noted by Newell (2004): "Policy integration is perhaps the greatest contribution that governments can make towards providing climate protection and it is also potentially the least economically costly."

3.1 Avenues for Integration

Adaptation considerations can be integrated into policies, guidelines, programs, strategies or projects in numerous sectors at a number of different levels, including at the local, sectoral, national and international level.

Local level. Local strategies for preparing for and responding to the anticipated impacts of climate change can be built into municipal planning processes and community level strategies, covering risk assessment practices, seed banks, community social services and emergency preparedness programs (AfDB *et al.* 2002).

Sectoral level. The impacts of climate change will be felt across a range of sectors, including human health, urban planning, agriculture, water, forestry, fisheries, coastal resources, transportation and disaster risk reduction. Consideration of these impacts needs to be built into sectoral planning processes (Huq and Reid 2004), such as infrastructure design and maintenance codes and standards.

The private sector also has a central role to play in building its own adaptive capacity. Businesses can bring adaptation considerations into their practices, policies and technologies, reducing their risk in the face of climate change and potentially identifying new economic opportunities (Berkhout *et al.* 2004).

National level. Adaptation considerations can be integrated into a plethora of national policies and planning processes. Particular attention might be given to integrating adaptation into national economic planning and budgetary processes. By examining budgets with an eye to whether planned expenditures will increase expo-

sure to the impacts of climate change, national governments can minimize their financial risk, promote macroeconomic stability, set aside sufficient funds to manage the consequences of climate shocks, and provide support for adaptation activities at the local and sectoral level (AfDB *et al.* 2002).

International level. Key opportunities exist for integrating adaptation into international processes. Most critically, the implications of climate change need to be more explicitly integrated into ongoing plans for achieving the Millennium Development Goals. Considerable opportunity also lies in integrating adaptation considerations into the Country Assistance Strategies of the World Bank, the lending practices of international financial institutions more broadly, and initiatives such as the Group of Eight Industrialized Countries' and other donors commitment to double their aid to Africa by 2010 compared to 2004 (G8 2005).

3.2 Tools, Methods and Technology for Adaptation

Integration of adaptation into policy processes requires a range of tools, methods and technologies at each step of the process. A variety of frameworks have been developed to guide different stakeholders through the integration process (see Box 1), which generally involve the following steps:

1. Understanding current risk and coping strategies;
2. Estimating future risks and impacts;
3. Using this information to review policies, programs and projects to determine: (a) how they will be affected by climate change; (b) how they contribute to adaptive capacity and/or adaptation; and (c) how they contribute to maladaptation;
4. Identifying the reform measures and investment options for minimizing vulnerabilities and supporting adaptive capacity in policies, programs and projects. This includes assessing the institutional changes and financial means necessary to implement reforms;
5. Implementation; and
6. Monitoring and evaluation.

Box 1: Taking an Integrated Approach to Adaptation

Several ongoing efforts within the international community are working to integrate adaptation to climate change into policy processes. The following is small sampling of these initiatives:

- As part of the Capacity Building for the Development of Adaptation Measures in Pacific Island Countries (CBDAMPIC) project, community level vulnerability assessments were undertaken in Samoa to identify measures to improve their adaptive capacity and contribute to integrating adaptation into Samoa's national policy framework (Sutherland *et al.* 2005).
- The Tyndall Centre has developed an organizational model to assist businesses in understanding their vulnerability to climate change and how to adapt their practices, policies and technologies to protect themselves while also making the most of new opportunities that may arise (Berkhout *et al.* 2004).
- Portland, USA, has investigated the potential impacts of climate change on water supply and demands and evaluated system expansion alternatives to meet these impacts (Palmer and Hahn 2002).
- UNDP-GEF has established the Adaptation Policy Framework, which offers a "structured approach to developing adaptation strategies, policies and measures in the face of climate variability and change" (UNDP 2004).
- The United Kingdom's Climate Impacts Programme has developed a risk-and-uncertainty decision-making framework to assess the risk posed by climate change and how best to respond (Willows and Connell 2003). This framework is currently being used to integrate adaptation considerations across all federal government policy and operational responsibilities, and private and public sector organizations are also being encouraged to follow suit (DEFRA 2005).
- The Climate Change Adaptation Program for the Pacific (CLIMAP) sought to integrate climate change adaptation into development planning in the Cook Islands and the Federated States of Micronesia, and into the Asian Development Bank's program and project operations (Brotoisworo 2004). The ADB is developing a set of guidelines for climate-proofing based on this experience.

The tools, methods and technologies used at each step of the process will differ according to the scale, sector and user. They can be drawn from existing resources found in a variety of disciplines.[6] New tools also need to be developed, such as those that will help understand how projects and programs will be affected by climate change and/or contribute to building adaptive capacity. The main short-term challenge though is applying existing tools and technologies in effective and efficient ways, and making sure they are transferred to areas that are most vulnerable to climate change. The transfer of technologies for adaptation faces additional barriers when compared to mitigation technologies;[7] the uptake of such technologies is dependent on the buy-in and involvement of an expanded stakeholder community, and there is unwillingness at present to provide the funding required to transfer these technologies (Klein *et al.* 2005).

