

A Way Forward

Canadian perspectives on
post-2012 climate policy

Edited by John Drexhage, Deborah Murphy and Jenny Gleeson



iisd

International
Institute for
Sustainable
Development

Institut
international du
développement
durable

A Way Forward:

Canadian perspectives on
post-2012 climate policy

Edited by
John Drexhage, Deborah Murphy and Jenny Gleeson

© 2008, International Institute for Sustainable Development

The International Institute for Sustainable Development contributes to sustainable development by advancing policy recommendations on international trade and investment, economic policy, climate change and energy, measurement and assessment, and sustainable natural resources management. Through the Internet, we report on international negotiations and share knowledge gained through collaborative projects with global partners, resulting in more rigorous research, capacity building in developing countries and better dialogue between North and South.

IISD's vision is better living for all—sustainably; its mission is to champion innovation, enabling societies to live sustainably. IISD is registered as a charitable organization in Canada and has 501(c)(3) status in the United States. IISD receives core operating support from the Government of Canada, provided through the Canadian International Development Agency (CIDA), the International Development Research Centre (IDRC) and Environment Canada; and from the Province of Manitoba. The Institute receives project funding from numerous governments inside and outside Canada, United Nations agencies, foundations and the private sector.

A Way Forward: Canadian perspectives on post-2012 climate policy

Edited by John Drexhage, Deborah Murphy and Jenny Gleeson

ISBN 978-1-894784-21-4

International Institute for Sustainable Development

161 Portage Avenue East, 6th Floor

Winnipeg, Manitoba

Canada R3B 0Y4

Tel.: +1 (204) 958-7700

Fax: +1 (204) 958-7710

Web site: <http://www.iisd.org>

This document was developed under the Post-2012 Climate Dialogue Project, a two-year initiative implemented by IISD. The project aimed to contribute to an increased understanding of Canada's situation vis-à-vis the climate change issue and Canadian approaches to a post-2012 climate regime.

This project was funded through grants from Environment Canada, and the governments of Alberta, British Columbia, Manitoba, Nova Scotia and Ontario. Support was also provided by ConocoPhillips, Manitoba Hydro, Shell Canada, Spectra Energy, Suncor Energy and TransCanada Pipelines. The generous support of these organizations is gratefully acknowledged.

The views expressed remain those of IISD and do not necessarily reflect those of the funders, nor should they be attributed to them.

Foreword

The International Institute for Sustainable Development (IISD) has been working on post-2012 issues for the last few years, exploring Canadian perspectives and contributions to developing a sustainable global climate change regime after 2012 (the end date of the first commitment period of the Kyoto Protocol). Prior to the Montreal Conference of the Parties (COP) in 2005, IISD began to look at these issues and published two documents, *Which Way Forward?* and *Canada in a Post-2012 World*.

This book, *A Way Forward: Canadian perspectives on post-2012 climate policy*, covers the four main elements of the 2007 Bali Action Plan: mitigation of greenhouse gas emissions; adaptation; technology; and financing and investment. These issues will be discussed under the dialogue on long-term cooperative action under the United Nations Framework Convention on Climate Change (UNFCCC). This dialogue will take place over the next two years, and negotiators will attempt to reach consensus on an international package for addressing climate change by COP-15 to be held in Copenhagen in 2009.

A Way Forward is a “living” document that attempts to reflect the evolving expectations of the international community. The decisions made at Bali have determined that the post-2012 regime will be very much a package deal. Targets will be an important part of the deal, but the mitigation commitments “tent” will need to be broadened beyond the current list of industrialized countries. Achieving this will be critically dependent on the extent to which tangible agreements are reached on adaptation, technology cooperation and, in particular, a road map on how to finance these vital areas over the period of the post-Kyoto regime.

Peter Haldan of the Swedish Defense Research Agency noted in *The Geopolitics of Climate Change* that “... writing about climate change today, is more difficult than shooting a moving target. In fact it is more like analysing a constantly mutating entity.” What makes this observation even more germane is that most analysts are typically referring to the geopolitics of climate change impacts and adaptation. It is clear that the geopolitics of greenhouse gas mitigation and carbon sequestration are evolving at the same rapid pace. And Haldan was only talking about the challenge of doing research on climate change. Pity the plight of the policy-maker who must try to make sense of this “mutating entity” in the context of governance and political institutions that do not seem equipped to adequately deal with such a set of complex variables.

Policies that cannot perform effectively under complex, dynamic and uncertain conditions—such as the conditions surrounding climate change—run the risk of not achieving their intended purpose. Additionally, they can become a hindrance to the ability of individuals, communities and businesses to cope with and adapt to change. Developments at Bali underscored the complex dynamics of the negotiations when faced with new information on the nature

of the climate change threat. In this writer's view, the most critical development at Bali was the increasing pressure on the international community to define what "dangerous levels of anthropogenic interference with the global climate system" actually represents. This eventually came out in the form of a footnote in the Bali Action Plan, referencing the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report which stated that a 2° Celsius ceiling on global warming would require developed countries to reduce greenhouse gas emissions in a range of 25 to 40 per cent below 1990 levels by 2020.¹ While this does not represent a commitment by any Parties to such a level, the very fact that it is the one set of "numbers" referenced in the Plan means that pressure will be on developed countries to agree to such a commitment by Copenhagen.

The conclusions of the IPCC synthesis report played a key role in this "footnote" controversy, particularly the conclusion that a global warming of 3.5°C or higher (roughly consistent with a doubling of pre-industrial emissions) would see the number of species at risk of extinction skyrocket to up to 40–70 per cent from around 20 per cent under a 2°C scenario. While the science justifies taking on increasingly stringent reductions, the reality of being able to do so given growing global energy needs, particularly in developing countries, makes this issue the poster child of the world being "between a rock and a hard place."

The concept of adaptive policy-making offers a practical way forward in today's uncertain world, and the need for adaptive policy development, management and implementation has never been more apparent. Addressing the many sides of the climate change debate requires "adaptive" policy-making and complex adaptive systems thinking on the part of public institutions, whether at the local, regional, national or international level. *A Way Forward* seeks to develop outcomes that will be more adaptive, and hence more effective, in addressing this rapidly changing political, social, economic and environmental challenge. The aim is to get to the heart of the issues being negotiated under the "four pillars" of the Bali Action Plan.

Chapter 1 of *A Way Forward* re-examines Canada's national circumstances in light of the agreements reached at Bali. In Canada, post-2012 policy will need to account for the rise to prominence of climate change as a public policy issue, the urgency demonstrated by the scientific community, and the desire of the Canadian public for action on climate change and movement toward meeting our Kyoto target. It will also need to account for the increasing role that natural resources—particularly the oil sands and natural gas reservoirs—are playing in the Canadian economy. This is already beginning to define a rising national dynamic in this country, pitting, if not carefully managed, manufacturing-intensive regions (such as Ontario and Quebec) against regions with

1 Notably, the footnote did not mention that a significant departure from projected emissions would also be required by major developing economies.

strong natural resource export capacity (such as Alberta, Saskatchewan and Newfoundland). How these issues will be managed over the next decade will be an increasingly critical factor in defining Canada's international profile in the multilateral community, including the G8 and United Nations.

The second chapter explores the tensions among GHG mitigation, economic growth and development, in both an international and Canadian context. There will be costs to reducing greenhouse gas emissions, but there is opportunity to minimize the costs with good policy design. In Canada, this includes an economy-wide price signal and mechanisms to stimulate significant technology deployment. Internationally, this means differentiated action, including in the areas of reducing emissions from deforestation and forest degradation, sectoral approaches and market-based mechanisms. In terms of mitigation, achieving development and economic goals in a sustainable manner implies the need for significant cuts from developed countries, meaningful actions from developing countries and a more nuanced approach to commitments than the Kyoto Protocol's two-tier system (given the wide disparity of circumstances facing developing countries and the overriding need for action by the large fast-growing emitters).

Canada has a critical stake in determining the structure and content of an international adaptation regime as climate change is already affecting Canada, particularly in its northern and Arctic regions. The third chapter, "Adaptation in a Post-2012 Climate Regime," examines Canada's role in supporting adaptation in an international context; and then looks at three main questions to be addressed in determining the scope of a post-2012 adaptation regime: the general design of the regime; financing adaptation, particularly in developing countries; and priority areas of support through the UNFCCC and other actors. A main concern for the post-2012 regime will be how to identify and report clearly on discrete adaptation actions in developing countries. To be fully effective, concerns related to adaptation will need to be placed in a broader policy context—i.e., they will need to be seamlessly integrated into development. An integrated approach calls for enhanced cooperation between the development and climate communities, as adaptation efforts cannot be effectively undertaken separately from ongoing development and governance processes.

The fourth chapter, "Technology's Role in the Emerging Post-2012 Climate Change Regime," looks at emerging perspectives on technology in a post-2012 regime, examining Canadian technology strengths and interests, identifying key considerations for international technology cooperation, and evaluating opportunities to address Canadian technology strengths and interests in the post-2012 climate change world. A fundamental challenge is how to promote a technology revolution on a global scale that would enable, at acceptable costs, the steep reductions required to stabilize atmospheric greenhouse gas concentrations at a safe level. A critical issue is the sufficiency of technology coopera-

tion under the UNFCCC, where actions rely mainly on public finances, and how to direct private investment flows to put countries on a path of low-carbon development. For Canada, this will require real action at both the domestic and international level, including support for developing countries; action through multiple venues both within and outside of the formal parameters of the UNFCCC; and allocation of significant funding to technology efforts at home and abroad.

Chapter 5 outlines the fourth and final area identified in the Bali negotiating process—financing and investment. This chapter examines the relationship between the international market and public resources, mechanisms to close the gap between current resources and future demands, and Canadian perspectives on financing and investment in a post-2012 regime. Financing and investment is a fundamental component of an international climate change package, and significant changes in the existing patterns of public and private investment and financial flows will be required. Improving access to adequate and sustainable financial resources and defining a financing path for adaptation, mitigation and technology cooperation represents a special challenge. How we define this path—when it is the global marketplace, more so than any public funding provisions, that will ultimately determine how climate-friendly future development will be—is critical.

It is these and other equally intractable issues that we have attempted to address in this latest effort of the Climate Change and Energy Team at IISD. Despite the considerable analysis set out in this report, it is only a beginning. The decisions reached at Bali have set in place a dynamic and powerful course of action that countries, including Canada, are only beginning to seriously address. A number of issues require further analysis. From a Canadian perspective (along with other key nations) this includes commodity-based growth, ways to de-link growth from carbon-intensive activities, and developing more sustainable consumption patterns. Financing and investment considerations also require serious examination given the fact that Canada, along with other developed countries, is committed to help finance the global transition to clean energy systems and sustainable adaptation strategies—no small order.

One thing is clear in Canada—domestic and international policy-making on climate change cannot continue to be developed in splendid isolation from one another. While perhaps not fully successful, we have attempted throughout this document to address international climate policy in a way that both focuses on the domestic implications of international developments and the international ramifications of domestic policy. Going forward otherwise would see Canada continue to grope aimlessly in the way it has (far too often) for the last 15 years.

I would like to thank the IISD staff and associates for their considerable efforts and devotion to this, the thorniest of all global issues. I would also like to thank

our many external peer reviewers who provided advice and direction; they include representatives from governments, First Nations, the scientific community, the private sector and civil society, including environmental constituencies. And of course, thanks to the many financial supporters of this effort, for without their assistance this exercise would not have been possible. At the end of the day, of course, the views contained in this document entirely remain those of IISD.

A handwritten signature in black ink, appearing to read 'J. Drexhage', enclosed within a large, stylized, hand-drawn oval shape.

John Drexhage
Director, Climate Change and Energy
International Institute for Sustainable Development

Table of Contents

Chapter 1: Canada in a Post-2012 World	1
1. Introduction	1
2. Setting the context: Canadian circumstances	3
3. Costs of inaction on climate change	10
4. Concluding comments	14
Chapter 2: Encouraging Mitigation and Economic Growth in a Post-2012 Climate Regime	21
1. Introduction	21
2. Mitigation: setting the context	22
3. The tensions between GHG mitigation, economic growth and development	25
4. Canadian mitigation and the implications for economic growth	32
5. Elements of a post-2012 international approach to mitigation	43
6. Reflections on a way forward	58
Chapter 3: Adaptation in a Post-2012 Climate Regime	67
1. Introduction	67
2. Setting the context	69
3. Canadian interests and strengths	76
4. The Bali Action Plan	82
5. Financing for adaptation	86
6. Support for adaptation	94
7. Reflections on a way forward	105

Chapter 4: Technology’s Role in the Emerging Post-2012 Climate Regime	135
1. Introduction	135
2. Technology in a post-2012 regime: setting the context	136
3. Canadian strengths and interests related to technology	142
4. Advancing technology cooperation	154
5. Reflections on a way forward	166
6. Conclusion	173
Chapter 5: Investment and Finance in the Emerging Post-2012 Climate Regime	191
1. Introduction	191
2. Setting the context: investment and finance	191
3. Financial obligations of developed countries under the Convention and the Kyoto Protocol	193
4. How have developed countries responded?	194
5. The role of Canada	203
6. Elements of an international approach to financing and investment for climate change	209
7. Reflections and implications for Canada	217

Abbreviations and Acronyms

AAU	Assigned Amount Units
AF	Adaptation Fund
AfDB	African Development Bank
AOSIS	Alliance of Small Island States
APP	Asia Pacific Partnership for Clean Development and Climate
APEC	Asia-Pacific Economic Cooperation
AR4	Fourth Assessment Report
AWG-KP	Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol
BAU	business as usual
BEET	balance of embodied emissions in trade
CANDU	Canada Deuterium Uranium
CCCDF	Canada Climate Change Development Fund
CCIAP	Climate Change Impacts and Adaptation Program
C-CIARN	Canadian Climate Impacts and Adaptation Network
C-GEEM	Canadian General Equilibrium and Emission Model
CCS	carbon capture and storage
CDCF	Community Development Carbon Fund
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CFE	Carbon Fund for Europe
CIDA	Canadian International Development Agency
CIP	Canadian Institute of Planners
CO ₂	carbon dioxide
CO ₂ -eq	carbon dioxide equivalency
COP	Conference of the Parties
CPF	Carbon Partnership Facility
CTI	Climate Technology Initiative
CSLF	Carbon Sequestration Leadership Forum
DAC	Development Assistance Committee (of the OECD)
DANIDA	Danish International Development Agency
DFAIT	Department of Foreign Affairs and International Trade, Canada

DFID	Department for International Development, United Kingdom
EC	European Commission
ECA	export crediting agency
EDC	Export Development Canada
EGTT	Expert Group on Technology Transfer
EIB	European Investment Bank
EOR	enhanced oil recovery
ESF	Exogenous Shocks Facility
EU	European Union
EU ETS	European Union Emissions Trading Scheme
ERU	Emission Reduction Unit
FAITC	Foreign Affairs and International Trade Canada
FAO	Food and Agriculture Organization
G8	Group of Eight
GDP	gross domestic product
GEF	Global Environment Facility
GENIV	Generation IV International Forum
GHG	greenhouse gas
GNEP	Global Nuclear Energy Partnership
GNI	gross national income
HIV/AIDS	Human immunodeficiency virus/acquired immune deficiency syndrome
HRM	Halifax Regional Municipality
IDRC	International Development Research Centre
IEA	International Energy Agency
IFC	International Finance Corporation
IFRC	International Federation of the Red Cross
IISD	International Institute for Sustainable Development
IISI	International Iron and Steel Institute
ILO	International Labour Organization
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPHE	International Partnership for the Hydrogen Economy
IPO	initial public offering
IPR	intellectual property rights
JI	Joint Implementation
LDC	least-developed country
LDCF	Least Developed Countries Fund
LULUCF	land use, land-use change and forestry
M&A	mergers and acquisitions
M2M	Methane to Markets
MDB	Multilateral Development Bank

MDG	Millennium Development Goal
MOP	Meeting of the Parties
Mt	megatonne
N ₂ O	nitrous oxide
NAPA	National Adaptation Programmes of Action
NEB	National Energy Board
NGO	non-governmental organization
NIMBY	not in my backyard
NRCan	Natural Resources Canada
NRTEE	National Round Table on the Environment and the Economy
NWP	Nairobi Work Program
OCHA	UN Office for the Coordination of Humanitarian Affairs
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PNG	Papua New Guinea
ppm	parts per million
R&D	research and development
RD&D	research, development and dissemination
REDD	reducing emissions from deforestation and forest degradation
REEEP	Renewable Energy and Energy Efficiency Partnership
RGGI	Regional Greenhouse Gas Initiative
RMU	removal unit
S&T	science and technology
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCCF	Special Climate Change Fund
SD-PAM	Sustainable Development Policies and Measures
SDTC	Sustainable Development Technology Canada
SEST	sustainable energy science and technology
SIDS	small island developing states
SPA	Strategic Priority on Adaptation
T&D	transmission and distribution
UKCIP	United Kingdom Climate Impacts Programme
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VER	Voluntary Emission Reduction
WBCSD	World Business Council for Sustainable Development
WCI	Western Climate Initiative
WCSB	Western Canadian Sedimentary Basin
WEO	World Energy Outlook
WSSD	World Summit on Sustainable Development

Chapter 1: Canada in a Post-2012 World

Deborah Murphy, John Drexhage, Jenny Gleeson and David Sawyer

1.0 Introduction

Climate change is now commonly identified as one of the most urgent and critical issues for the global community to address. The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC, 2007a) confirmed that the warming of the climate system is unequivocal, and human actions are changing the earth's climate and creating major disturbances in human systems and ecosystems. The report concluded that current climate change mitigation policies and related development practices will cause continued growth of global greenhouse gas (GHG) emissions over the next few decades, unless significant reductions are made. Another recent study, the Stern Review (2006), reported there are large economic, environmental and social costs of not acting; and that the benefits of early global action to mitigate climate change will be far greater than the costs related to the impacts of climate change. Grasping this reality, Canadians are demanding real action, both domestically and internationally, but at a pace that makes sense economically, environmentally and socially.

Parties to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol met in Bali, Indonesia, from December 3 to 14, 2007 to consider how to address climate change in the post-2012 period¹ when the Kyoto Protocol's first commitment period terminates. Negotiators agreed on a two-year process to finalize a post-2012 regime by December 2009.² The key elements are contained in UNFCCC decision 1/CP.13 on the Bali Action Plan, adopted by consensus on December 15 (UNFCCC, 2007a).

The Bali Action Plan, which is the focus of this book, represented a critical step in the development of a future climate change regime. The action plan is one of three tracks for moving forward, being complementary to the work of the Ad Hoc Working Group on Further Commitments for Annex I Parties under

1 The Kyoto Protocol entered into force in 2005 and established emission reduction targets for Annex I Parties which were intended to reduce their overall emissions of six greenhouse gases by an average of 5.2 per cent below 1990 levels from 2008 to 2012.

2 This process will build on the work of the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP) and a "Dialogue" to consider long-term cooperation under Convention as initiated at COP-11 in Montreal in December 2005. The main purpose of both processes was to exchange information and ideas regarding a follow-up to Kyoto.

the Kyoto Protocol (AWG-KP) and the second review under Article 9 of the Kyoto Protocol. The AWG-KP is examining the scale of emission reductions to be achieved by Annex I countries, and developing draft decisions on further commitments by these countries to be forwarded to COP/MOP at its fifth session in 2009. The second review of under Article 9 will take place at COP/MOP-4 in 2008, where countries will address issues of interest and provide information on progress in meeting commitments.³

Bali was successful in delivering the expected outcome and building blocks for future negotiations, but not without considerable controversy. Decision 1/CP.13 addresses “a shared vision... including a long-term global goal for emission reductions” and “enhanced action” on the four building blocks: mitigation, adaptation, technology and finance. The aim of the process is to implement the Convention and approach its objective through “long-term cooperative action” (UNFCCC, 2007a). The process will be conducted by an ad hoc working group, open to all Convention Parties that will meet four times in 2008, with the first meeting held in Bangkok, Thailand, in April.

With the agreement of the United States and developing countries, there seems to be for the first time an opportunity to foster a global response to climate change. One price paid for this political deal was the abandonment of an effort to include preambular language containing quantitative indicators for the mitigation effort by developed countries by 2020 and globally by 2050.⁴ The Plan also retains a significant distinction between developed and developing countries with respect to their mitigation actions; action by developed countries may include “commitments,” including Kyoto-type “quantified emission limitation and reduction objectives,” while similar language is not included for developing countries (including high-emitting developing countries).

Whether this political compromise will be adequate to meet the challenge laid down by the IPCC remains to be seen. The IPCC (2007a) findings note that “global emissions of greenhouse gases need to peak in the next 10 to 15 years and be reduced to very low levels, well below half of levels in 2000 by the middle of the twenty-first century in order to stabilize their concentrations in the atmosphere and that achieving the lowest stabilization level assessed by the IPCC would require Annex I Parties as a group to reduce emissions in a range of 25 to 40 per cent below 1990 levels by 2020.”

As noted above, there are four elements under the Bali Action Plan. The mitigation building block incorporates action on reducing emissions from deforestation and forest degradation (REDD), as well as cooperative approaches in

3 See the decision from COP-13/MOP-3, *Scope and content of the second review of the Kyoto Protocol pursuant to its Article 9*.

4 These indicators are, however, retained in the conclusions of the AWG and the underlying IPCC findings are referenced in footnote 1 to decision 1/CP.13.

specific sectors identified in the Convention. The building block on adaptation addresses all countries, but emphasizes the needs of the particularly vulnerable developing countries. It includes international cooperation to support adaptation through vulnerability assessments, financial needs assessments, capacity building, integration into national planning, and other ways to incentivize the implementation of actions. The technology development and transfer building block considers mechanisms to remove barriers and obstacles, and provision of financial and other incentives to scale up the transfer of technology to developing countries, and cooperation on research and development. The financing and investment building block considers improved access to adequate and sustainable financial resources, positive incentives for developing countries, and mobilization of public and private funds to facilitate carbon-friendly choices.

In this book, IISD examines emerging approaches and options for post-2012 climate change cooperation, focusing on salient Canadian sensitivities and perspectives, and how Canada might contribute to the development of a robust and equitable climate change regime. This first chapter provides context for the analysis by examining the national circumstances in which Canada will develop and negotiate a position under the Bali Action Plan. Chapter 2 addresses how the post-2012 regime may address the urgent need for mitigation, and the basic fact of economic growth, particularly in developing nations. The analysis includes international and domestic perspectives, describing how the various possible elements of an international agreement fit with Canadian interests. Using this lens, the subsequent chapters look at adaptation, technology, and financing and investment—reviewing the options and assessing how Canadian strengths and interests might best be addressed.

Climate change is a complex issue with a range of interests and a diversity of stakeholders, within Canada and internationally. An effective post-2012 climate regime will need to encourage deep reductions in the release of GHG emissions to prevent an increase in the Earth's average temperature, while ensuring equitable economic development in all countries and promoting significant energy development in developing nations. Interwoven in all these considerations is the need for adaptation to help nations cope with climate change impacts.

2.0 Setting the context: Canadian circumstances

Environment has climbed to the top of the political agenda and climate change continues to attract widespread attention from the Canadian public. According to an Environmental Monitor poll released in September 2007, Canadians are expressing alarm about climate change in greater numbers than in any developed nation except France. Two-thirds of Canadians rated climate change as a “very serious” problem, up from 57 per cent in 2006. Concern about environmental issues in Canada is at a record high according to this poll, with the concern highest in the North where the impacts of a warming climate

have been felt most dramatically (McAllister and Globescan, 2007). Canadians are demanding an expanded discussion and debate on the issue of climate change, and are increasingly favouring tough action at home and leadership in international fora to respond to what they believe to be a serious challenge.

2.1 Evidence of climate change

In its Fourth Assessment Report, the IPCC concluded that it is more than 90 per cent certain that the current global warming is the result of human activities, particularly related to industrial, consumption and land-use practices. The world has warmed by an average of 0.76° Celsius since pre-industrial times, and global average temperature is projected to increase further by 1.8° to 4°C if no action is taken. The IPCC notes that more intense and longer droughts have been observed over wider areas, the frequency of heavy precipitation events has increased and widespread change in extreme temperatures have been observed. In the Arctic, average temperatures have increased at almost twice the global average rate in the past 100 years, sea ice extent has shrunk and temperatures at the top of the permafrost layer have generally increased (IPCC, 2007d: 7–9). In its Synthesis Report, the IPCC (2007a) also notes that a 2°C global temperature change (we are already on track for at least a 2°C change) puts 20 per cent of the world’s species at risk, but a 3.5°C temperature change, which would still require significant shifts in energy and land-use practices, starting today, would result in up to 40–70 per cent of the world’s species being at risk of extinction.

Canadians contribute to and experience the impacts of climate change. Canada’s high-latitude location and large landmass means that it is highly exposed to climate change; and IPCC climate projections indicate that the largest warming is expected to occur in winter over northern parts of Canada and Alaska, reaching a 10°C increase in the northernmost parts (IPCC, 2007d: 889). An unbroken chain (of a dozen years and counting) of record warm temperatures globally and mounting evidence that some of the most serious and wide-ranging impacts of climate change are occurring in the Arctic are issues that increasingly resonate with Canadians. A growing acceptance of the science—that climate change is occurring and is impacted by anthropogenic interference—is generated partially by the physical evidence of climate change.

Early indicators of the consequences of these changes in Canada include the instability of infrastructure due to melting permafrost, the increase of ice-free open water in the Northwest Passage, the ravages of the mountain pine beetle on forests in British Columbia and the droughts in the western provinces. Environment Canada (2007a) acknowledges that temperatures are rising, particularly in the north where permafrost is thawing and the ocean’s ice cover is melting. Canadian research corroborates international research, indicating that greater changes are expected in the future, including continued increases in temperatures, shifts in rainfall patterns and increases in certain types of haz-

ardous weather such as heat waves and heavy rains. Environment Canada (2007a) notes that “As a cold northern country, Canada will be one of the most greatly affected countries in the world.”

2.2 Greenhouse gas emissions profile

The nation’s most recent GHG emissions profile demonstrated that Canadians have not been effective in reducing emissions, despite international commitments and increasing domestic concern. In 2005, Canada’s total GHG emissions were estimated to be 747 megatonnes of CO₂ equivalent (CO₂-eq), up 25.3 per cent from 1990 and 32.7 per cent above the nation’s Kyoto Protocol target of reducing emissions by at least six per cent below 1990 levels by 2008–2012 (Environment Canada, 2007c: 3). Of all Annex I Parties, Canada was the fifth largest emitter of GHGs in 2004, behind the United States, the Russian Federation, Japan and Germany (Government of Canada, 2006).

Looking at the International Energy Agency (IEA, 2007) reports on CO₂ emissions to allow comparability across all nations, Canada’s total CO₂ emissions were 548.59 Mt in 2005, the seventh highest out of 136 nations, behind the four Annex I nations mentioned above and China and India. Canada ranked third in per capita CO₂ emissions amongst OECD nations, surpassed only by the United States and Australia.

Most of the increases in Canada’s GHG emissions between 1990 and 2005 were in the energy and transportation sectors, which accounted for 137 Mt of the overall increase in emissions of 151 Mt. Environment Canada (2007c: 13–14) noted that much of the increase in emissions from the oil and gas sector can be attributed to a rapid rise in exports to the United States; in 2005, net emissions associated with these exports had increased 162 per cent over 1990 levels.

Many argue that special circumstances account for Canada being one of the world’s highest emitters and affect post-2012 climate regime policy choices. While GHG emissions per unit of GDP decreased by approximately 18 per cent from 1990 to 2005 because of increases in energy efficiency (Environment Canada, 2007c: 4), the growth in the economy and particularly in resource-based industries meant continued high levels of emissions. Canada’s large size, low population density and northern climate—in addition to economic growth being linked to resource-based energy-intensive sectors that are mostly geared for export markets—led to high levels of emissions.

2.3 Economic and energy profile

Canada’s GHG emissions are influenced by the country’s economic and energy profile. Critical factors are solid economic growth and a reliance on natural resource extraction and processing, which is discussed in greater detail in Chapter 2, Section 4. Added to this is that Canada’s energy systems have both domestic and international components, an inescapable reality related to geography, energy infrastructure and economics. The country’s positive trade balance

is extremely dependent on the export of oil and gas, including exports equivalent to 2.3 million barrels of oil a day to the U.S. market in 2006 (Natural Resources Canada [NRCan], 2007a). The two countries are each other's largest trading partners, with the United States representing approximately 80 per cent of Canada's exports and two-thirds of imports in 2006 (Statistics Canada, 2007).

The linkages with the U.S. economy and the increasing integration of the Canada-U.S. energy systems have a major impact on Canada's GHG emissions. Significant increases in oil and gas production between 1990 and 2005, with almost all exports provided to the United States, have resulted in a significant increase in the emissions associated with the production and transportation of fuel for export. Canada is increasingly meeting oil needs in the United States, particularly in the transportation sector where demand is driven by a relatively fuel-intensive fleet of vehicles. That said, directives in the Energy Independence and Security Act of 2007, which was signed into law in December 2007, could have a direct impact on oil sands development. Section 526 prevents U.S. federal agencies from buying vehicle fuel derived from non-conventional sources unless the lifecycle GHG emissions are the same or less than that of conventional petroleum (Mittelstaedt, 2008).

There could be growing pressure to increase the level of energy exports. Washington insiders have indicated that President Bush is relying on Canada to help the United States lessen its reliance on Middle Eastern oil, a goal defined as a national security objective (CBC.ca, 2007). The Security and Prosperity Partnership between Canada, the United States and Mexico was launched in 2005 and committed to joint cooperation in the areas of: regulation, energy efficiency; natural gas; science and technology; reliability of electricity transmission grids; oil sands production; nuclear energy; hydrocarbons; and energy information, statistics and projections. An agreement for cooperation in energy science and technology was one outcome of the 2007 summit. Energy security is a significant policy driver in the United States; and Canada, because of its endowment of energy resources, is an important piece in the North American energy security puzzle.

Competitiveness concerns have arisen in Canada, particularly with the U.S. decision not to ratify the Kyoto Protocol. There is optimism that the United States may be more engaged under a new administration after 2008, and a number of bills on emissions trading are circulating in Congress. Yet there are fears that a CO₂-constrained Canada could have difficulty controlling emissions if the United States does not implement comparable domestic GHG emission control measures.

Canada's vast forests and the importance of forests in the global carbon cycle is another consideration. NRCan (2007b) indicates that Canada's forest cover is 310 million hectares (of which 236 million ha is managed forest), and estimates that between 1990 and 2005, Canada's forest was an overall sink—except for five years when it was an overall source mainly due to natural forest fires and decay

associated with the mountain pine beetle. Analysis suggests that between 2008 and 2012, there is a 90 per cent chance that Canada's forests will be a net carbon source, leading the government to decide not to include forest management in Canada's Kyoto accounting. Land use, land-use change and forestry (LULUCF) activities are a key issue in Canada. In the post-2012 discussion, NRCan (2007b: 2) expects that Canada will likely seek changed rules for forest carbon accounting that provide positive incentives for forest management activities, but do not punish or reward countries for emissions and removals that are beyond their control. Application of current LULUCF rules, for example, would place Canada 54.2 per cent above its 1990 emissions levels, rather than 25.3 per cent growth without LULUCF activities included (UNFCCC, 2007b).