3.3 Challenges for Integrating Adaptation into Policy Processes

The international community's understanding of the importance of and options for integrating adaptation considerations into decision-making processes is only in the early stages of development (EU 2004). Progress is needed in some key areas, including:

- *Increase in awareness and dialogue* – The limited awareness and knowledge of policy-makers in developing and developed countries regarding the implication of climate change for the achievement of local and national sustainable development objectives is "an immediate and continuous challenge" (EC 2005).
- *Sharing of knowledge, technologies and tools on adaptation* – The exchange of information related to tools, technology and methodologies between countries, such as through networks, is needed to facilitate continual learning (Willems 2005; Agrawala 2004; Huq and Reid 2004).
- *Mobilization of tools and technologies* – Policy-makers, project implementers and other stakeholders require a variety of tools and technologies to design and implement appropriate adaptation strategies while coping with the physical and socio-economic uncertainty associated with climate change. Existing tools and technologies may be appropriately modified and new tools developed, such as those that will help undertake economic valuation of climate change impacts (OECD 2005).
- *More flexible institutional and policy processes* – There is a growing need to develop and implement effective policies that are robust across a variety of possible futures, rather than optimized for a specific future, and have the ability to adapt to circumstances as they emerge over time (Walker *et al.* 2001).
- *Capacity building* – Further skills are required in areas such as: identification and analysis of policies affected by climate change; ability to effectively communicate impacts and adaptation responses to policy-makers; integrated policy formulation, planning and coordination; and integrated policy implementation, evaluation and modification (Kimenyi *et al.* 2004).
- *Monitoring and evaluation* – There is a growing need to develop the data and information banks, tools and processes needed to monitor and review adaptation actions in order to ensure their effectiveness and promotion of adaptive capacity (Kiminyi *et al.* 2004; Willems 2005).

4.0 Mobilizing the Resources Needed

Appropriate human, institutional, technological and financial resources are needed to adapt to current and future impacts. Individuals require the knowledge and capacity to understand and address their vulnerability to the impacts of climate change. Institutions need to be able to respond effectively to circumstances increasingly characterized by complexity, change and uncertainty due to interconnected global trends, such as climate change. Tools need to be modified for use in new circumstances, and technologies developed, diffused and deployed in a manner that addresses the needs of the most vulnerable communities. Mobilizing these human, institutional and technical resources can be facilitated through the exchange of knowledge, experiences and

6 Some existing tools, approaches and technologies that can be applied in support of adaptation to climate change include vulnerability risk assessments, human health surveys, sustainable livelihood assessments, Geographical Information Systems, simulations of water and coastal resources, adaptation decision matrix, and cost benefit analysis.

7 A full discussion of this issue is provided in the theme paper "Climate Change and Technology."

lessons learned. This exchange can take place from the North to the South, but equally importantly on a South-North, South-South and North-North basis. For example, communities presently adapting to the impacts of climate change, such as those in Pacific Small Island Developing States (SIDS) and the Arctic, could exchange lessons learned and coping and adaptive strategies.

The UNFCCC is already playing an important role in supporting the mobilization and sharing of these types of resources. Convention activities presently support: the collection and dissemination of information on impacts, vulnerability and adaptation; the sharing of practical actions for anticipating and responding to impacts; and capacity building and enabling activities related to adaptation. Workshops and initiatives such as the *Compendium of methods and tools to evaluate impacts of, and vulnerability and adaptation to, climate change* have played, and will continue to play, an important role in extending international efforts to engage in adaptation efforts.

Adequate financial resources are also required to ensure the presence of sufficient human, institutional and technological capacity to cope and adapt to climate change. The pervasiveness of the current and anticipated impacts of climate change—across sectors, geographies, social groups and from the local to the global—implies that hundreds of billions of dollars will be required in the near and long term.[8] Recent calculations estimate that the financial toll of climate change is presently doubling every decade (Simms *et al*. 2004).

It is increasingly recognized that stand-alone funds *by themselves* are insufficient to provide the financial resources required to adapt to climate change; financing mechanisms that specifically target climate change impacts need to be accompanied by the integration of adaptation considerations into day-to-day budgeting processes. As noted earlier, an integrated approach to adaptation enhances the economic efficiency of responding to the impacts of climate change, although the process of climate-proofing itself may result in additional costs (Brotoisworo 2004).

4.1 Targets for Funding

Effective utilization of available financial resources may be supported by directing it to those areas of potential greatest need. Among others, these areas include:

- *Highly Vulnerable Countries*, particularly Least Developed Countries (LDCs) and SIDS. Although developing countries will need to undertake a significant level of adaptation by relying on their own resources and adaptive capacities (Huq and Burton 2003), as recognized under the UNFCCC, these countries also require external financial assistance to increase their technical, human and institutional capacities. In contrast, developed countries typically have the technical and financial resources needed to support vulnerable communities and adaptation activities in their jurisdiction.
- *Climate-Sensitive Economic Sectors*, such as agriculture, forestry, fishing, herding, and hunting and trapping. These sectors are already feeling the impacts of climate change, which in turn is affecting the communities that depend upon them. Adaptation strategies that promote sustainable natural resource management are, therefore, priorities for a number of countries.
- *Disaster Risk Reduction*, as the most immediate evidence of climate change is likely to be an increase in the frequency and intensity of extreme weather events.[9] Effective and efficient arrangements are needed to increase the ability of vulnerable communities and the poor to prepare for and recover from the impacts of these events (Linnerooth-Bayer *et al*. 2003).

4.2 Opportunities Under the Convention

Through decisions of the COP and direction provided to the Global Environment Facility (GEF), the international community has established a number of avenues for supporting developing countries' capacity to

8 For example, Easterling *et al*. (2004) compared two studies that analyzed the estimated cost of sea level rise for coastal communities in the United States. The studies estimated that a metre rise in sea level would place US$429 billion of property and infrastructure in jeopardy by 2100 while the financial cost of protecting all developed areas would be US$115 to US$174 billion—indicating that appropriate adaptation could reduce the severity of damages to development by about three-fifths to three-quarters, compared with no adaptation (Easterling *et al*. 2004: 14).

9 Already, the number of people affected by disasters has risen from 740 million in the 1970s to two billion in the 1990s (Simms *et al*. 2004).

adapt to climate change. These provide important financial resources to countries that already lack sufficient funding to respond to the impacts of climate change occurring today (Simms *et al.* 2004).

4.2.1 The Marrakesh Funds

Three funds specifically designed to meet the adaptation needs of developing countries were created under the Marrakesh Accords: the Least Developed Countries Fund and the Special Climate Change Fund under the UNFCCC; and the Adaptation Fund under the Kyoto Protocol. While representing a promising start, long-term, firm and regular financing under the Convention is needed to ensure the viability of these funds and to provide developing countries with a predictable source of adaptation funding (ICCTF 2005).

There is also a need to ensure that the future modalities of the Adaptation Fund complement activities supported by the LDCF and SCCF. The LDCF has retained a tight focus on helping LDCs develop and now implement their National Adaptation Programmes of Action (NAPAs), while the adaptation mandate of the SCCF is quite broad, covering natural resource management activities, health impacts and disaster monitoring and prevention.[10] There is a need to consider how these funds can be used in the future in a complementary way.

4.2.2 The Global Environment Facility

There has been a continual call for the GEF to introduce more flexible approaches to funding adaptation activities, particularly with respect to the incremental cost formulation. In principle, the GEF only funds the agreed incremental cost of activities that provide global environmental benefits; most of the benefits associated with adaptation activities though accrue at the local level. Moreover, because many adaptation activities are intimately connected to other aspects of development, such as water management, desertification prevention and disaster preparedness, it can be difficult to determine the adaptation component of a project (IISD 2004). In response to this challenge and guidance from the COP, the new Funds created to address adaptation were intended to be more flexible than funds available under the GEF Trust Fund. In administering these more flexible funds, the GEF has recently proposed that funding from the LDCF and SCCF be used to finance "the additional costs of achieving sustainable development imposed on vulnerable communities by the impacts of climate change" (GEF 2004b: 10).

In addition, the co-financing requirements that the GEF has established in operationalizing the LDCF and SCCF are perceived as overly burdensome by many LDCs and SIDS (IISD 2004). Many of these countries lack access to internal and external funding opportunities and are less likely to have the human capacity required to develop complex funding proposals. Parties have additionally raised concerns (such as at COP-10) regarding the GEF's introduction of criteria and indicators additional to those adopted by the COP, as well as the narrow scope of adaptation projects eligible under the GEF (IISD 2004).

It is unrealistic to expect the GEF to cover the full cost of adaptation projects: the billions of dollars this would require would quickly exhaust the resources of the GEF (Corfee-Morlot *et al.* 2002). Moreover, international development experience demonstrates that the provision of local financial contribution and ownership results in more sustainable and effective development activities (OECD 1996). However, the current approach to co-financing of GEF supported adaptation projects under an expanded or extended Strategic Priority for Adaptation,[11] which is intended to be consistent with existing GEF practices, as well as the appropriateness of the sliding scales for co-financing of projects under the LDC and SCCF, may warrant reconsideration in view of developing country concerns and challenges (IFC 2005; GEF 2004a; IISD 2004).

4.3 Leveraging Financial Flows Outside the Convention

Significant financial resources that could be leveraged in support of adaptation to climate change exist outside of the UNFCCC process. Greater attention might be given to identifying and utilizing these opportunities to support adaptation efforts in developing countries in particular.

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10 The SCCF is to support: adaptation activities in the areas of water resources management, land management, agriculture, health, infrastructure development, fragile ecosystems, including mountain ecosystems and integrated coastal zone management; improved forecasting, monitoring, and prevention of diseases and vectors affected by climate change; capacity-building for preventive measures, planning, preparedness and management of disasters relating to climate change; and strengthening or establishing national and regional centres and information networks for rapid response to extreme weather events (UNFCCC 2003).

11 The GEF Trust Fund's new strategic priority for adaptation (SPA) has been established to assist countries with integrating adaptation into their development planning. The GEF SPA will cover the "incremental cost of those adaptation activities that generate global environmental benefits as well as the incremental cost of selected adaptation activities that are identified as high priorities by national communications" (GEF 2004a: 7).

4.3.1 Bilateral Development Agencies

The contribution of bilateral agencies, and their multilateral development counterparts, in assisting developing countries to address climate change is explicitly called for under the Convention.[12] Annex II Parties have played an important role thus far in facilitating implementation of the Convention through the provision of financial resources directly to the GEF, to the Marrakesh Funds, and through various multi-donor and bilateral programs. The level of funding provided for these initiatives, though, represents only a small proportion of bilateral development agencies overall portfolio of activities.[13] Supporting climate change adaptation has rarely been a top priority of donor agencies, although this is changing (OECD 2005).

Integration of adaptation considerations into the mainstream work of development agencies would allow for more cost-effective and wide-ranging support to be provided, as well as ensure that investments are not exposed to unacceptable risk (Huq and Burton 2003). However, some concerns also need to be recognized. Bringing adaptation into the centre of decision-making and programming makes it even more challenging to separate financial flows that are "new and additional" (as mandated by the UNFCCC) from non-climate change ODA activities (Huq and Reid 2004). As well, using existing funds in support of adaptation could also reduce the pressure on donor agencies to provide additional resources (Yamin 2004). Greater emphasis on the provision of support to developing countries through bilateral processes also increases the opportunity for duplication of activities and reduction of synergies, a disadvantage in comparison to channelling funding through the GEF (Greene 2004).

4.3.2 World Bank and other International Financial Institutions

The World Bank has been active in building its understanding of the risks associated with climate change impacts, such as through its participation in the VARG, and is beginning to integrate adaptation considerations into its regular activities and the policies of its partner countries (OECD 2005). However, like other international financial institutions, such as the Asian Development Bank and the African Development Bank, effective integration of climate change considerations, including adaptation, into the main activities of the Bank has not yet taken place (Newell 2004). The World Bank has completed few adaptation projects and has not strengthened the capacity of its client countries to address adaptation concerns (OECD 2005).