Agriculture is another sector of economic importance that impacts on climate change policy. In 2004, the agricultural sector was responsible for 7.6 per cent of total GHG emissions in Canada; with the sector accounting for 66 per cent of Canada's total emissions for nitrous oxide and 25 per cent of methane emissions (Environment Canada, 2007c: 7). At the same time, agricultural practices can make a significant contribution at a low cost to increasing soil carbon sinks, reducing GHG emission reductions and contributing biomass feedstocks for energy use (IPCC, 2007c: 64). A study of the mitigation potential of agricultural soils in Canada concluded that the sector is likely to sequester more CO₂ than it emits, with projections of a decline in net emissions, particularly with the adoption of several sink-enhancing practices (Boehm *et al.*, 2005: 298). Several challenges related to agriculture—such as design of efficient policies and measurement and assessment methods—will need to be resolved at the international level to ensure that a future framework more effectively addresses the challenges and opportunities of this sector.

2.4 Political response

While Canada is a net energy exporter, primary energy sources are unequally distributed across the country with the oil-rich areas being Alberta, Saskatchewan and the Northwest Territories; and hydroelectricity potential being mainly located in Quebec, British Columbia, Newfoundland and Manitoba. Two-thirds of the electricity produced in Canada comes from hydropower (Canadian Hydropower Association, 2004) and other renewable sources of electricity are being integrated into the electricity system at a rapidly growing rate, although they currently comprise a small share of supply. Ontario is home to 20 of Canada's 22 CANDU nuclear reactors, which generate 50 per cent of the province's electricity (Canadian Nuclear Association, 2005). Energy demand also varies, with Ontario accounting for almost one-third of total energy consumed in Canada, followed by Alberta. Ontario is the most populated province with a large industrial base, while Alberta consumes a lot of energy to produce energy for other regions of Canada and for export markets. The geographic reality of energy production and consumption means that provinces have very different perspectives when developing climate

change policies and programs, and have different expectations in regard to Canada's commitments under the UNFCCC.

Provinces have constitutional authority for the development of energy resources, and the federal government has responsibilities for international energy and environment issues including trade, inter-provincial issues and climate change. There are many other shared and overlapping responsibilities that impact climate change programs and policy; and integration has proven to be difficult because of differing interests in each jurisdiction. It can be a difficult and lengthy process to reach a compromise that satisfies all interests on climate change mitigation, evident from the inability to reach agreement on specific provincial action within Kyoto. Provinces and territories have moved toward creating a shared vision, with the Council of the Federation (2007) agreeing in August 2007 on *A Shared Vision for Energy in Canada* and committing to reduce GHG emissions and address the impacts of climate change. The premiers called upon the federal government to acknowledge the constitutional jurisdiction of the provinces and territories, and to formally include them in international discussions and negotiations that affect their jurisdiction. There is rising scope for clashes between the provinces and the federal government, which has become increasingly active on the environment and climate change files as these issues have attracted more attention from the Canadian public.

The Government of Canada (2007b) highlighted the importance of climate change in its October 2007 Speech from the Throne, which noted that a global solution to climate change is required. The government stated that Canada will not meet its Kyoto commitment within the compliance period, but will act "even more aggressively at home" while pursuing an international consensus. While recognizing that Canada will not meet its Kyoto target, the government has not clarified if it will honour the non-compliance provisions of the Kyoto Protocol, which include making up the difference between its emissions and its assigned amount during the second commitment period, plus an additional deduction of 30 per cent.

The national strategy includes the *Regulatory Framework for Air Emissions* from large final emitters, introduced in April 2007, which sets a goal of reducing absolute GHG emissions by 20 per cent below 2006 levels by 2020, and 60 to 70 per cent below 2006 levels by 2050 (Government of Canada, 2007a). Companies will have an emissions-intensity reduction target based on an improvement of 18 per cent per unit of production over the next three years.⁵

5 GHG intensity refers to the amount of GHGs produced per unit of economic activity (e.g., GDP or unit of production), thus emissions intensity targets mean that GHG emissions are relative to the economic output of various industries. Intensity-based targets are criticized by many because GHG emissions can continue to rise so long as they decrease relative to economic expansion (see, for example, Marshall, 2007; Footitt, 2007; Bramley, 2007). Absolute targets, such as those set under the Kyoto Protocol, are specified in tonnes relative to a historical baseline.

Each year after that, industry will have to achieve a further two per cent improvement in emission intensity. Compliance tools in the regulatory framework include an emissions trading system with offsets and access to the Clean Development Mechanism (CDM), and a technology fund. Draft regulations are expected to be published beginning in spring 2008, though questions persist as to the scope, timing and implementation of a national regulatory framework. Other regulatory initiatives include energy efficiency standards for home appliances, vehicle fuel emissions standards and renewable fuel content standards. The federal government's action plan to reduce GHGs also includes fiscal incentives and direct investment in a number of areas—including renewable energy, biofuels, transportation, energy efficiency, carbon capture and storage (CCS) and agriculture. The federal government's trust fund for clean air and climate change supports many provincial initiatives.

The provinces and territories are becoming increasingly active in the area of climate change, introducing an array of policies and programs:

- Ontario, Saskatchewan, New Brunswick and the Northwest Territories introduced new climate change plans in 2007;
- British Columbia introduced a revenue-neutral carbon tax in February 2008. The tax will put a price on carbon emissions for virtually all fossil fuels sold in the province starting July 1, 2008. The tax will be phased in over five years and will start at a rate of \$10 per tonne of carbon emitted. It will rise \$5 a year to \$30 per tonne by 2012. British Columbia introduced Bill 44, the Greenhouse Gas Reduction Targets Act, in November 2007, making it the first province to establish emission targets (reductions of 33 per cent by 2020 from 2007 levels, and 80 per cent reductions by 2050 from 2007 levels). This Bill requires the provincial government and all public sector organizations to undertake actions to minimize GHG emissions. The province is expected to introduce legislation for non-government sectors in 2008 that will include provisions for a cap and trade system for large emitters.
- Alberta is the first Canadian jurisdiction to regulate large emitters; as of July 1, 2007, regulations set a 12 per cent emissions intensity reduction target for all large facilities;
- Ontario is the first jurisdiction in North America to introduce feed-in tariffs in its Renewable Energy Standard Offer Program, which provides small electricity generators a standard pricing regime;
- Nova Scotia's 2007 Environmental Goals and Sustainable Prosperity Act establishes a goal of reducing GHG emissions to 10 per cent below 1990 levels by 2020;
- Quebec renewed its climate plan in 2006, and became the first Canadian jurisdiction to tax carbon, when its Carbon Tax came into effect in 2007.

Revenues from the tax are allocated to a Green Fund to implement Quebec's climate change plan;

- Manitoba has been a leader on climate change, stating in its 2002 plan that it intended to meet and exceed the Kyoto reduction target;
- Prince Edward Island, Newfoundland, Yukon Territory and Nunavut also have developed climate change plans or strategies; and
- Several provinces have committed to, or expressed interest in, adopting California fuel pipe standards, including British Columbia, Manitoba and Quebec.

A summary table of climate change plans of Canadian governments is included in Appendix 1.

Many provinces are collaborating with American states, perhaps indicative of the desire to address competitiveness issues through the linking of carbon markets and establishing similar regulations and standards. Recent collaboration includes British Columbia, Manitoba, Ontario and Quebec committing to participate with 40 states in the Climate Registry; and British Columbia, Manitoba and Ontario signing climate change agreements with California. British Columbia, Quebec and Manitoba have joined the Western Climate Initiative (WCI) with six western U.S. states seeking to jointly cut emissions 15 per cent below 2005 levels by the year 2020, including the development of a regional cap and trade program to attain that goal. Saskatchewan and Ontario are official observers of the WCI. Ontario and Quebec are exploring the possibility of joining the Regional Greenhouse Gas Initiative (RGGI), a carbon cap and trade system involving 10 northeastern states. Ontario, Quebec, New Brunswick, Nova Scotia and Newfoundland are partners in the *Conference of New England Governors and Eastern Canadian Premiers Climate Change Action Plan*.

The environment and climate change are now considered pivotal issues with governments. Yet, all this recent activity will not set Canada on a pathway to meet its Kyoto target. Environment Canada (2007b) reports a gap of 260 Mt CO₂-eq per year on average for the five years of the Kyoto Protocol's first commitment period (2008–2012). To reduce this gap domestically would require a 33 per cent annual reduction from business-as-usual levels per year from 2008 to 2012. Canada has one year to begin bringing about such GHG emission cuts, and these reductions are almost assuredly not going to occur, particularly given the government's decision not to directly participate in the global carbon market.

3.0 Costs of inaction on climate change

There will be costs associated with making the required emissions reductions, and these costs will impact on policy responses and influence post-2012 positions (discussed in greater detail in Chapter 2). The Stern Review (2006) esti-

mates that the costs of reducing GHG emissions to avoid the worst impacts of climate change can be limited to around one per cent of global GDP each year. Without action, the overall costs and risks of climate change will be equivalent to losing at least five per cent of global GDP each year; and estimates of damage could rise to 20 per cent of GDP or more if a wider range of risks and impacts is taken into account.

While there are costs associated with actions to reduce emissions and adapt to climate change, there are also costs associated with inaction. If climate change is allowed to continue unabated, it will result in physical impacts that have economic, environmental and social costs. In Canada, the Arctic will be especially affected by climate change,⁶ suggesting that the costs of inaction (ongoing and intensified costs) and the benefits of action (avoided future damages) need to be carefully considered when making decisions on the issue.

In thinking about designing effective climate policy in Canada, at least from an economist's narrow efficiency lens, there is a serious problem of information asymmetry. The economist would prefer a policy that enables cost-effective reductions at the level of abatement where the costs and benefits are balanced. While economists have said quite a lot about the merits of emission pricing policies to enable cost-effective reductions, there is less of a contribution to the policy discourse on the desired level of abatement. Simply, information on the scope and scale of the possible benefits of action are too uncertain to enable recommendations on the preferred stringency of the policy.

This information asymmetry impacts on policy-making in Canada. Armed with only a conceptual understanding of the benefits of abatement or adaptation expenditures, Canada will continue to be locked into a policy cycle of questioning the appropriateness of taking action to attain targets, regardless of their stringency. That is, Canada will continue to set targets, discuss policy options, reveal the associated costs and then ultimately question the affordability and distributive impacts of target attainment. So, the opportunity of revealing the benefits of action or the cost of inaction is that it could enable the policy debate to continue in a more balanced and perhaps measured fashion.

This is especially true as climate policy transitions to a longer-term view, as it has under the government's *Regulatory Framework* and given international discussions suggesting the need for long-term targets. To halve emissions by 2050 will require action on a substantial scale, raising questions of cost, affordability and distributional impact, and the latest science out of the IPCC is showing us that this level of reductions will likely be insufficient—certainly if we want to avoid a situation of warming the planet significantly above 2° over the next many centuries.

6 The IPCC (2007c: 11) Synthesis Report of the AR4 identified four regions likely to be especially affected by climate change: the Arctic, Africa, small islands, and African and Asian megadeltas.

With an economy about doubling to mid-century and a GHG intensity that is only moderately declining, total emissions in Canada will about double by mid-century. To achieve the mid-century objective, GHG intensity improvements will need to be 20 times greater annually than the forecast no climate policy levels.⁷ NRTEE's (2007) recent modelling suggests that emission prices to deliver this level of decarbonization will need to rapidly climb to in excess of \$200 per tonne of CO₂-eq. The costs of climate mitigation through domestic action could therefore be significant out to mid-century, which could only intensify domestic questions of cost, affordability and distributional impact.

Of course, Canada's response to climate change is not just a question of domestic policy choice and implementation; climate change requires a global solution. Canada's contribution to the stock of atmospheric carbon has been, and continues to be, relatively small—two per cent (despite individual Canadians having one of the highest carbon footprints in the world)—but without global action, the adverse effects of climate change in Canada will intensify. Yet, a supply of global abatement effort that fails to stabilize atmospheric carbon will likely mean that the current adverse effects of climate change in Canada will intensify, even if substantial domestic reductions are attained. So, as in the case of the domestic debate, there is value in revealing the costs of inaction or the benefits of action globally.

Reducing the information asymmetry on the benefits of action so that the costs of inaction can be avoided could contribute to domestic policy and post-2012 debates in a number of areas:

- *Validate abatement effort domestically.* A better understanding of the scope, scale and distribution of adverse impacts, will mean more informed options. Policy choice can then move from a conceptual weighing of the benefits of action to a more balanced and certainly informed understanding of policy trade-offs.
- *Reveal opportunities for domestic adaptation.* Any reckoning of the expected costs of inaction will reveal areas where adaptive measures can be targeted. As with abatement, if damages are known, the appropriate level of response can be set.
- *Advocate abatement effort internationally.* As with domestic action, the level of international effort should ideally be scaled to damages. But as in Canada, there is a dearth of good information on the social costs of carbon internationally. This has led post-2012 discussions to centre on stabilizing atmospheric concentrations at a level that is linked to the avoidance of dangerous climate change. Again, this leads to a conceptual weighing of uncertain and diffuse global benefits against more certain costs stemming from

7 Average annual improvement with no policy is -0.08 per cent and to hit the targets the required annual reduction is about -1.7 per cent.

alternative burden-sharing schemes. As with the domestic debate, this will most likely lead to an undersupply of global reductions and thus there is value in adding a Canadian view to the common understanding of global benefits. Improved information on the international global supply of abatement is important to Canada and closely linked to Canada's sensitivity to climate change, which remains largely uncertain.

- *Aid in international burden-sharing negotiations.* The global burden-sharing debate seems to be mostly focused on affordability (i.e., tryptich and multi-stage) and past and future contributions to the stock, which implies targets more or less allocated proportionate to national income. But, this seems to be an incomplete definition of equity focused only on income and not on how national wealth is impacted. Presumably, even with global action, damages will continue from unabated emissions, and impacts will not be evenly distributed. A more comprehensive view of affordability might instead balance the affordability of abatement with the impacts on wealth from unabated emissions. Revealing the costs of unabated emissions on a country's wealth of natural, produced and social capital may highlight that allocating abatement effort globally is both a function of the costs of abatement and the costs to national wealth of unabated emissions, or a net effect. Without a notion of the impacts of unabated emissions on national wealth, burden-sharing will continue to be focused narrowly on affordability.

Implicit in this discussion is the need for Canada to allocate resources to better understand the impacts of climate change. Simply, it is in Canada's national interest to reveal the benefits of action so that the costs of action are avoided. Richard Tol (2007: 6), a noted authority on the social costs cost of carbon, explains:

“...more research is needed into the economic impacts of climate change—to eliminate that part of the uncertainty that is due to lack of study, and to separate the truly scary impacts from the scare-mongering. Papers often conclude with a call for more research, and often this is a call for funding for the authors or a justification for further papers by the authors. In this case, however, quality research by newcomers in the field would be particularly welcome.”

Putting this need through the policy lens, points to a need for:

- *Bringing scientific information into the policy “space,”* through quantification and where possible the monetization of benefits.
- *Revealing new areas of impact that are largely unknown.* This most likely means looking beyond the traditional view that climate impacted sectors are those that rely heavily on climactic variables as factors of production, such as forestry, agriculture and infrastructure (i.e., more extreme events). A major outcome from research here could reveal a climate-adjusted economic baseline that is on a lower trajectory than current business-as-usual

forecasts predict. If it is revealed that ongoing damages result in a lower level of total economic activity with disproportionate sectoral and regional variations, policy can then be targeted to mitigate the change.