Continued and stronger efforts to integrate climate change into World Bank activities could have significant benefits, particularly given its high level of lending,[14] support for long-term infrastructure development projects and role as a re-insurer.[15] For example, the World Bank's carbon funds—the BioCarbon Fund and the Community Development Carbon Fund—have the potential to contribute to reducing the vulnerability of local communities to the impacts of climate change.[16]

4.3.3 Private Sector

Significant portions of foreign direct investment, presently the largest component of external financing to developing countries, is directed toward energy infrastructure development projects through public-private partnerships. More than $680 billion was invested in infrastructure projects in more than 120 developing countries between 1990 and 2000 (Heller and Shukla 2003). Climate-proofing these investments would help minimize risk to investors and developing countries. As well, consideration might be given to the provision of incentives for investments in those activities that support sustainable, adaptation-friendly activities, such as the development of technologies that support adaptation or implementation of decentralized renewable energy systems (reflecting the World Summit on Sustainable Development's recognition that energy provision is a necessary pre-condition for poverty alleviation and sustainable development, and by extension to reducing vulnerability to climate change).

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12 Article 11.5 of the UNFCCC states: "The developed country Parties may also provide and developing country Parties avail themselves of, financial resources related to the implementation of the Convention through bilateral, regional and other multilateral channels" (UN 1992).

13 An OECD DAC review found that, on average, bilateral donor activities targeting the objectives of the UNFCCC—mitigation and adaptation—constituted 7.2 per cent of annual ODA commitments in 1998–2000, or about US$2.97 billion annually (Greene 2004).

14 In 2004, the IBRD approved 87 projects for US$11 billion in fiscal 2004 in 33 countries (World Bank 2004).

15 The World Bank is the third largest "re-insurer" in the world, according to its own statistics, and issued post-disaster loans (though not all weather-related disasters) in the region of US$30 billion in the 1980 to 2001 period.

16 The BioCarbon Fund and Community Development Carbon Fund provide financing for projects such as reforestation to conserve and protect forest ecosystems, community afforestation activities, mini and micro-hydro and biomass fuel projects (World Bank nd-a; World Bank nd-b). These types of project contribute not only to the mitigation of climate change but also to reducing rural poverty and improving sustainable management of local ecosystems, thereby enhancing adaptive capacity.

On a different scale, micro-credit schemes have demonstrated their effectiveness in increasing the financial resources of the poor and supporting income-generation and livelihoods activities. Expansion of these schemes may be an important tool, along with micro-insurance, in improving the resilience of the poor in the face of a changing climate.

4.3.4 Non-Governmental Development Organizations

Participation by non-governmental development organizations in climate change adaptation activities has thus far been quite limited and could be expanded. Unlike their larger government counterparts, NGDOs have a greater ability to reach the most vulnerable members of communities and to support the small-scale, site-specific projects needed to enhance the adaptive capacity of the poor and rural communities (Huq and Reid 2004).

4.4 Insurance and Alternative Risk-transfer Instruments

Insurance and other pre-disaster risk-transfer instruments are increasingly recognized as important means of accessing the substantial financial flows within capital markets, increasing private sector funding for coping with weather catastrophes, and contributing to incentives for loss reduction (Huq 2005; Linnerooth-Bayer *et al*. 2003). The potential role of insurance is acknowledged in Articles 4.8 and 4.9 of the UNFCCC and Article 3.14 of the Kyoto Protocol, and it has been considered as an option for meeting the specific needs of developing countries since COP-7.

4.4.1 Insurance Schemes

Given the rising toll of weather-related catastrophes, and the anticipated increase in their frequency and intensity in the future, demand for insurance is growing and insurers are looking for innovative ways to keep premiums low and reduce risk (Linnerooth-Bayer *et al*. 2003). Insurance is important in helping individuals and countries recover from shocks such as extreme weather events. It can also influence human behaviour in the face of risk by encouraging risk-abating behaviours (e.g., limited coverage for settlement in floodplains, prompting people to live in less exposed areas or invest in flood protection) or risk-taking behaviours (e.g., planting climate-sensitive crops knowing that insurance will cover drought-related losses).

Insurance options and risk transfer opportunities are vastly different in developed and developing countries (Vellinga and Mills 2001). In developed countries, the commercial insurance sector plays a leading role in spreading risk. Nevertheless, insurers and the insured need better information on future risks as premiums calculated based on past climate variability are no longer relevant for covering future risks. Moreover, low awareness of emerging risks has translated into insufficient coverage and inadequate risk-reducing measures. Better cooperation between climate scientists, hazards specialists, government and the insurance industry could certainly fill this gap.

In developing countries, formal insurance schemes play a limited role in protecting individuals and countries. Only one per cent of disaster losses are insured in low-income countries (Hoff *et al*. 2003), while these countries bear the brunt of disaster fatalities[17] and incur significant economic losses. Governments, local communities, families and foreign aid must step in to meet the costs of recovery. The likelihood of developing a traditional commercial insurance market in the developing world to cover climate-related risks is limited, as there is no guarantee of commercial returns particularly in light of the expected impacts of climate change (Hamilton 2004). For this reason, the international community will need to devise alternative risk transfer and risk management schemes that can protect the most vulnerable communities against economic shocks, enhance their adaptive capacity and enable their sustainable development. Some options include:[18]

- *International Insurance Pool:* Proposed in 1991, the pool was envisaged as a collective loss-sharing fund to compensate the victims of sea-level rise, to be administered by a board under the UNFCCC and funded by mandatory contributions from industrialized countries in proportion to their GHG emissions and Gross National Product (Hamilton 2004; Linnerooth-Bayer *et al*. 2003; Muller 2002).
- *Public-Private Insurance Partnerships:* Schemes where the insurer is the government, but the policies are developed and managed by the private insurance sector, and sometimes joint, mutually beneficial activities are undertaken.

17 Ninety-five per cent of deaths from disasters occur in developing countries (Linnerooth-Bayer *et al*. 2003).

18 Fuller descriptions of these options are contained in Annex A.

- *Regional Catastrophe Insurance Schemes:* Regional cash reserves are pooled through mandatory contributions from member governments. These reserves are then used for on-lending to members affected by a weather catastrophe (DFID 2004). These schemes or risk pools could be backed by a regional facility that provides a layer of re-insurance cover.
- *Micro-insurance:* Micro-insurance uses risk-pooling to provide compensation to (low-income) individuals or groups adversely affected by a specified risk or event (Hoff *et al.* 2003). Especially relevant to individuals and communities in developing countries, these schemes can be index-based (Skees *et al.* 1999) and should be developed jointly with governments, non-governmental organizations and private companies. Local calamity funds, savings and credit schemes are examples of micro-insurance.

4.4.2 Alternative Risk Transfer Instruments

Alternative Risk Transfer Instruments have also been developed by financial institutions to reduce financial exposure to climate change impacts (UNEP-FI 2005). These instruments include:

- *Catastrophe bonds*, which provide private insurers with protection against extreme natural catastrophe events. Capital is provided by institutional investors, with money raised on the stock market by issuing bonds against a particular catastrophic event (DFID 2004; Hamilton 2004). While slowly growing, the market for these bonds is targeted primarily to OECD countries and its potential in developing countries has not yet been fully explored.
- *Weather derivatives* are financial mechanisms developed to hedge financial risk associated with weather volatility. They are financial contracts whose value is tied to, or derived from, an underlying asset such as a temperature or precipitation index. While the weather derivative market continues to grow in the U.S. and Europe, developing countries have not yet been engaged (Figueres 2005).
- *Weather hedges* provide farmers with protection against extreme weather events. Insurance against a specific local weather phenomenon is sold by banks, farm cooperatives and micro-finance institutions to buyers at the same premium, who in turn receive the same indemnity payment per unit of insurance. Catastrophe bonds can be used to backstop this micro-scheme to ensure that the insurance provider has sufficient capital to cover claims (Linnerooth-Bayer *et al.* 2003).

Insurance and alternative risk transfer instruments, while expanding the financial options available for managing the impacts of climate change, can be more expensive than traditional state-supported, loss-sharing financial mechanisms. Public-private partnerships might provide an avenue for meeting these costs if, for example, the international donor community hedge the disaster liabilities of vulnerable countries as a partial substitute for post-disaster relief, or if governments were to provide tax incentives for the charitable investment of their citizens in developing country catastrophe bonds (Linnerooth-Bayer *et al.* 2003).

5.0 Priorities for Future Activities

Integrating climate change adaptation into policy processes and decision-making across a range of sectors and scales is a critical next step in managing the impacts of climate change. Efforts to achieve this objective might be undertaken under the direction of the UNFCCC or independently initiated by local and national governments, multilateral institutions and the private sector. An important issue for Parties is, therefore, determining the role (if any) the UNFCCC should play in supporting the integration of adaptation concerns into (for example): national or sectoral policies and decisions; private-sector strategies, management plans and investments; and multilateral institutions such as the other Rio Conventions, UN agencies and the World Trade Organization.

5.1 Priorities for Supporting an Integrated Approach to Adaptation

Integrating adaptation considerations at the local, sectoral, national and international level requires the engagement of a diversity of stakeholders from a variety of disciplines. Bringing non-climate experts into efforts to develop anticipatory strategies for addressing climate change impacts is essential, and efforts to reach out to the private sector, national finance ministries, international financial institutions, non-governmental development organizations, and various agencies in the United Nations, for example, should be accelerated to enable effective integration to take place on a variety of fronts.

There is also a need to develop, disseminate and implement the knowledge, tools and technologies required to effectively and efficiently engage in an integrated approach to adaptation. Priority should be given to applying existing tools and technologies in new ways that help reduce vulnerability to climate change. At the same time, new tools are needed to address gaps that have already been identified, such as tools for screening projects for their exposure to climate risks (Agrawala 2004) and undertake economic valuation of climate change impacts (OECD 2005). There is also a need to develop effective mechanisms for sharing knowledge, tools and technologies between Parties, such as through knowledge networks and various information clearinghouses. The five-year SBSTA program of work on impacts, vulnerability and adaptation to climate change will be an important venue for furthering efforts to meet these needs.

Financing vulnerability reduction activities and costs associated with the impacts of climate change is a key question for all countries, but particularly for developing countries. The financial resources available to developing countries through the LDCF and SCCF are insufficient to implement the full range of activities that currently fall within their mandates. Greater demand upon these resources can be expected in the future as climate change proceeds. Long-term, firm and regular financial support is needed by developing countries such as through these Funds. Continuing efforts are also needed to address developing country concerns and challenges related to current co-financing requirements under the LDC and SCCF, as well as under the GEF's Strategic Priority for Adaptation.

Bilateral development agencies should also play an enhanced role in addressing the adaptation concerns of developing countries. Greater awareness within some of these agencies is needed regarding the interconnectedness of climate change impacts and the sustainable development objectives of developing countries and the opportunities for achieving synergies between current development activities and efforts to reduce vulnerability to climate change. Potential difficulties will also need to be overcome, such as demonstration of the provision of "new and additional" financial resources to developing countries when adaptation efforts are integrated into mainstream policies, programs and projects.

International financial institutions and the private sector should be more effectively engaged as well to support adaptation efforts. Mechanisms are needed to ensure that long-term investments in infrastructure, for example, account for predicted future climatic changes to minimize the risk to investors and developing countries. Private-sector involvement could be enhanced by providing incentives to promote activities that support sustainable, adaptation-friendly activities (such as the development and deployment of technologies for adaptation).

Finally, there is a pressing need to identify ways to more effectively utilize other existing financial and capital flows such as: insurance or alternative schemes for protecting against losses in developing countries; micro-credit and micro-insurance schemes; and financial markets and alternative risk transfer instruments such as catastrophe bonds, weather derivatives and weather hedges. Innovative public-private partnerships could be established to address the additional cost of alternative insurance and risk-transfer instruments compared to traditional state-supported, loss-sharing financial mechanisms.