- *Revealing to Canadians a more personal impact.* A major element of the social cost of carbon is valued health outcomes associated with mortality from heat and disease vectors. This could bolster the political and stakeholder will to implement action to attain targets.

4.0 Concluding comments

Canada has provided clarity on its perspectives and priorities for an international climate agreement. The Speech from the Throne in 2007 stated that Canada believes an effective global approach requires binding targets that apply to all major emitters and that it will press for an international agreement that cuts global emissions in half by 2050. Canada's submission to the Convention Dialogue (UNFCCC, 2007c), a letter sent from the Prime Minister to the UN Secretary General in September 2007 and reiteration of considerations for Canada at COP-13 in Bali, provide an overview of important elements, from the perspective of the federal government, for a global post-2012 framework:

- participation by all developed countries and major emitting developing countries;
- balance between environmental protection and economic prosperity;
- long-term focus setting the scale and timing of global emission reductions through to 2050;
- further action on adaptation;
- support for the development and deployment of existing and new technologies;
- action to reduce emissions from deforestation in developing countries;
- least cost and market solutions compatible with sustainable economic growth;
- flexibility to allow countries to choose tools and policies that suit their unique circumstances; and
- maximization of the opportunities for co-benefits in areas such as clean air, clean water and biodiversity.

The adoption of the Bali Action Plan has increased global impetus to reach agreement on long-term climate policy, and these perspectives influence how Canada will be motivated to act on climate change over the next two years. In Canada, post-2012 policy will need to account for the rise to prominence of climate change as a public policy issue, the urgency demonstrated by the sci-

entific community, and the desire of the Canadian public for action on climate change and movement toward meeting our Kyoto target. The influence, policies and positions of Canada's provinces and regions will also impact the path forward. Manitoba and Quebec are strong supporters of the Kyoto Protocol; Alberta is supporting the development of new technologies and a nuclear power facility to reduce CO₂ emissions from oil sands projects; and British Columbia has introduced targets and a carbon tax, and is moving toward participation in an emissions trading system. The situation in the Arctic demonstrates the real need for action in the area of adaptation, and the need for an increased understanding of the costs of inaction to enable a more informed policy debate.

Climate change policy will need to address the economic and environmental realities of Canada's resource-based economy, and the dominance of the United States as a trading partner and large investor in energy resources. American and other nations' actions in regard to energy security, technology and emissions trading have the potential to impact the development of Canada's post-2012 climate policy framework.

One theme that is becoming clear is that the UNFCCC will be but one actor, albeit a critical one, in the development of the post-2012 climate regime. The actual implementation of effective adaptation and technology may very well find better homes outside of the UNFCCC in complementary fora. This is consistent with the findings of IISD's *Canada in a Post-2012 World: A Qualitative Assessment of Domestic and International Perspectives* (Bell *et al.*, 2005), which concluded that a regime that included a combination of approaches inside and outside the UNFCCC—including targets for the near and long term, policies and measures, technology agreements, and support for mitigation and adaptation in developing countries—would best meet Canadian interests.

How Canadian economic, environmental and social interests can best be reflected in a post-2012 global climate change regime is the subject of analysis of this report. An examination of the emerging approaches and options for post-2012 climate change cooperation continues in the next four chapters. The analysis of mitigation, adaptation, technology, and financing and investment opportunities helps to identify areas where Canada might be able to influence the evolution of the international regime while accounting for national sensitivities and perspectives.

Appendix 1: Climate change plans and strategies of federal, provincial and territorial governments

Jurisdiction Plan(s)/Legislation	Goals/Targets	Main Initiatives/Other Aligned Programs
<p>Canada Regulatory Framework for Air Emissions and Turning the Corner: An Action Plan to Reduce Greenhouse Gases and Air Pollution – 2007</p>	<p>Reduce GHG emissions by 20% below 2006 levels by 2020; 60% to 70% below 2006 levels by 2050. GHG intensity reduction targets for industrial emitters of 18% (relative to 2006 levels) by 2010. Targets would then rise by 2% a year to reach 26% by 2015. Draft regulations are expected to be published beginning in spring 2008.</p>	<p>Compliance tools in the regulatory framework include an emissions trading system with offsets and access to the CDM, and a technology fund. EcoTRUST – \$349.9M for provincial projects. EcoAGRICULTURE – \$500M biofuels/ bioproducts development. EcoENERGY – retrofits, renewable energy, heat, development, efficiency, technology. EcoTRANSPORT – \$100M fleets, public transport, technology.</p>
<p>British Columbia Throne Speech 2007 <i>Greenhouse Gas Reduction Targets Act</i> – 2007</p>	<p>By 2020 and for each subsequent calendar year, B.C. GHG emissions will be at least 33% below 2007 levels. By 2050 and for each subsequent calendar year, B.C. GHG emissions will be at least 80% below 2007 levels. By December 31, 2008, the minister must establish B.C. GHG emissions targets for 2012 and 2016.</p>	<p>Carbon tax for virtually all fossil fuels sold in the province starting July 1, 2008. The tax will be phased in over five years and will start at a rate of \$10 per tonne of carbon emission. It will rise \$5 a year to \$30 per tonne by 2012. \$25M Innovative Clean Energy Fund for commercialization of clean technologies. Public sector organizations to be carbon neutral by 2010. B.C. Trust Fund to fund valid offsets for government travel. Emission reduction strategies required in all community and regional plans. Adopt California tailpipe emission standards and low-carbon fuel standards. 5% renewable fuel standard for diesel by 2010.</p>
<p>Alberta <i>Climate Change and Emissions Management Amendment Act</i> and Administrative Penalty Regulation – 2007 Albertans and Climate Change: Taking Action – 2002 A new plan is expected in 2008</p>	<p>Limits GHG emissions intensity for large emitters (>100,000 t GHG/yr must reduce emissions intensity to 12% below facility's average emissions intensity from 2003 to 2005 by the end of 2007. New facilities must reduce intensity by 2%/yr after third year of operation. Reduce GHG emissions intensity relative to GDP by 50% below 1990 levels by 2020.</p>	<p>Canada-Alberta ecoEnergy Carbon Capture and Storage Task Force. \$239M Bioenergy Strategy. \$200M Energy Innovation Fund (to support research on bioenergy, water management and value-added energy production). \$100M to study clean carbon and hydrocarbon upgrading technologies using carbon capture and storage. \$85 million pilot project to produce electricity from municipal solid waste; energy efficiency programs.</p>
<p>Saskatchewan Saskatchewan Energy and Climate Change Plan – 2007</p>	<p>Emissions stabilized by 2010. Reduce GHG emissions by 32% from 2004 levels by 2020 and by 80% from 2004 levels by 2050.</p>	<p>Technology Fund and Emissions Offset Fund, aiming to ensure that benefits of compliance measures taken in province under federal regime (via offset purchases or Technology Fund contributions) remain within Saskatchewan.</p>

Jurisdiction Plan(s)/Legislation	Goals/Targets	Main Initiatives/Other Aligned Programs
Manitoba Kyoto and Beyond: Manitoba's Climate Change Action Plan – 2002	Intention to meet and exceed Kyoto Protocol reduction targets (up to 18% below 1990 levels by 2010).	Adopt California tailpipe emission standards.
Ontario Ontario Action Plan on Climate Change – 2007	Reduce GHG emissions to 6% below 1990 levels by 2014, 15% below 1990 levels by 2020 and an 80% reduction from 1990 levels for 2050.	Closure of coal-fired power generation plants by 2014. Investments in rapid transit. Doubling renewable energy generation and improvements to energy conservation through Ontario Power Authority's Standard Offer Program and demand-side management programs.
Quebec Quebec and Climate Change: A Challenge for the Future – 2006	Reduce GHG emissions level to 6% below 1990 levels by 2012.	Carbon tax collection of \$0.01/L from petroleum companies (2007). Expanding renewables (wind and hydropower focus).
New Brunswick Climate Change Action Plan – 2007	Reduce GHG emissions to 1990 levels by 2012 and 10% below 1990 levels by 2020.	Demand-side management and renewable energy in the electricity sector. Improvements in public transit. Fuel efficiency and alternative fuels in the transportation sector.
Nova Scotia <i>Environmental Goals and Sustainable Prosperity Act – 2007</i>	Reduce GHG emissions to 10% below 1990 levels by 2020.	Nova Scotia Green Trust. New Renewable Energy Standards Regulations (2007) requiring that 20% of Nova Scotia's electricity generation will come from renewable sources of energy by 2013.
Prince Edward Island Climate Change Strategy for Prince Edward Island – 2005	No provincially initiated targets, but committed to targets set by Conference of New England Governors and Eastern Canadian Premiers Climate Change Action Plan of 1990 levels by 2010 and 10% below 1990 levels by 2020.	Renewable Portfolio Standard of 15% by 2010 through <i>Renewable Energy Act</i> .
Newfoundland Climate Change Action Plan – 2005	No provincial-initiated targets, but committed to targets set by Conference of New England Governors and Eastern Canadian Premiers Climate Change Action Plan of 1990 levels by 2010 and 10% below 1990 levels by 2020.	40 action items including energy efficiency; "house in order" strategy for government; addressing fuel efficiency of fishing vessels; and carbon accounting in forestry management.
Yukon Climate Change Strategy – 2006	No specific GHG emissions reduction targets.	N/A
Northwest Territories Greenhouse Gas Strategy: 2007–2011 – 2007	Reduce GHG emissions in government operations to 10% below 2001 levels by the year 2011.	N/A
Nunavut Nunavut Climate Change Strategy – 2003	No specific GHG emissions reduction targets.	N/A

References

- Bell, W., J. Van Ham, J. Parry, J. Drexhage and P. Dickey, 2005. *Canada in a Post-2012 World: A Qualitative Assessment of Domestic and International Perspectives*. Winnipeg: International Institute for Sustainable Development.
- Boehm, M., B. Junkins, R. Desjardins, S. Kulshreshtha and W. Lindwall, 2005. "Sink potential of Canadian agricultural soils." *Climatic Change* 65: 297–314.
- Bramley, M., 2007. *Analysis of the Government of Canada's April 2007 Greenhouse Gas Policy Announcement*. Drayton Valley: Pembina Institute.
- Canadian Hydropower Association, 2004. *Quick Facts*. <http://www.canhydropower.org/hydro_e/pdf/Quick_Facts_2004.pdf>.
- Canadian Nuclear Association, 2005. *Nuclear Energy: Reliable, affordable and clean electricity*. Ottawa: Canadian Nuclear Association.
- CBC.ca, 2007. "U.S. urges 'fivefold expansion' in Alberta oilsands production." *CBC News*. January 18. <<http://www.cbc.ca/canada/story/2007/01/17/oil-sands.html#skip300x250>>.
- Cellucci, P., 2003. "Canada's Big Role in Continental Energy Security." *Canadian Speeches*. <http://goliath.ecnext.com/coms2/gi_0199-3296153/Canada-s-big-role-in.html>.
- Council of the Federation, 2007. *A Shared Vision for Energy in Canada*. Ottawa: Council of the Federation.
- Environment Canada, 2007a. *Climate Change*. <<http://www.ec.gc.ca/default.asp?lang=En&n=6EE576BE>>.
- Environment Canada, 2007b. *The Cost of Bill C-288 to Canadian Families and Business*. <http://www.ec.gc.ca/doc/media/m_123/toc_eng.html>.
- Environment Canada, 2007c. *Inventory Report 1990-2005: Greenhouse Gas Sources and Sinks in Canada*. Gatineau: Environment Canada.
- Footitt, A., 2007. *Climate Change Policy and Canada's Oil Sand Resources: An Update and Appraisal of Canada's New Regulatory Framework for Air Emissions*. A Report for WWF. London: Tyndall Centre for Climate Change Research.
- Government of Canada, 2007a. *Regulatory Framework for Air Emissions*. <http://www.ec.gc.ca/doc/media/m_124/toc_eng.htm>.
- Government of Canada, 2007b. *Speech from the Throne: Strong Leadership. A Better Canada*. (October). <<http://www.sft-ddt.gc.ca/eng/media.asp?id=1364>>.

Government of Canada, 2006. "Greenhouse Gas Emissions." *Canadian Environmental Sustainability Indicators*. <<http://www.environmentandresources.gc.ca/default.asp?lang=En&n=A85B7F27-1>>.

International Energy Agency (IEA), 2007. "Selected Energy Indicators for 2006." *Key World Energy Statistics*. Paris: IEA. pp. 48–57.

IEA, 2006. *World Energy Outlook 2006*. Paris: IEA.

Intergovernmental Panel on Climate Change (IPCC), 2007a. *Fourth Assessment Report. Climate Change 2007: Synthesis Report*. Geneva: IPCC.

IPCC, 2007b. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.). Cambridge and New York: Cambridge University Press.

IPCC, 2007c. *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds.). Cambridge and New York: Cambridge University Press.

IPCC, 2007d. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Avery, M. Tignor and H.L. Miller (eds.). Cambridge and New York: Cambridge University Press.

Marshall, D., 2007. *Intensity-based Targets: Not the Solution to Climate Change*. Vancouver: David Suzuki Foundation. <<http://www.climateaction-network.ca/e/resources/publications/member/dsf-intensity-targets.pdf>>.

McAllister and Globescan, 2007. *Poll: Increasing Majority Call Canada's Pollution Laws Inadequate: Global warming is top environmental issue; Concern higher now than in 1992 when UN Climate Change Convention first signed*. Press release, September 4. <<http://www.gvrd.bc.ca/smartsteps/pdfs/mcallistreglobescanpressreleasesep07.pdf>>.

Mittelstaedt, M., 2008. "Alberta crude may be too dirty, U.S. law says." *Globe and Mail*. January 15.

National Roundtable on the Environment and the Economy (NRTEE), 2008. *Getting to 2050: Canada's Transition to a Low-emission Future*. <<http://www.nrtee-trnee.ca/eng/publications/getting-to-2050/Getting-to-2050-eng.pdf>>

NRTEE, 2007. *Interim Report to the Minister of the Environment: Medium- and long-term scenarios for GHG emission and air pollutant reductions*. Ottawa: NRTEE.

Natural Resources Canada (NRCan), 2007a. *Canada top US supplier as scientific research and technological innovation fuels energy sector*. Press release. <http://www.eurekalert.org/pub_releases/2007-04/nrc-cu041807.php>.

NRCan, 2007b. *Is Canada's Forest a Carbon Sink or Source?* Canadian Forest Service Science-Policy Notes. Ottawa: NRCan.

Stern, N., 2006. *Stern Review: The Economics of Climate Change*. Report presented to the Prime Minister and the Chancellor of the Exchequer on the Economics of Climate Change.

Statistics Canada, 2007. *Imports, exports and trade balance of goods on a balance-of-payments basis, by country or country grouping*. <<http://www40.statcan.ca/l01/cst01/gblec02a.htm>>.

Tol, R.S.J., 2007. *The Social Cost of Carbon: Trends, Outliers and Catastrophes*. University of Hamburg Working Paper FNU-144. <<http://www.fnu.zmaw.de/fileadmin/fnu-files/publication/working-papers/margcostmetawp.pdf>>.

United Nations Framework Convention on Climate Change, 2007a. *Bali Action Plan*. Decision adopted by COP-13 and CMP 3. December 2007. <http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf>.

UNFCCC, 2007b. *Emissions Summary for Canada*. GHG emission profiles for Annex I Parties. May 25, 2007. <http://unfccc.int/files/ghg_emissions_data/application/pdf/can_ghg_profile.pdf>.

UNFCCC, 2007c. *Submission from Canada*. Dialogue on long-term cooperative action to address climate change by enhancing implementation of the Convention, Fourth workshop, Vienna, August 27–31, 2007, Dialogue working paper 12 (2007), August 21.