When seeking ways to support an integrated approach to adaptation, it also will be important to recognize that efforts to prepare for and respond to the impacts climate change will of necessity take place at the same time as efforts to reduce greenhouse gas emissions. Greater emphasis could be given to the identification and implementation of actions that simultaneously support mitigation and adaptation to climate change, such as in the areas of urban planning and expansion of decentralized renewable energy systems.

5.2 Exploring Post-2012 Options for Addressing Adaptation Under the UNFCCC

Adaptation will need to be addressed in any future international climate regime, and in a more prominent manner than in the past. It could be treated as a separate issue or, perhaps more effectively, approached as a cross-cutting theme that is fully integrated into the design of a new climate regime. As a cross-cutting theme, adaptation could be integrated into UNFCCC actions related to future commitments, research, capacity building, technology transfer and sustainable development more generally (EU 2004), as well as into national, sectoral and local-level decision-making and management practices.

A few broad proposals that specifically incorporate adaptation into the design of a post-2012 regime have been put forward (Bodansky *et al.* 2004). These include: the Climate Action Network's three track Global Framework proposal; the North-South Dialogue on Equity in the Greenhouse proposal for a Global Climate Agreement; and the Center for International Climate and Environmental Research – Oslo (CICERO) proposal for Broadening the Climate Regime.

- *Global framework* – This proposal lays out a future climate regime that includes three parallel, interlinked tracks: a Kyoto Track that builds on the UNFCCC and the Kyoto Protocol; a Greening Track that focuses on decarbonization supported by the rapid introduction of clean technologies; and an Adaptation Track for the most vulnerable regions. Countries would move from Track 2 to Track 1 based upon factors such as historical responsibility, level of per capita emissions, and ability or capacity to act. Few details are provided regarding the content of the Adaptation Track beyond that it would build upon the Marrakesh Funds, be funded by industrialized countries, include compensation for damages, and that countries in Track 3 would also be eligible for involvement in Track 2 and, as appropriate, Track 1 (CAN 2003).
- *North-South dialogue proposal* – Subtitled "A proposal for an adequate and equitable global climate agreement," this proposal puts forward a comprehensive approach to addressing mitigation and adaptation in the post-2012 period. Proposed elements include: linking funding for adaptation to responsibility for the impacts of climate change based on the "polluter pays" principle; support for capacity building in developing countries in a range of areas including sector-specific adaptation strategies, sensitization of policy-makers, public awareness and negotiating skills; modification of existing GEF rules related to adaptation projects on incremental costs and global benefits and facilitating access to funding; and the piloting of innovative insurance schemes for the management of climate risk at the local, national and international level (Ott *et al*. 2004).
- *Broadening the climate regime* – This proposal set forward a three-stage approach in which countries in three different stages of development, as determined by an index based on GDP and emissions per capita, have different levels of mitigation commitments. It is suggested that a separate Adaptation Protocol be established to complement this multi-stage approach. The Adaptation Protocol would be designed to secure the transfer of funds and technology to those countries most vulnerable to the impacts of climate change. It is noted that adaptation funding could also be earmarked to support the implementation of policies and measures that move recipient countries on to a low-emission development path while increasing their adaptive capacity (Torvanger *et al*. 2005).

Specific elements of a post-2012 approach to adaptation will also need to be determined. These elements could include:

- *Financial instruments for supporting adaptation in developing countries*. Future financing of adaptation could be provided through voluntary contributions (as with the Marrakesh Funds). However, mandatory contributions based on criteria such as historical emissions, ability/capacity to pay, or per capita emission levels are more likely to generate firm and regular financial resources at the high levels required.
- *Support for national-level activities*. These activities could range from efforts that build knowledge to the transfer of technologies for adaptation to the implementation of concrete projects that reduce vulnerability and respond to immediate impacts.[19] The implementation of actual projects will most effectively be achieved when integrated with other planning and development instruments.
- *UNFCCC-led activities that support all Parties in their efforts to adapt to climate change*. The UNFCCC could play a stronger role in further knowledge sharing and communication, such as by serving as a one-stop information clearinghouse or as a knowledge broker.

Most existing proposals focus specifically on options for increasing the availability and effective use of finances for adaptation in developing countries. A number of the insurance and risk-transfer instruments described in Section 4.4, for example, could be integrated into a post-2012 approach to adaptation. These financial instruments serve to reduce the financial risks associated with climate-related extreme weather events, and increase adaptive capacity by creating systems that allow for quick access to capital for reconstruction following a disaster.

19 Examples of possible activities include: the development, deployment and diffusion of technologies for adaptation; building institutional capacity; raising awareness among decision-makers, the private sector and the public; demonstration projects; monitoring and evaluation of adaptation activities; socio-economic analysis of projected impacts; risk-reduction measures; relocation assistance for vulnerable communities and infrastructure; coastal zone protection; crop substitution; watershed management projects, catastrophic insurance and risk pooling schemes, micro-insurance initiatives; and the development of targeted tools and projects that specifically target vulnerable communities.

Specialized funds have also been suggested, such as a *Solidarity Fund with Mandatory Contributions* structured to support preventative measures as well as relief from impacts. A *Climate Change Insurance Fund* to meet the restorative costs of the impacts of climate change has been advocated as well. Financing for such a fund could come from a share of proceeds from a levy on fossil fuel sales in Annex I countries, contributions from governments, insurance funds and high GHG emitting industries (Government of Tuvalu 2005).

Finally, to support the adaptation activities of all Parties, it has been suggested that a *Vulnerability Assessment Clearinghouse* be established. This entity would operate as a toolbox for assisting countries with implementation of their vulnerability assessments (Government of Tuvalu 2005).

Although existing proposals warrant consideration, they are presently few in number, possibly reflecting the international community's current lack of practical experience in implementing adaptation strategies. Further research is needed by the international policy community to develop options that might be appropriate for addressing adaptation in an integrated manner in a post-2012 climate regime.

5.3 Moving Forward

The international community is only beginning to understand the complex socio-economic and environmental impacts that will accompany the ongoing process of climate change. Experience and analysis is needed to support greater policy coherence between climate change and development within and outside of the UNFCCC regime (Agrawala 2004; Burton and van Aalst 2004; OECD 2005). Economic and social development at all levels needs to be undertaken with an eye to ensuring that it is "climate proof" and "climate friendly." Doing so requires mobilizing human capacity and knowledge, institutions and governance, tools and technologies, and appropriate financial resources in developing and developed countries. Given the scale of the response needed, efforts within the UNFCCC process will need to support and be accompanied by those of bilateral and multilateral development agencies, the private sector and international financial institutions.

As the international community moves forward in its efforts to take an integrated approach to addressing current and future impacts of climate change, and works to collectively increase its capacity to adapt and reduce its vulnerability, consideration can be given to addressing the following questions:

- How can Parties to the UNFCCC support an integrated approach to adaptation to climate change by bringing these concerns into other multilateral processes such as the Rio Conventions, World Trade Organization negotiations and efforts to achieve the MDGs, and by more effectively reaching out to and engaging with other communities, such as the private sector, the financial sector, and non-governmental development and disaster reduction organizations?
- What role, if any, should the UNFCCC Secretariat play in developing the knowledge, tools and technologies needed to integrate adaptation into policy- and decision-making processes?
- As bilateral donors increasingly integrate efforts to reduce the vulnerability of developing counties to climate change into their mainstream development activities, how can Annex II countries effectively track and report upon their financial contributions to non-Annex I countries?
- What mechanisms might be used to encourage private sector investment in activities that reduce the vulnerability of countries to the impacts of climate change? What incentives and policies can promote these investments and transfers?
- How might the LDCF and SCCF be energized with long-term, firm and regular financial commitments? What lessons from the establishment of the LDCF and the SCCF might be applied to the future development of the AF? How can Parties ensure that activities support by the Marrakesh Funds complement each other as well as bilaterally- and nationally-funded efforts to integrate adaptation considerations into national development processes?
- Should the UNFCCC Secretariat host an international workshop to support efforts to identify and describe possible approaches to addressing adaptation in the post-2012 period?

Annex A: Glossary of Terms

Adaptation
The actions that people take in response to, or in anticipation of, projected or actual changes in climate, to reduce adverse impacts or take advantage of the opportunities posed by climate change (Tompkins and Adger 2003).

Adaptive capacity
Adaptive capacity is the ability of a system to adjust to climate change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC 2001).

Adaptation Fund
The Adaptation Fund is a Kyoto Protocol Fund, to be financed through a two per cent levy on the sale of certified emission reduction (CERs) credits generated by Clean Development Mechanism (CDM) projects as well as other sources of funding. Its purpose is to support concrete adaptation projects and programs in developing countries that are Parties to the Kyoto Protocol. The AF was established with the Marrakesh Accords and entry into force of the Kyoto Protocol. The modalities for the operation of this fund have not yet been determined. Estimating the financing that will be available through the AF is difficult given the current uncertainty associated with size of the market for CERs and the price associated with their sale. An indicative range based on a projected size of the CDM market in 2010 suggests that the levy could generate US$113 million to US$244 million per year for the AF. This estimate is based on an assumed value of the CDM project activity market in 2010 ranging between US$112.97 billion to US$243.76 billion (CER demand: Haites 2004; CER prices: NatSource, cited on IADB Web site – http://www.iadb.org) and that value of CERs represents five per cent of this total project value.

Buenos Aires Program of Work on Adaptation and Response Measures
Agreed to at COP-10, decision 1/CP.10 recalls and builds upon earlier agreed SBI adaptation activities, including improving data collection, strengthening training and in-country capacity to address adaptation, carrying out pilot adaptation projects, promoting the transfer of technology for adaptation and building institutional capacity related to the management of disasters related to climate change. It also creates a process for the development of a SBSTA five-year program of work on adaptation. On response measures, the decision calls for expert meetings to exchange information on the possible impacts of mitigation measures and ways to promote economic diversification in oil-producing countries (Pew Center 2004).

Catastrophe Bond
An insurance instrument whereby the investor receives an above-market rate or return when a specific catastrophe, such as an earthquake, does not occur but shares the insurer's or government's losses by sacrificing interest or principle following the event (Linnerooth-Bayer *et al.* 2003: 21).

Exposure
The degree of climate stress upon a particular unit of analysis; it may be represented as either long-term changes in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events (IPCC 2001).

International Insurance Pool
In 1991, the Alliance of Small Island States put forth a proposal to create an international insurance pool to compensate small island states and low-lying developing countries for loss and damage stemming from sea-level rise. No formal negotiation of such a mechanism is taking place at present. The pool was envisaged as a collective loss-sharing fund to compensate the victims of sea-level rise, to be administered by a board under the UNFCCC and funded by mandatory contributions from industrialized countries proportional to GHG emissions and GNP. Advocates point to the fact that there are precedents in other international agreements that provide compensation to victims where harm is foreseeable. Examples of other international insurance pools include the 1963 Brussels Convention on Third Party Liability in the Field of Nuclear Energy and the treatment of oil spills under the 1992 Civil Liabilities Convention and the 1992 Fund Convention. Under the Fund Convention, an International Oil Spill Pollution Compensation fund is constituted to offset damage from oil spills, through a levy imposed on receivers of oil shipped in bulk, who tend to be oil companies, based on total tonnage received (Hamilton 2004; Linnerooth-Bayer *et al.* 2003; Muller 2002).

Least Developed Countries Fund
The LDCF is a UNFCCC fund established to support a program of work for LDC countries, including the development of National Adaptation Programmes of Action (NAPAs) by the 49 LDCs. NAPAs are to communicate priority activities addressing the urgent and immediate needs and concerns of LDCs relating to adaptation to the adverse effects of climate change. One LDC (Mauritania) has completed the development of its NAPA. A draft decision agreed to at the Subsidiary Body meetings in June 2005 will provide further guidance in the future operation of the Fund when adopted by the COP. A total of US$42.8 million has been raised as of April 2005 in support of the LDCF since its establishment in 2000, of which over US$11 million has been expended (GEF 2004a).