Chapter 2: Encouraging Mitigation and Economic Growth in a Post-2012 Climate Regime

David Sawyer, Aaron Cosbey, John Drexhage and Deborah Murphy

1.0 Introduction

This chapter addresses mitigation, the first of the four pillars of the Bali Action Plan. The focus is how the post-2012 regime will deal with the urgent need for mitigation and the basic fact of economic growth, particularly in developing nations. The analysis includes international and domestic perspectives, describing how the various possible elements of an international agreement fit with Canadian interests.

The Bali Action Plan calls for mitigation actions by all developed countries, including quantified emission limitations and reduction objectives; as well as mitigation actions in developing countries in the context of sustainable development “that are supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner.” (UNFCCC, 2007a: 1). Mitigation commitments for developed countries will likely include actual reduction targets as well as support and assistance to developing countries. Mechanisms will need to be put in place to account for these technology, financing and capacity-building contributions by developed countries. The Bali plan also calls for consideration of:

- action and positive incentives in the areas of reducing emissions from deforestation and forest degradation in developing countries, and conservation and sustainable management of forests;
- sectoral approaches and sector-specific actions that support technology cooperation in relevant sectors, including energy, transport, industry, agriculture, forestry and waste management;
- market-based opportunities to enhance the cost-effectiveness of actions, accounting for different circumstances in developed and developing countries;
- economic and social consequences of response measures; and
- ways to strengthen the role of the Convention in encouraging multilateral bodies, public and private sectors and civil society to support mitigation in an integrated manner.

Chapter 2 examines the need for effective mitigation in a world with continued economic growth, and what this means for both developed and developing countries. Section 2 looks at how the decision on a long-term global goal will impact on mitigation actions and the extent of participation. Section 3 examines the tensions between GHG mitigation, economic growth and development. Section 4 discusses the Canadian situation, including emission trends and efforts at mitigation. Section 5 analyzes select elements of an international approach to mitigation, looking at reducing emissions from deforestation, sector-based options and market-based approaches. The concluding section provides reflections on a way forward for Canada, looking at initial ideas for a Canadian response to mitigation in a post-2012 regime.

2.0 Mitigation: Setting the context

The Bali Action Plan calls for a shared vision that includes a long-term global goal for emission reductions; a goal that will influence the necessary actions and design of the international post-2012 regime. This section examines the stringency of the targets, the timing of the actions, and the extent of participation by major global economies.

2.1 Mitigation targets and timelines

Over the next two years, the international community will strive to agree on the commitments and structure of a post-2012 regime that will allow it to meet the objective of the UNFCCC (Article 2) “to achieve... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.” Parties have yet to define what level of GHG emissions would actually represent dangerous anthropogenic interference, although the Bali Action Plan makes reference to the emission reduction estimates outlined in the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) that suggest that Annex I Parties will need to reduce emissions in a range of 25 to 40 per cent below 1990 levels by 2020,¹ and developing countries will need to deviate below their current emission paths in this same timeframe. This means that global GHG emissions will need to peak in the next 10 to 15 years and be reduced to below half of 2000 levels by 2050.

The AR4 concluded that stabilizing CO₂-eq at between 445 and 490 ppm (resulting in an estimated global temperature 2 to 2.4°C above the pre-industrial average) would require that emissions peak before 2015, with 50 to 85 per cent reductions on 2000 levels by 2050. A stabilization rate of 535 to 590 ppm (resulting in an estimated temperature increase of 2.8 to 3.2°C) means that emissions would have to peak before 2030, with a change in CO₂ emissions in

¹ The reference in the Bali Action Plan only makes mention of the OECD reduction requirements, but it is clear from Chapter 13 of the AR4 that not going beyond a 2°C scenario will only be achievable with significant GHG reductions by major developing countries.

2050 of -3 to +5 per cent of 2000 levels (IPCC, 2007b: 39). It should be noted that even keeping temperature increase to this higher level will be a challenge for the global community, requiring large emission reductions for both developed and developing countries. And the scientific evidence is making an increasingly compelling case for arguing that the more stringent 2°C limit should be the objective of the international community. The IPCC (2007a: 13) notes that 40 to 70 per cent of species around the world are likely to be at increased risk of extinction if increases in global average warming exceed 3.5°C.

The European Union and the Alliance of Small Island States (AOSIS) advocate keeping the rise in global temperatures to below 2°C of pre-industrial levels (1.4°C above present levels), requiring that GHG concentrations remain under 450 ppm CO₂-eq. The G8 (2007: 2) struck an agreement in Heiligendamm stating, “that the decisions made by the EU, Canada and Japan, which include halving global emissions by 2050, will be considered in setting a global goal.” The Government of Canada’s (2007) *Regulatory Framework for Air Emissions* includes a commitment to reduce Canada’s total absolute GHG emissions, relative to 2006 levels, by 20 per cent by 2020 and by 60 to 70 per cent by 2050.

Halving global emissions by 2050 from a 1990 baseline will take place in a world where population increases from 6.1 billion in 2000 to 9.1 billion in 2050 (UN, 2006), while in the same time period GHG emissions are reduced from 38,869 to 17,028 million tonnes CO₂-eq per person (International Energy Agency [IEA], 2006). Global GHG emissions per capita will need to decrease from 6.34 to 1.85 tonnes CO₂-eq per person over the 50-year time period. Canada, with per capita emissions of 23.72 tonnes CO₂-eq in 2004 (UNFCCC, 2006), will need to make significant reductions in emissions, requiring fundamental shifts in energy systems, and significant innovations in technology and in the social and institutional context.

Mitigation efforts will also take place in a world of continued economic growth. Discussed in more detail in section 3.1, global growth is projected to be 4.1 per cent in 2008, even after a marked slowdown in the fourth quarter of 2007. Average rates of growth are predicted to be 6.9 per cent in emerging market and developing economies, and 1.8 per cent in advanced economies over 2008 (International Monetary Fund [IMF], 2008). While future rates of growth are extremely uncertain, the patterns of future economic growth will have an important bearing on the prospects for emissions reductions and sustainable development, and the shape of international mitigation efforts. Fast growing economies have increasing energy demand, which has implications for GHG reduction efforts.

The world is a very different place than when the Kyoto Protocol was negotiated. In 1990, China and India were listed among the World Bank’s low-income developing countries; China’s GDP per capita was less than Cameroon’s or Albania’s, and India’s fell below Lao PDR and Benin (World

Bank, 1997). Brazil's maternal mortality rate was nearly twice that of Vietnam, at 200 per 100,000 live births, and in South Africa only 46 per cent of the population had access to sanitation.

The major developing country emitters (Brazil, India, Indonesia, China, South Korea, South Africa and Mexico) have experienced phenomenal economic growth that has been matched by a rise in aggregate GHG emissions. China is reported to have surpassed the United States in total emissions in 2006 (Netherlands Environmental Assessment Agency, 2007). As a whole these seven countries in 2005 had CO₂ emissions equivalent to over 90 per cent of the top five Annex I emitters (see Table 1). By 2012, if current trends continue, developing countries as a whole will overtake the OECD as global emitters of CO₂, with China and India contributing the lion's share; China alone is projected to be responsible for almost 40 per cent of global increases in emissions between 2004 and 2030 (IEA, 2007: 81).

Of course, compared with many Annex I Parties, the major developing country emitters are still developing, with significantly lower economic indicators and commensurately lower GHG emissions per capita (see Table 1). And much of the rest of the developing world is still in the same position in relation to the OECD countries as they were when Kyoto was negotiated. Yet, the world will be much different again in 2012, after five more years of economic growth; and an effective post-2012 regime will require flexibility to be able to account for such changes.

Table 1: Major developing emitters and Annex I's five biggest CO₂ emitters (2005)

Country	CO ₂ emissions (Mt)	CO ₂ emissions per capita (Mt/CO ₂ /population)	GNI per capita
China	5,059.87	3.88	1,740
India	1,147.46	1.05	720
South Korea	448.92	9.30	15,830
Mexico	389.42	3.70	7,310
Indonesia	340.98	1.55	1,280
South Africa	330.34	7.04	4,960
Brazil	329.28	1.77	3,460
United States	5,816.96	19.61	43,740
Japan	1,214.19	9.50	38,980
Germany	813.48	9.87	34,580
Canada	548.59	17.00	32,600
United Kingdom	529.89	8.80	37,600
World	27,136.00	4.22	6,987

Source: IEA, 2007a:48–57; World Bank, 2007: 288–289.

But the most fundamental dilemma remains: how do we reduce GHG emissions in all countries, but especially developing countries, without slowing their economic growth? Developing countries, and especially the major developing emitters, account for most of the increase in GHG emissions each year. Yet, developed countries are responsible for the majority of GHGs already in the atmosphere,

and poorer countries demand their right to development. The obvious solution, and a major consideration in international post-2012 negotiations, is for rich countries to help finance the low-carbon transformation in poorer countries.

But negotiations over the next two years will prove that the solution is not so simple. While the major developing country emitters are poorer than developed countries as overall societies; as industrial competitors, many of them are peers. There may not be a large appetite in developed nations for wealth transfers to some of the major developing emitters, where rising economic power makes them global competitors whose influence is significant. These countries are competitive with developed countries on a range of products and services. The economies of China, India and many others are running fast, fuelled with carbon-intensive fossil fuels. This points to the need for developing country involvement, or at least the involvement of the major emitters among them, in a more meaningful way than was negotiated in the first commitment period. And this means finding a path forward that meets the needs of all Parties, while accounting for the UNFCCC principle of common but differentiated responsibilities.

3.0 The tensions between GHG mitigation, economic growth and development

The notion that advancing development in a sustainable manner should be integral to the international response to climate change is rooted in the understanding of the fundamental links between climate change mitigation, economic growth and development. The line of reasoning that encompasses those links is as follows:

- economic growth is a means to development—one that will continue to be used in the foreseeable future;
- there are a number of potential conflicts between economic growth and action on climate change;
- but there are synergies between climate change action and *development* actions aimed at both adaptation and mitigation that can contribute to development;
- unchecked climate change will undermine development goals and economic growth;
- thus advancing development goals in a sustainable way should be a central part of efforts to address climate change in all countries; and
- therefore, there are a number of reasons why the international community should focus not only on achieving this in their own countries, but also in helping achieve this in developing and least-developed countries.

These points will be fleshed out in greater detail in the remainder of this section, in an effort to give some conceptual grounding to the international dis-

cussions. To date, there has not been much effort to explicitly frame the discussions or define objectives, and the resulting talks—while valuable—have been extremely wide-ranging.² Such an open-ended dialogue may have been exactly the right starting point from a political perspective, but there will eventually be a need to agree on at least the basis for discussion. The argument that follows aims to contribute to such an agreement.

It is important to note at the outset that when we talk about development goals we are not only talking about development in so-called developing countries. Development as used in this chapter means increases in human well-being, and as such it is clearly a key priority of all governments, no matter what their state of industrialization.

3.1 Economic growth is a means to development—one that will continue to be used in the foreseeable future

Development goes beyond simply alleviating income poverty. There have been a number of measures of well-being proposed that try to encompass a broader approach, the UNDP's Human Development Index being but one of these.³ The Millennium Development Goals (MDGs) may be the clearest international statement to the effect that development goes well beyond economic growth. Much current thinking follows Nobel Laureate Amartya Sen (1999) in defining poverty as a lack of freedom to pursue life ambitions, and conversely defines development as a process of fostering such freedom.

Yet nevertheless, none of these approaches goes so far as to deny the critical role of economic growth and increased incomes in the development process. In fact the MDGs have addressed income poverty as the first goal. Even Sen allows for the major enabling role of income as a determinant (albeit one of many) of one's capabilities throughout his work.⁴

So economic growth is important even for development more broadly cast. Moreover, economic growth continues to be of primary importance to national governments, whether in developing or developed countries.⁵ It is still the metric by which progress is conventionally measured. And as much as policy-makers might look for growth with a human face, at the end of the day any growth will often be considered better than no growth.

2 There have been some notable exceptions. See Sokona (2006) for an excellent “foundation” discussion.

3 Others include, for example, the Human Wellbeing Index (Prescott-Allen, 2001) and the Genuine Progress Indicator (Venetoulis and Cobb, 2004). For a survey of such indicators, see Boarini, Johansson and Mira d’Ercole (2006).

4 See Cosby (2005: Section 3.2)

5 In countries plagued by poverty and inequity, growth of the pie may be seen as a much easier alternative to more equitably dividing the pie.

Further, economic growth of one kind or another will continue, at least for the foreseeable future and will persevere as a key element of national development efforts. The IMF (2008) foresees global growth over 2008 at 4.1 per cent—a deceleration from 4.9 per cent growth in 2007 because of continuing financial turbulence that originated in the U.S. subprime sector. Yet, this rate still implies a doubling of global GDP in 17 years. It is driven by projected continued growth of 6.9 per cent in 2008 in emerging market and developing economies, including projected growth of 10 per cent in China in 2008. The clear message is that growth will probably continue to occur, even if possibly not at the dizzying pace seen over the last few years.

3.2 There are a number of potential conflicts between economic growth and action on climate change

This seems to be a fairly straightforward proposition: as the economy grows, so too will GHG emissions. The equation appears simplest for carbon emissions associated with increased use of energy in industrial, residential/commercial (lighting, heating and appliances) and transportation sectors. All of these tend to increase with income, other things being equal (Shafik and Banyopadhyay, 1992). As such, for example, the IEA's World Energy Model, used to derive its authoritative projections of energy demand, is based on projected economic growth (along with demographics, fossil fuel prices and technological development) as a key exogenous assumption. The massive reductions in GHG emissions from economies in transition since 1990 have been driven almost entirely by economic crisis involving negative growth rates.

The reality of the impacts of growth is a little more complex. Copeland and Taylor (1994) developed a seminal model that can be used to break down the environmental effects of economic growth into three effects; scale, composition and technique effects:⁶

- As the economy grows, if all technology and production patterns are held constant, we get a sheer increase in scale of production—the *scale effect*. This will always have a negative effect on the environment.
- If growth is accompanied by an improvement of techniques of production, such as increased energy efficiency, then the *technique effect*—which is almost always a positive influence on the environment—comes into play. Drivers include economic incentives and government policies.
- The *composition effect* occurs when growth is accompanied by a shifting of the patterns of production. For example, a given economy may evolve to produce relatively less of a good that is highly polluting, and relatively more

6 Their model was originally used to describe the impacts of trade liberalization, but it is also applicable to economic growth.

of a relatively cleaner good. This effect is not so relevant at the international level, though it can occur in limited ways.⁷

Thus, the final impact of any economic growth is, *ex ante*, indeterminate. It will often boil down to a contest between the scale and technique effects—a contest, however, that is almost always won by the power of scale. That is, the rate of development and dissemination of new technology does not normally keep pace with the rate of growth in scale. For example, the Chinese government’s current five-year plan involves a 20 per cent reduction in the energy intensity of its economy—a level of ambition with few international precedents. But over those five years at current rates of growth, China’s GDP will be almost 66 per cent larger.⁸ Barring any composition effects (and of course assuming the targets can be met), this means an overall increase in energy use of 33 per cent over this period.

The same dynamic can be seen repeatedly over time; for example, the increasing efficiency of automobiles is routinely swamped by increased miles driven.⁹ In part this is due to an effect known in the ecological economics literature as the “rebound” effect—a derivative of the original “Jevons’ Paradox,” whereby increasingly efficient technology for coal use actually increased the use of coal.¹⁰ Increased efficiency effectively lowers the price of the associated goods and services, and as the price of any normal good decreases, we consume more of it.

The OECD (1994) notes another type of environmental effect—the regulatory effect.¹¹ Economic growth can enrich citizens who will demand better environmental regulations, and can provide governments with the financial resources to propound and enforce them. This is clearly an important consideration in the context of international climate change efforts.

In summary, the overall effects of economic growth will often—but not always—conflict with climate change objectives. This holds true for energy-associated carbon emissions, as argued above. It is also probably true in the context of non-CO₂ GHG emissions, most of which are associated with goods for which demand increases as income rises. Air conditioner ownership in

7 The composition effect is usually a response to shifts in comparative advantage among nations—that is, it simply involves shifting to a different division of the same bundle of production among countries.

8 Assumes an annual rate of growth of 9.625 per cent—the average of 2005 and 2006 (actual) and 2007 and 2008 (projection) figures from IMF (2008). Copeland and Taylor’s conception of the technique and scale effects covered only productive activities (efficiency and scale of production), but the concept here has been extended to cover end-use efficiency as well.

9 For an illustration of this effect in China, see IISD (2004: 119–122).

10 For a summary of the modern literature on this subject, see Alcott (2005).

11 Like the framework used by Copeland and Taylor, the OECD framework is meant to describe the effects of trade, but can also serve to describe the effects of economic growth.

urban China, for example, more than tripled between 2000 and 2007, and with it the production of the GHG HFC-22.¹²

3.3 But there are synergies between climate change goals and development

While it may be true that economic growth often conflicts with climate change objectives, this is not necessarily the case for development (which is, in the end, the *object of growth*).¹³ In fact there are important synergies between development and climate change objectives.

There are, for example, a number of ways in which development efforts can lead to mitigation:

- Efforts to restore forest cover or avoid deforestation/land degradation, for example, can have significant development payoffs, including reduced time spent collecting fuelwood, reduced indoor air pollution from inefficient biomass use, and flood control in watersheds (Stern, 2006: chapter 25). In the process, such efforts also address a source of some 20 per cent of total anthropogenic emissions, reducing GHGs emitted and increasing carbon sink capacity (Baumert *et al.*, 2005).
- Efforts to provide energy to the poor constitute development in their own right.¹⁴ If that energy is in the form of renewables (e.g., biogas digesters, micro hydro, solar cookers, photovoltaic panels), then those efforts will count toward mitigating emissions, compared to a baseline of conventional new energy provision.¹⁵
- Fuel switching efforts may be aimed at reducing the burden of import costs, improving balance of payments and generating domestic employment.¹⁶ At the firm level they may simply be about improving efficiency and/or saving on fuel costs. But they can also yield significant emissions reductions.¹⁷

12 See Bradsher (2007). Ownership went from 24.4 per 100 urban households to 87.2. Rural ownership between 1995 and 2005 increased 35-fold.

13 Development is hereinafter used to mean an increase in human well-being.

14 See World Summit on Sustainable Development (WSSD) (2002: para. 9); World Bank (2006); IEA (2004: chapter 10); van Geel (2005); UNDP (2005).

15 This sort of mitigation *relative to a hypothetical baseline of new energy provision* has in fact been accepted as additional by the Methodology Panel and Executive Board of the CDM. See the important work done by SouthSouthNorth on the theoretical basis and actual calculation of “suppressed demand” baselines (Winkler and Thorne, 2002).

16 Bradley and Baumert (2005) note that Brazil’s ethanol program, replacing petroleum as automobile fuel, has reduced Brazil’s external debt by \$100 billion from the baseline case and created hundreds of thousands of jobs among the rural population. It is also, incidentally, offsetting some 26 million tonnes of CO₂ annually.

17 Note the results of the Brazilian ethanol program cited in Bradley and Baumert (2005). UNEP-Risø’s CDM pipeline of projects (<http://www.uneprisoe.org>) as of February 1, 2008 showed potential mitigation of 178 million tonnes of CO₂ equivalent to 2012 from 99 firm-level fuel switching projects.

There are also a number of ways in which efforts to mitigate GHG emissions can contribute to development:

- Efforts to achieve energy efficiency have enormous potential to reduce GHG emissions.¹⁸ Household energy efficiency programs can also reduce expenditures on heating and lighting (yielding particularly strong development benefits when targeted at the poor).¹⁹ And overall energy efficiency, other things being equal, leads to a stronger more competitive economy, with significant economic benefits for all.
- Efforts to avoid the emissions associated with deforestation, as in the provision of improved cookstoves or solar cookers to fuelwood users, can yield significant development benefits as well, including reduced indoor air pollution (Malhotra and Rehman, 2004). As noted above, avoided deforestation itself yields a number of development benefits.
- Efforts to capture methane emissions from landfills and livestock operations contribute powerfully to GHG emission reductions.²⁰ Such efforts also reduce odours, and often the containment technologies used significantly lower the risk of leaching and containment spills—a benefit to local populations.
- Efforts to encourage emission reductions in the European Union’s proposed climate action and renewable energy package are linked to other EU policy frameworks and its implementation is expected to enhance energy security, create jobs, provide opportunities for small and medium enterprises, and promote innovation and research and development (Commission of the European Communities, 2008).

As well as the links to mitigation efforts, development objectives can have strong links to adaptation. This stands to reason; the key objective of adaptation measures is to reduce vulnerability to the immiserating impacts of climate change, so any successful adaptation efforts will, by definition, constitute development.

But it is also possible for appropriately designed development efforts to strengthen adaptive capacity while simultaneously achieving their primary objectives.²¹ OECD (2005: 21) notes that in many cases this does not involve new plans, but rather involves the successful implementation of existing plans

18 The IEA’s World Alternative Policy Scenario—a scenario of projected policy activism to address energy security and environmental concerns—derives almost 60 per cent of its projected reduction in CO₂ emissions from energy efficiency measures (IEA, 2004).

19 Cosby *et al.* (2006), in assessing the development dividend from CDM projects, found that household energy efficiency projects scored higher than all other project types.

20 UNEP-Riso’s CDM pipeline of projects (<http://www.uneprisoe.org>) as of February 1, 2008, showed potential mitigation of 281 million tonnes of CO₂ equivalent to 2012 from 406 such projects.

21 Of course, successful adaptation being development as noted above, there is often no bright line to easily distinguish adaptation objectives from development objectives.

in areas such as “water or energy conservation, forest protection and afforestation, flood control, building of coastal embankments, dredging to improve river flow and protection of mangroves.” As such, a number of aid agencies are now making efforts to “climate-proof” their programming.²²

Just as development has linkages to active climate policies, it also has linkages to the failure of climate policies. Many of these are simply the obverse of the links discussed above. For example, as noted above, successful adaptation policies constitute development; it is conversely true that a lack of adaptation policies will lead to mal-development—a decrease in human well-being.²³

But there are also linkages that are novel. A failure of successful mitigation efforts, for example, will have a number of important development impacts, most of them which also threaten to undermine the basis for economic growth. Kjørven (2006) makes the case that climate change unchecked will seriously undermine the achievement of the MDGs. The scenarios of this type are countless, but a few key examples include:

- Patterns of agricultural production will be disrupted, as producers (who constitute some 40 per cent of the population in developing countries as a whole, and over 80 per cent in some [ILO, 2004: chapter 3]) are forced to cope with increased variability and uncertainty of weather patterns. Poor dryland farmers will be heavily affected, and the final effects will directly increase malnutrition and poverty in poor countries (Hadley Centre, 2006; Stern, 2006: chapter 4; Magrath, 2006). Impacts will also be significant for developed country producers.²⁴
- Droughts, floods and extreme weather events will become more frequent and more severe, taking a human and economic toll (IPCC, 2007a).
- Risk of immiserating vector-borne diseases such as malaria, and diseases based on a lack of potable water, may increase for tens of millions of people (van Lieshout *et al.*, 2004).
- Sea level rise will threaten populations and infrastructure in coastal communities worldwide (IPCC, 2007a).²⁵ The effects of an abrupt disruption—a disaster scenario such as the melting of the Greenland ice sheet—would imply incalculable damage, eventually raising sea levels by up to seven metres (Baer, 2007).

22 See, for example, Danish Ministry of Foreign Affairs (2005). Kjørven (2006) estimates that 27–40 per cent of current donor-funded activities are “climate-exposed.” See also http://www.iisd.org/security/es/resilience/climate_phase_2.asp on the development of the CRiSTAL tool to screen development interventions for climate change concerns.

23 See OECD (2005) for case studies of this linkage in action.

24 See Natural Resources Canada (forthcoming) for an assessment of the implications for Canadian producers.

25 Also see Dasgupta *et al.* (2007), who calculate conservatively that 56 million people in developing countries would be impacted by a one-metre sea level rise.

- Glacial recession will significantly reduce flows of rivers critical to the well-being of huge swaths of the population in developing countries (Rai, 2005; Barnett *et al.*, 2005; Chevalier *et al.*, 2005).

The failure of adaptation efforts will have effects that amount to intensified vulnerability to the sorts of impacts described above.

3.4 Thus advancing development goals in a sustainable way should be a central part of efforts to address climate change in all countries

There are a number of important elements that should feature in any national and international approaches to address climate change, including adaptation, development and dissemination of new technologies, and financing and investment. These elements are all discussed in the chapters that follow this one. The analysis in this section argues strongly that advancing development goals in a sustainable way should also be central.²⁶

The argument starts with the urgent need for, and the international commitments to, action on both climate change and development. It notes that governments worldwide are pursuing strategies to increase economic growth, which often has inherent conflicts with climate change objectives.

Appropriate development strategies can deal with all of these priorities simultaneously. They achieve the ends for which economic growth is a key means (and potentially alleviate the pressure for such growth). In the process they address climate change objectives by means of the many positive linkages between such development and mitigation. And where development strategies relate to adaptation, they will by definition advance both development and climate change-related goals.

The key is the emphasis on win-win policies that can simultaneously achieve development and climate change objectives. Win-win opportunities will not by themselves take us as far as we need to go in addressing either climate change or development needs,²⁷ but from the perspective of climate change policy they are an obvious starting point.

4.0 Canadian mitigation and the implications for economic growth

Stemming from Bali, there can be little doubt that the pressure for ever more stringent mitigation targets and actions will only increase. The implications for

26 In fact, as noted below, there is a great deal of overlap between advancing development goals sustainably and the other elements listed here.

27 Michaelowa and Michaelowa (2005) caution, in particular, that much development-related climate change spending might not necessarily mesh with the highest development priorities of the recipient countries.

Canada—socially, economically and politically (e.g., federal-provincial relations)—will clearly not be insignificant. This section identifies the implications of various mitigation targets on Canada’s economic position. That is, what is the scope of the economic growth vs. mitigation trade-off in Canada? The section then provides a perspective on how Canada could move forward with mitigation, with a particular emphasis on the implications for accessing international mitigation opportunities. Key sections include:

- Canada’s high emission rates will continue to be influenced by urban planning policies, climate and resource extraction energy industries;
- Canada’s economic growth and emissions will continue to grow through 2020; but
- domestic mitigation costs are high and thus access to international mitigation opportunities is important.

4.1 Canada’s high emission rates will continue to be influenced by urban planning, climate and resource extraction industries

Canada’s large size, northern climate and urban planning policies²⁸—in addition to economic activity being linked to resource-based energy-intensive sectors that are mostly geared for export markets—have led to high levels of emissions. While GHG emissions per unit of GDP decreased by approximately 18 per cent from 1990 to 2005 due to increased energy efficiency (Environment Canada, 2007: 4), the growth in the economy and particularly in resource-based industries has meant growing emissions. The nation’s most recent GHG emissions profile demonstrates that Canada continues to increase GHG emissions despite international commitments and increasing domestic concern. In 2005, Canada’s total GHG emissions were estimated to be 747 megatonnes of CO₂-eq, up 25.3 per cent from 1990 and 32.7 per cent above the nation’s Kyoto Protocol target of reducing emissions by at least six per cent below 1990 levels by 2008–2012 (Environment Canada, 2007: 3).

Of all Annex I Parties, Canada was the fifth largest emitter of GHGs in 2004, behind the United States, the Russian Federation, Japan and Germany (Government of Canada, 2006). The IEA (2007a) reports that Canada’s had the seventh highest GHG emissions of 136 nations, behind the four Annex I nations mentioned above and China and India. Canada ranked third in per capita CO₂ emissions amongst OECD nations, being surpassed only by the United States and Australia.

28 Eighty per cent of Canadians live in urban areas (UNDP, 2007), which has a large impact on GHG emissions partly because of the structure and design of these areas. It is estimated that half of Canada’s GHG emissions can be controlled or reduced by municipal governments (Duncan, 2007); transportation being one example, as two-thirds of emissions in this sector are in urban areas in Canada (Gélinas, 2003).

Economic growth and population levels explain much of Canada's GHG performance. Canada led the G8 nations between 2000 and 2004 in economic growth, with output increasing at an annual average rate of 3.1 per cent (Cross, 2006). Canada also had the highest population growth rate (5.4 per cent) among G8 countries over roughly the same period (Statistics Canada, 2007). Adding to this is population dispersion and the design of cities, which increases distances travelled thereby contributing to a relatively higher emission profile on a per capita basis.

Also contributing greatly to emissions is Canada's energy and natural resource extraction and processing sectors that are highly energy-intensive. Collectively, these energy intensive sectors accounted for roughly 50 per cent of Canada's emissions in 2005 but contributed only about 15 per cent of national GDP. Increasingly, the domestic energy sector is becoming more emission intensive, primarily a result of a shift from conventional to unconventional sources such as the oil sands, coal bed methane, light gas and liquefied natural gas. Notably, investments in the oil sands tripled from \$5.2 billion in 2003 to a planned \$16.1 billion in 2007 (Cross, 2007: 3.4), and represented 46 per cent of all domestic oil output in 2006 (NRCan, 2006). As the share of conventional crude oil extracted has declined, the energy requirements and hence emissions have steadily increased, with nearly a doubling in emission and energy intensity between 1990 and 2000 (Environment Canada, 2007: 10).

Canada, along with Norway and Australia, is in a unique class of industrialized nations where resource exports significantly impact the domestic economy. This increased demand is fuelled in part by an insatiable international demand, with energy exports increasing as a share of the total value of exports from 12.5 per cent in 2002 to 22 per cent in 2006 (National Energy Board [NEB], 2007: 3). Net export revenues increased for crude oil and coal by 58 per cent and 97 per cent respectively from 2005 to 2006 (NEB, 2007: 3), with the increases in coal largely reflecting Asian demand. Virtually all oil and gas exports are to the United States, with exports equivalent to 2.3 million barrels of oil a day to the U.S. market in 2006 (NRCan, 2007). Environment Canada (2007: 13–14) noted that much of the increase in emissions from the oil and gas sector can be attributed to a rapid rise in exports to the United States which grew 162 per cent between 1990 and 2005. Fossil fuels and electricity account for nearly two thirds of the Canada-U.S. trade surplus (Weir, 2006: 2). The linkages with the U.S. economy and the increasing integration of the Canada-U.S. energy systems are therefore another major driver of Canada's GHG emissions.

Canada is heavily integrated into the international economy and much of the increase in total GHG emissions is associated with exports, especially increased oil and gas exports to the United States. But at the same time that exports have increased in quantity and value, so too have imports, meaning that emissions embodied in exports are almost balanced out by imports. Peters and Hartwich (forthcoming) assessed the balance of emissions embodied in trade for a num-

ber of countries, and concluded that Canada's balance of embodied emissions in trade (BEET) was 15.5 MtCO₂ for the period (embodied emissions in exports were 173.4 MtCO₂, embodied emissions in imports were 158.0 MtCO₂)²⁹ (See Table 2). Canada's imported CO₂ is more or less balanced out by exports. The United States, by contrast, has a BEET of -438.9 MtCO₂, China's is 585.5 MtCO₂ and Russia's is 324.8 MtCO₂. In general Annex B countries were found to be net importers of CO₂ emissions; but as a percentage of production-based emissions (i.e., the higher the figure, the more impact production-based activities would have on the country's mitigation target), there was considerable variation. The highest impacts are for small trade-intensive economies, and Canada's impact is very low.