Micro-insurance
Can be defined as, "the provision of financial service that uses risk-pooling to provide compensation to (low-income) individuals or groups that are adversely affected by a specified risk or event" (Hoff *et al.* 2003). It is especially relevant to individuals and communities in developing countries, as they often require only a small amount of money to recover from weather-related catastrophes. These schemes can be index-based, whereby insurance is based on area-yield, rainfall or soil moisture indices (Skees *et al.* 1999), and should be developed jointly with governments, non-governmental organizations and private companies. Local calamity funds, savings and credit schemes are examples of micro-insurance.

Mitigation
Actions to cut net emissions of greenhouse gases and so reduce climate change. Examples are using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings and expanding forests and other "sinks" to remove greater amounts of carbon dioxide from the atmosphere (UNFCCC 2005).

Public-Private Insurance Partnerships
Refers to establishing schemes where the insurer is the government, but the policies are developed and managed by the private insurance sector—e.g., actuarial calculations, underwriting and marketing. Under some public-private partnerships, joint activities are undertaken, such as hazard assessments, to the benefit of both parties.

Regional Catastrophe Insurance Schemes
Pooling regional cash reserves may also provide a form of self-insurance. Mandatory contributions from member governments in, for example, the Caribbean, are collected and then used for on-lending to members affected by a weather catastrophe (DFID 2004). The possibility for regional pooling is currently being explored in the Caribbean and Pacific and shows promise for other regions as well. These schemes, or risk pools, could be backed by a regional facility that provides a layer of re-insurance cover, such as is provided by the World Bank in a number of countries through initiatives like the Turkish Catastrophe Insurance Pool.

Resilience
The capacity of a system to absorb disturbance, undergo change and still retain essentially the same function, structure, identity and feedbacks (Resilience Alliance: http://www.resalliance.org).

Special Climate Change Fund
The SCCF is a UNFCCC fund that supports: (1) adaptation activities, as a top priority; (2) technology transfer and capacity building; (3) energy, transport, industry, agriculture, forestry and waste management; and (4) economic diversification. The fund is to become operational in 2005, providing funding for adaptation activities, technology transfer and capacity building. Decisions on the priorities and focal areas for the third and fourth parts of the SCCF remain outstanding. Donors have pledged US$39.8 million in support of the SCCF as of April 2005.

Strategic Priority for Adaptation
The GEF Trust Fund has established a new strategic priority for adaptation to assist developing countries with integrating adaptation into their development planning. A total of US$50 million will be allocated to these activities between 2005 and 2007. The GEF SPA will cover the "incremental cost of those adaptation activities that generate global environmental benefits as well as the incremental cost of selected adaptation activities that are identified as high priorities by national communications" (GEF 2004a: 7).

SBSTA Programme of Work on Impacts, Vulnerability and Adaptation to Climate Change
At COP-10, the COP requested SBSTA develop a five-year program of work on the scientific, technical and socio-economic aspects of the impacts of, and vulnerability and adaptation to, climate change. The program of work is to assist Parties in addressing: methodologies, data and modelling; vulnerability assessments, adaptation planning, measures and actions; and integration into sustainable development. Draft text developed at SBSTA-22 suggests that the work program provide the COP and SBI with timely information and advice related to capacity building, economic diversification and financial assistance; and include information sharing to promote cooperation, avoid duplication and effectively utilize complementarities (FCCC/SBSTA/2005/L.14).

Vulnerability
The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of "exposure" and "adaptive capacity" (IPCC 2001).

Vulnerability and Adaptation Resource Group
An informal network of bilateral and multilateral institutions hosted by the World Bank. The purpose of the VARG is to share existing information and experiences for the purpose of integrating climate change adaptation into development processes.

Weather derivatives
An alternative risk-transfer mechanism developed to hedge financial risk associated with weather volatility. Weather derivatives are financial contracts whose value is tied to, or derived from, an underlying asset such as a temperature or precipitation index. They emerged in the United States in 1997 in response to deregulation of the power industry, which led companies to seek a financial vehicle to help manage their weather risk and reduce the impact of adverse weather on a company's bottom line. For example, by buying a rainfall derivative that locks into a future precipitation level, hydro generation plants could protect themselves against the financial impact of diminished rain, and fossil fuel electricity generators could protect themselves against the financial impact of excessive rain (Evomarkets.com nd). The market for weather derivatives has expanded from involvement of large energy trading companies to include end-user industries affected by the weather, and had a notional market value of US$4.2 billion in 2001 (Evomarkets.com nd). While the market continues to grow in the U.S. and Europe, developing countries have not yet been engaged. Experience has shown that the main barriers to the successful use of weather derivatives are data availability and quality, the existing regulatory environment and the credit worthiness of end user (Figueres 2005).

Weather hedges
These provide farmers with protection against extreme weather events. Insurance against a specific local weather phenomenon is sold by banks, farm cooperatives and micro-finance institutions to buyers at the same premium, who in turn receive the same indemnity payment per unit of insurance. Catastrophe bonds can be used to backstop this micro scheme to ensure that the insurance provider has sufficient capital to cover claims (Linnerooth-Bayer *et al*. 2003).

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Which Way Forward?

Issues in developing an effective climate regime after 2012

The Kyoto Protocol will expire in 2012, and the international climate policy community is seeking a new framework to address climate change in the near and long term. In "Which Way Forward?," members of the Climate Change and Energy Team at the International Institute for Sustainable Development frame the dialogue by focusing on issues of economic growth, technology, the carbon market and adaptation to the impacts of climate change. This publication is intended for anyone interested in becoming further informed on the status of efforts to establish an effective global climate regime after 2012: from Ministers to graduate students; from environmentalists to industry stakeholders.

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