Table 2: Emissions Embodied in Trade (BEET) for select countries

Annex B			Non-Annex B		
	BEET MtCO ₂	BEET as a % of production-based emissions		BEET MtCO ₂	BEET as a % of production-based emissions
Switzerland	-63.1	-122.9%	Singapore	-62.8	-128.2%
Latvia	-4.6	-60.7%	South Korea	-45.4	-11.4%
United Kingdom	-102.7	-16.6%	Morocco	-2.5	-6.3%
Germany	-139.9	-15.7%	Mexico	-17.6	-4.5%
Japan	-197.0	-15.3%	Brazil	+2.5	+0.8%
United States	-438.9	-7.3%	India	+70.9	+6.9%
Canada	15.5	+2.8%	China	+585.5	+17.8%
Australia	57.9	+16.5%	Indonesia	+58.1	+19.0%
Russia	324.8	+21.6%	South Africa	+123.5	+38.2%

Source: Peters and Hertwich, forthcoming.

4.2 Canada's economic growth and emissions will continue to grow through 2020

Canada's economy is forecast to grow at a rate of about 2 to 2.5 per cent annually between now and 2020, resulting in a growth in GDP from the 2005 level of \$1.25 trillion to about \$1.7 to \$1.8 trillion (NRCan, 2006; NRTEE, 2008). While a number of sectors in the economy, including energy and emission intensive sectors such as oil and gas extraction, are forecast to grow, there are not likely to be significant divergences from the national average growth rate. With this growth will of course come more GHG emissions. Several recent reports suggest that GHG emissions are likely to increase by roughly 15 per cent between 2005 and 2020, from their current level of 750 Mt CO₂-eq to a 2020 level of 850 to 900 Mt CO₂-eq (NRTEE, 2008).

29 The study tracked CO₂ only and these figures do not include emissions from international transportation.

This then implies that the GHG intensity of the economy is falling in time, and is forecast to fall roughly in line with historical rates of about 1–1.5 per cent per year. This trend applies to all sectors except oil and gas extraction, where the emissions intensity is projected to increase because of rising oil sands production and decreasing conventional production. Petroleum emissions are expected to grow from a share of 10 per cent of all energy-related GHGs in 2005 to 16 per cent in 2020 (NRCan, 2006). Table 3 below provides an overview of the distribution of Canada’s energy-related GHG emissions by major economic sector.

Table 3: Growth in energy-related GHG emissions from 2005 to 2020, by sector (fugitive emissions are another 167 Mt in 2020)

	2005		2020	
	Mt	Share of Total	Mt	Share of Total
Chemical	19	2.8%	22	2.7%
Coal mining	3	0.5%	3	0.4%
Commercial	37	5.5%	57	7.1%
Electricity	129	19.5%	122	15.3%
Industrial minerals (cement)	14	2.2%	19	2.4%
Iron and steel	15	2.3%	16	2.0%
Metals	12	1.8%	10	1.3%
Mining	5	0.7%	7	0.9%
Natural gas extraction and transmission	73	11.0%	75	9.4%
Other manufacturing	21	3.2%	30	3.8%
Crude oil extraction and transmission	70	10.6%	135	16.8%
Petroleum refining	23	3.5%	35	4.4%
Pulp and paper	14	2.1%	13	1.6%
Residential	42	6.3%	41	5.1%
Transportation	186	28.0%	215	26.9%
Total energy-related GHGs	662	100%	801	100%

Source: NRCan, 2006 and CIMS Model Forecast

4.3 Canada’s economy will continue to grow under well-designed carbon mitigation policy

A central driver in identifying the trade-offs between mitigation and economic growth is mitigation stringency. Simply, the level of mitigation determines abatement effort, which then drives costs and economic outcomes. A second important driver is policy design, where a well-designed policy can minimize costs while making available cost-effective abatement opportunities. This section first looks at various mitigation targets and then identifies the trade-off between economic growth, measured in GDP lost, and mitigation. This assessment is conducted using numerical models of the Canadian energy economy calibrated to economic and emission forecasts for 2020.

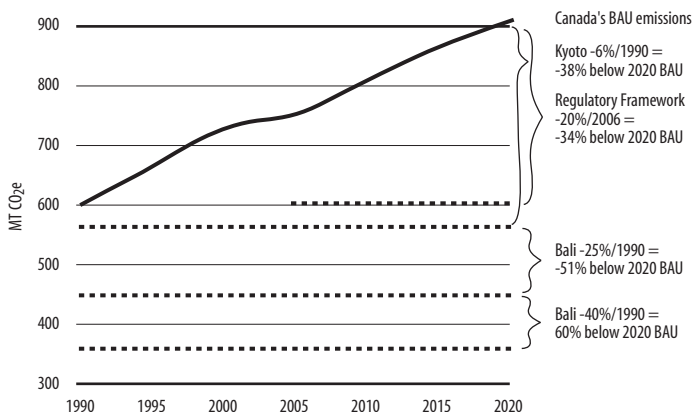
To date, there are three targets that frame the possible range of mitigation stringency out to 2020. These include the:

- Kyoto target of six per cent below 1990;
- Government of Canada’s *Regulatory Framework* target of 20 per cent below 2006; and
- the so-called “Bali Footnote” targets of 25 per cent to 40 per cent below 1990.

These three targets provide a range of mitigation action under which it is useful to assess the implications on economic growth.

In Chart 1 below, the growth in Canada’s total emissions (with fugitives) are compared with the four targets. As can be seen, the range of possible abatement efforts to achieve these targets ranges between more or less stabilizing 2020 business as usual (BAU) emissions at 1990 levels, through a reduction below the BAU of 34 per cent (*Regulatory Framework*) to 60 per cent below BAU for the most stringent of the Bali targets (40 per cent below 1990). A central observation is that all of these targets are relatively stringent compared to current policy, and thus they likely imply the need for a significant shift in policy, and importantly, the current energy system. This then implies a reduction in forecast economic growth.

Chart 1: 2020 BAU and various mitigation targets



To investigate the economic implications of these targets, we use two models, the CIMS energy economy model and C-GEEM (Canadian General Equilibrium and Emission Model):

- The *CIMS model* simulates the technological evolution of fixed capital stocks in Canada (such as buildings, vehicles, and equipment) and the resulting effect on costs, energy use, emissions, and other material flows of various carbon policies such as pricing and standards.³⁰ With the carbon policy, old stocks are retrofitted to reflect the increased cost of carbon while new and less emission-intensive capital stocks are acquired at retirement and with growth in stock demand (e.g., rising electricity demand). Market shares of technologies competing to meet new stock demands with the carbon policy are determined by standard financial factors as well as behavioural parameters from empirical research on consumer and business technology preferences.
- The *C-GEEM* is a simple general equilibrium model of the Canadian economy that aggregates Statistics Canada M-Level input/output data for 2003 into eight energy producing and using sectors, namely crude oil production and extraction, gas extraction and transmission, refined petroleum product manufacturing, coal extraction, electricity generation, energy intensive manufacturing, other manufacturing, and the rest of the economy. In the model, a representative household supplies labour and capital to industrial sectors. The industrial sectors supply intermediate inputs to one another, and final commodities to the household. Imports and exports to the rest of the world are explicitly modelled. All markets interact through relative producer and consumer prices with policy shocks changing these prices, leading to new equilibriums in the various markets.

Together, these two models combine the technology richness required to understand emissions and cost implications of carbon policy (CIMS) with the macroeconomic capabilities of general equilibrium models (C-GEEM). Emissions and economic activity in both models are calibrated to the Canadian Energy Outlook (NRCan, 2006). We construct a simple scenario to trace out the impact on economic growth of the various targets:

- *An economy-wide domestic carbon price.* Emission pricing is implemented across the entire economy as a cap and trade program, a carbon tax or a combination of the two, with cap and trade for large emitters and a carbon tax for those not covered including buildings, transportation and other manufacturing. In the modelling we apply a generic carbon price to “hit” the various targets. This approach is the most cost-effective alternative, but technology standards and other complementary policies will also be required (NRTEE, 2008).
- *Revenue recycling and tax shifting.* With carbon pricing there will be significant financial flows that can accrue to governments, households (depending on revenue recycling) or inter-industry transfers as in cap and trade

30 A more complete description of CIMS is available in Bataille *et al.* (2006) and Rivers and Jaccard (2005).

(with no auctioning). As well, taxes are distortionary by definition, and reducing a tax through carbon pricing and tax shifting can reduce the economic impact of carbon pricing alone.³¹ Finally, there are distortions in the economy that preclude the deployment of some renewable technologies, notably a wedge between the social and private returns to technologies such as carbon capture and storage and renewable grid-power electricity, and thus there are reasons to provide incentives to their deployment. We therefore explore two scenarios to demonstrate the impact of revenue recycling and tax shifting on economic growth under carbon pricing:

- The first scenario does not have recycling revenue where government revenues rise; and,
 - The second scenario with recycling and tax shifting. Specifically, 50 per cent of the carbon revenue remain with industry (through inter-industry transfers through permit trading or recycling carbon tax to industry based on output), seven per cent is used to incent carbon capture and storage in upstream oil and gas and electricity, seven per cent is used to incent renewable electricity and the remaining revenue is used to reduce personal income taxes.
- *Domestic action only.* For these scenarios we investigate domestic action only. This assumption is relaxed later in the chapter to see if costs can be reduced.

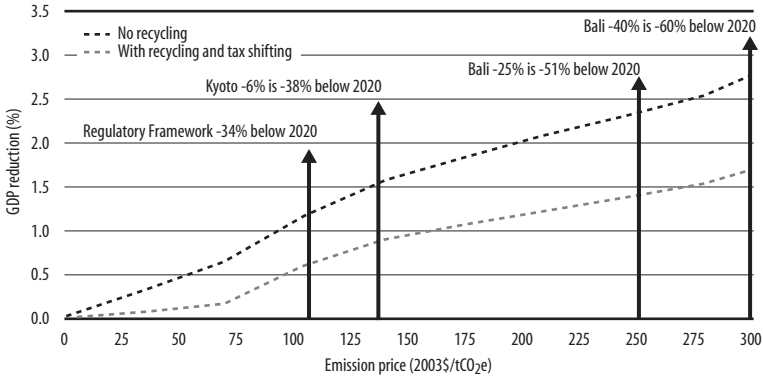
Using these scenarios, the relative impact on economic growth of the various targets can be assessed. We also comment on the carbon price required to hit the targets, as well as sectoral implications that may be masked by the national macroeconomic impact.

Chart 2 provides an overview of the economics of economy-wide carbon pricing under two alternative revenue recycling and tax shifting scenarios:

- *The carbon price to achieve the targets will be in excess of \$100, and could be much higher.* Emerging from this assessment is that the carbon price to achieve the target varies between about \$100 per tonne of CO₂-eq) for the least stringent policy to around \$300 in 2020 for the most stringent of the Bali targets.
- *The impact on GDP is about equivalent to the forecast annual growth rate, but in the worst case, could result in no economic growth at all.* In Chart 2, the modelling indicates that economic growth could be as low as 0.5 per cent for the least stringent policy with revenue recycling and tax shifting (Regulatory Framework) or as high as 2.5 per cent annually for the most stringent Bali target and no recycling or tax shifting. Since economic growth is forecast to range between two and 2.5 per cent in 2020, this last scenario could result in no growth. This finding points to a growth versus mitigation trade-off, and importantly that policy design matters.

31 Bovenberg and De Mooij (1994), Goulder (1996), and Chiroleu-Assouline and Fodha (2006).

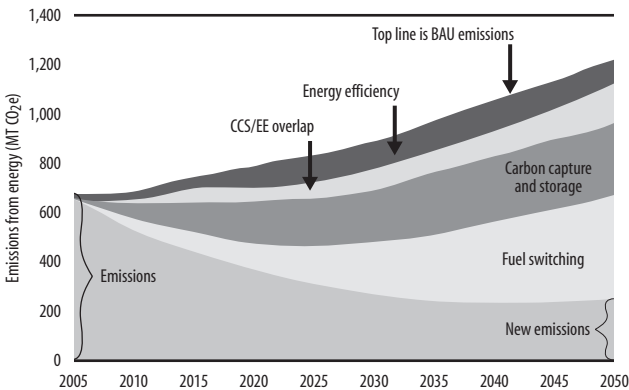
Chart 2: Carbon price and GDP impacts to achieve the various domestic targets



Source: CIMS and C-GEEM

Technology deployment would be significant and widespread. With economy-wide carbon pricing, significant technology deployment would need to occur across the Canadian economy, with reductions coming from energy efficiency (81 Mt in 2020), carbon capture and storage (171 Mt in 2020), and fuel switching (104 Mt), including renewables. Chart 3 provides the relative contributions from these various technologies. These are clearly large numbers and indicate a need to realign investment patterns and technology deployment in a very short period of time that are, perhaps, beyond historical comparison.

Chart 3: Technology deployment for mitigation of -25% below 1990 in 2020 and 80% in 2050



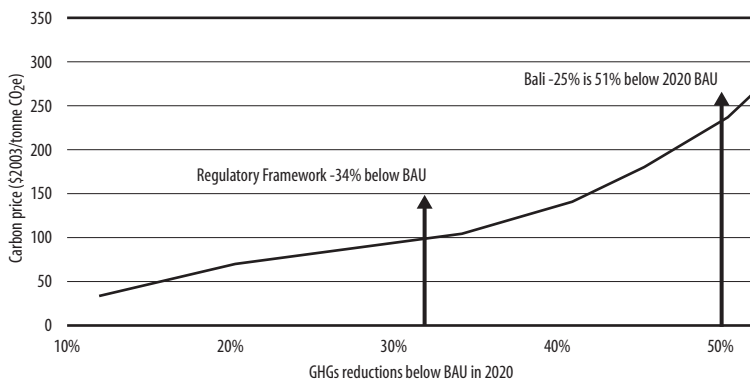
Source: CIMS and C-GEEM

Based on the above discussion, we see that even with the most stringent of the possible mitigation targets there is likely to be continued growth in Canada. Further, there are opportunities to minimize compliance costs through either efficient policies, such as economy wide carbon pricing, but also through using carbon price proceeds to recycle revenue, for example to renewable electricity, carbon capture and storage or building retrofits; and tax shifting, which involves reducing other taxes such as labour and capital taxes.

4.4 But, domestic mitigation costs are high and thus access to international mitigation opportunities is important

An important observation is that the costs of the targets rise exponentially with mitigation stringency. Chart 4 below provides emission price associated with the various targets. As can be seen, at reductions greater than 30 per cent below BAU, the carbon price must rise exponentially, thereby increasing overall costs. This observation, that mitigation costs increase sharply after 35 per cent below the 2020 BAU, indicates a need to seek emission reductions through cost-effective domestic policy, as well as through international opportunities. This is particularly the case since some international sources peg 2020 carbon prices from developed countries at about \$100 per tonne (Deutsche Bank, 2007). There would be a significant pool of reductions from the developing world at prices below this, which present real opportunities to lower mitigation costs so that reductions in economic growth are minimized.

Chart 4: Rising carbon price with increasing mitigation



Source: CIMS and C-GEEM

The case for looking internationally is further strengthened when the sectoral implications of the various targets are explored. The economy-wide economic impacts mask clear sectoral differences, especially for those emission intensive

sectors. In Table 4 below, the various impacts on sectoral impacts estimated by C-GEEM for the various targets is provided. While GDP impacts seem relatively small, sector output for the energy intensive sectors falls—oil could have a decreasing impact as carbon capture and storage becomes available at high carbon prices, natural gas extraction and transmission and petroleum refining could experience large declines, and coal mining could be all but wiped out. Interestingly, the electrification of the economy due to a shift towards low emitting energy sources results in significant growth in the electrical generation sector. Finally, the low emission intensity of the rest of the economy, and notably the service sector, results in a small but negative impact on output.

Table 4: Sectoral impacts for the various mitigation targets (domestic action only)

	Emissions below BAU in 2020	GDP decrease in 2020	Sector Output Change from BAU in 2020						
			Crude oil extraction	Natural gas extraction and transmission	Coal mining	Petroleum refining	Electricity generation	Energy-intensive manufacturing	Rest of economy
Regulatory Framework	~34%	-1.2%	-20%	-22%	-73%	-17%	15%	-5%	-0.6%
Bali -25%	~50%	-2.1%	-10%	-32%	-84%	-21%	25%	-8%	-1.3%
Bali -40%	~60%	-2.7%	-8%	-36%	-88%	-23%	30%	-9%	-1.9%

With mitigation at the level currently contemplated for 2020 and cost-effective policies such as economy-wide carbon pricing, adverse economic impacts—especially in the fossil fuel sector—can still be expected. While economic growth will likely continue—that is the economy will grow in 2020 even with stringent mitigation targets—there are risks. These include bad policy design where flexibility does not allow for cost-effective emission reductions as well policies that do not recycle the proceeds of carbon pricing to emitters or to reduce distortionary taxes. Additionally, the rising cost of domestic abatement is a real risk and points to the need for access to lower cost and verifiable reductions internationally.

4.5 Concluding comments

Access to international credits will be necessary in the short term for Canada because of the structure of the economy; but domestic action is also needed in this time frame to begin the economic and social transformation to a low-carbon world. Canada needs to start now to drive the necessary changes, developing a policy framework that includes an economy-wide emissions price signal and mechanisms to stimulate technology transformation. NRTEE (2008) recommended that the federal government:

- implement a clear and consistent GHG emission price signal;
- institute an emission tax or cap and trade system, or combination of the two;

- develop regulatory policies for sectors that do not respond to price signals;
- support RD&D of technologies and strategic investments in infrastructure;
- establish a Canada-wide plan to better coordinate federal, provincial and territorial mitigation actions; and
- apply mitigation policies that incorporate adaptive management practices.

It will be important to move quickly to put Canada on a path of greater emission reductions. As noted above, we need to realign investment patterns and technology deployment in a very short period of time to effectively increase energy efficiency and decrease emissions in energy production. For example, CCS is a necessary transition technology for emission reductions in Canada, requiring supportive policy frameworks and public financing to reach commercial levels in the short term. And proper regulatory policies and strategic investments (e.g., in public transportation systems and green buildings) can help to create the needed transformation in Canadian urban centres. A well-planned approach can help to leverage co-benefits, including health benefits through air pollution reductions and economic benefits through the marketing of clean energy technologies.

Mitigation in Canada will come with a price, and the data in Table 4 point to a real issue as Canada moves forward to mitigate emissions: the possible impact of policies and actions on the growing profile of the energy exporting side of the Canadian economy. An emerging economically-based dynamic that is defined by natural resources poses challenges for the Canadian fabric. Approaches to climate policy could pit provinces that are economically dependent on fossil fuel sectors and export markets (such as Alberta, Saskatchewan and Newfoundland) and much less enthusiastic about restricting oil sands growth or imposing a carbon tax, against other provinces that are more manufacturing-intensive (such as Quebec and Ontario).

5.0 Elements of a post-2012 international approach to mitigation

Section 4 implies that Canada will be required to adopt a broader perspective and approach to mitigation on the international stage. This section examines a range of possible mitigation opportunities set out in the Bali Action Plan, and begins to look at a strategy for how Canada can access cost-effective emission reductions internationally so that the domestic costs of mitigation are minimized.

Differentiated action seems to be a common theme for a post-2012 world. Simply this means different rules and obligations for different classes of actors, of which we identify three: developed countries, major developing emitter countries (or newly industrialized) and other developing countries.

The G-77 and China comprise the major developing country coalition in the UNFCCC negotiations, with most non-Annex I countries belonging to G-77. Yet differences in economic growth rates and levels of development between the major emitters and the poorer developing countries (and hence differences in needs and priorities in regard to climate change mitigation and adaptation) could result in developed countries pursuing different strategies with various groups of developing countries. Indeed, Canada has called for engagement of all major emitting countries and commitments by major developing countries to limit and then stabilize emissions growth. (IISD, 2007). This will mean that complexity in a post-2012 regime will necessarily increase.

This section examines three mitigation areas set out in the Bali Action Plan, exploring Canada's interests:

- reducing emissions from deforestation and forest degradation (REDD) can lead to mitigation and development assistance opportunities (para 1[b][iii]);
- sectoral approaches to mitigation can result in mitigation in major emitting developing countries and lessen competitiveness concerns (para 1[b][iv]); and,
- expanded market mechanisms can add flexibility options for mitigation and target attainment (para 1[b][v]).

There are both risks and opportunities in each of these areas that need to be better understood so that positions and, perhaps more importantly, actions can be undertaken accordingly.

5.1 Reducing emissions from deforestation and land degradation

Avoided deforestation has been excluded in the first commitment period of the Kyoto Protocol primarily due to concerns over baseline setting, leakage and other technical issues. Another major concern is over the use of low-cost avoided deforestation carbon reductions by Annex I countries to avoid taking domestic action. In 2005 this historical bias changed with a push by the Coalition of Rainforest Nations for inclusion of avoided deforestation in a post-2012 regime. In Bali there was recognition that decreases in deforestation rates from an established baseline could somehow result in credit and/or compensation in a post-2012 regime. This section explores the implications of this new opportunity and discusses the relevance of this for Canada, and the country's mitigation efforts more specifically.

5.1.1 Background

Emissions and removals of carbon from land use change are a significant part of human contributions to the global carbon cycle. IPCC (2000b) calculates

total annual carbon emissions from land use change between 1989 and 1995 at 1.6 gigatonnes per year, or 20 per cent of global anthropogenic emissions.³²

The elements that make up land-use change figures are deforestation for cultivation or pasture, deforestation for forest products or fuelwood, abandonment of cultivation or pasture activities (and subsequent regrowth), and shifting cultivation (slash and burn). Deforestation for cultivation or pasture, mostly centred in developing countries, dwarfs the other elements of this mix, amounting to just over 100 per cent of net emissions (Baumert *et al.*, 2005). To put this in perspective, at these levels predicted CO₂ emissions from this type of deforestation *every year* during the first commitment period would amount to roughly double the reduction all Annex I Parties combined had achieved in their annual GHG emissions between 1990 and 2004.³³

As such, avoiding and reversing tropical deforestation is an obvious focal point for international efforts aimed at mitigation. Enkvist *et al.* (2007) argue that forestry has the highest potential of any sector to contribute to low-cost mitigation between now and 2030. Moreover, a number of studies have suggested that sequestering carbon in forests is likely to be much less costly than other approaches to reducing atmospheric CO₂ (Stavins and Richards, 2005).³⁴

As well as being key to mitigation efforts, deforestation is also strongly linked to development. Clearing of land in developing countries is primarily for agriculture; subsistence farming in Africa, cattle ranching and soy plantations in South America, palm oil and coffee plantations and timber products in South East Asia.³⁵ Deforestation negatively impacts those—most directly, the poor—who rely on the affected ecosystems for fuel, food and flood prevention among other things. And widespread low-efficiency fuelwood use generates significant air pollution and health problems. Given the strength of these linkages there is a host of development projects dedicated to avoiding deforestation and land degradation via improved natural resource management, increased fuelwood efficiency and improved agricultural practices.³⁶

32 Table 2. This figure has an error limit of 0.8 gigatonnes at a 90 per cent confidence interval.

33 Calculations of emissions reductions taken from UNFCCC (2006), based on total aggregate emissions without LULUCF, where a reduction of 0.7 gigatonnes CO₂ equivalent was achieved. (The corresponding figure for reductions with LULUCF is 0.8 gigatonnes.) Calculations for emissions from deforestation based on IPCC (2000b: 13), where annual net stock change from all LULUCF over 2008–2012 is predicted to be between 1.6 and 1.2 Mt.

34 See, though, Enkvist *et al.* (2007) for a contrary view, holding that a wide range of other policies and measures would be more cost effective.

35 Stern (2006: chapter 25). According to FAO (2005), between 2000 and 2005 Brazil (3.1 million ha) and Indonesia (1.9 million ha) accounted for 1.5 times the forest loss of the other top eight countries put together.

36 As of February 9, 2007, the Asian Development Bank's global database of development projects that address environment and poverty contained 25 entries in this area (some comprising a number of projects), making up over 30 per cent of all entries. See <http://www.povertyenvironment.net>.

Stern (2006: 540) puts it succinctly:

“Effective action to protect existing forests and encourage afforestation and reforestation requires changes to the structure of economic incentives that lead to unsustainable logging and to the conversion of forestland to agriculture.”

In other words, deforestation is fundamentally an economic phenomenon. Addressing it will call for measures that alter the basic economics of deforestation. Efforts to this end can be made at the domestic level; Costa Rica and Mexico already pay landowners to be stewards of forested land (Stern, 2006:544).

5.1.2 Review of the Bali mandate and mitigation

These compelling considerations led to the inclusion of a mandate on REDD in the Bali Action Plan. Parties are committed to addressing mitigation through, *inter alia*, considering “policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries.” The question to be answered between now and 2009 is exactly what form the final agreement on avoided deforestation will take. The discussion below starts by considering the needs and possibilities in this area.

This considerably expands opportunities for developing country participation. The Kyoto Protocol only includes afforestation and reforestation activities in developing countries under the CDM; deforestation was negotiated out largely due to concerns over methodology and leakage.

5.1.3 Possible mechanisms for addressing deforestation

How might a post-2012 regime address REDD? The possible approaches boil down to carbon market financing, a fund or some combination of the two. The challenge is then to set a global framework for deforestation avoidance, including its linkages with other regimes. Solving technical matters such as baseline setting, verification and monitoring will also be key.

But the challenge will be to reconcile all competing interests: Annex I countries will seek to gain credit for investments in reducing deforestation internationally, developing countries will seek to gain compensation for the lost economic opportunity associated with reversing deforestation, and the major developing emitters will seek to count REDD towards any mitigation commitments that they may face moving forward in time.

These varying perspectives have emerged in a number of proposals for how REDD might be treated post-2012. At least four competing proposals reflect this divergence of opinion:

- *The Papua New Guinea/Costa Rica proposal. A Modified CDM Approach (project crediting)*. In the lead up to COP-11, Papua New Guinea (PNG) and

Costa Rica proposed that the international community “consider appropriate expansion of the Marrakesh Accords,” in order to allow the CDM to credit projects that reduce emissions from tropical deforestation (PNG/Costa Rica, 2005). The concept is not elaborated in the PNG/Costa Rica paper, but presumably the idea would be to allow the CDM to use existing rates of deforestation as a baseline in determining the impacts of a project or program in reducing GHG emissions. This would involve an amendment of the Marrakesh Accords in the first commitment period or, more relevant to the present analysis, agreement that in any post-2012 regime that there be scope for such crediting.

It would also, however, involve some difficult methodological considerations with respect to verification and monitoring. IPCC (2000b) makes it clear that there are no easy definitions of what constitutes deforestation, or even what constitutes a forest for that matter. While the principle behind this proposal is simple enough, putting it into practice would be challenging.

- *Brazil’s proposal for reducing emissions from deforestation. New Dedicated “Non-Market” Fund to UNFCCC with Annex I Funding but No Access to Reductions.* In a submission to the *Dialogue on Long-Term Cooperative Action* (specifically in the context of advancing development goals in a sustainable way) Brazil elaborated on earlier proposals to propose a new agreement, under the auspices of the UNFCCC, to compensate developing countries for avoided emissions from deforestation.³⁷

Unlike the PNG/Costa Rica proposal, this proposal does not envision the reduced emissions from avoided deforestation being used by Annex I countries to count towards their obligations; these reductions would be additional to any such obligations. It would presumably involve establishment of a funding mechanism with contributions from developed country Parties. Financial incentives would be awarded to countries that lowered their rates of deforestation below an established baseline rate. No penalty would apply to those countries that exceeded their baseline rate, but for the purposes of calculating financial incentives due from the fund, such failure would count against any future reductions.

The financial incentives would be in the form of new and additional payments, technology transfer, and/or capacity building. The latter might be particularly important. Avoiding deforestation involves significant domestic-level challenges that typically require, at a minimum, strengthening legal and regulatory systems (particularly involving property rights and enforcement) and natural resource management capacity.

37 The PNG/Costa Rica proposal also mentions the idea of a separate agreement as one option for addressing tropical deforestation, but does not elaborate any further.

- *Sustainable Development Policies and Measures (SD-PAMs). Compensated Reductions with No Annex I Access to Reductions.* In its fundamentals, as applied to deforestation, this idea is similar to the Brazilian proposal. It has been proposed that one way to engage developing countries in a post-2012 regime without actually embarking on the politically difficult course of setting quantitative targets is to allow them to pledge to undertake sustainable development policies and measures that will reduce GHG emissions (Bradley and Baumert, 2005). Such pledges would be voluntary, and would be designed primarily to serve domestic policy needs not related to climate change objectives. They would, if successfully carried out, be rewarded with funding, either by agreement through existing channels (e.g., Official Development Assistance [ODA], the Global Environment Facility [GEF], multilateral development banks) or through some expressly designed international mechanism.

If a post-2012 regime chose to involve developing countries in this fashion, it could allow for pledges to curb deforestation, thus directing financial support toward efforts to do so.

- *Developing country commitments post-2012. New Kyoto Trading Mechanism (national-level crediting).* A final possible regime design is to assign quantitative targets to developing countries, and to allow avoided deforestation to count toward fulfillment of those obligations. If the regime allowed for emissions trading along the lines of the present regime, this would allow countries such as Brazil and Indonesia to generate large quantities of AAU-like credits, generating significant revenues that could be devoted to forest protection. There is strong opposition among developing countries to the idea of such targets in a post-2012 regime—opposition that would hardly be overcome by designing a system that would benefit only a sub-set of countries (those with major deforestation problems). If the regime allowed afforestation and reforestation to count toward commitments with a high cap, or no cap, it might broaden the group of benefiting countries somewhat, certainly including China, for example.³⁸

Each of the elements discussed above posited a regime that contained a market mechanism similar to the CDM, which allowed developing countries to help finance their efforts to simultaneously reduce GHG emissions and foster sustainable development. There are significant differences in the proposals however, in terms of access by Annex I countries to REDD credits as well calls for Annex I countries to finance developed country efforts without access to the reductions for target attainment purposes. Also missing from this are proposals from the major developing emitting countries that will inevitably seek to gain credit through REDD as they take on commitments over the longer term.

³⁸ China reported an annual net gain in forest area from 2000–2005 of over four million ha. This was almost four times the gain of the next nine leading nations combined (FAO, 2005: table 2.6).

5.1.4 How would REDD address the central challenge of mitigation in the context of economic growth?

The main benefit of gaining access to REDD reductions is cost. If the reductions can be accessed at rates lower than domestic costs in Canada, then lower mitigation costs dampen the impact on economic growth. Further, if the pool of international reductions can be enlarged, there would be downward pressure on the price of international carbon, thereby further reducing possible mitigation costs.

Indeed, it seems that moderate carbon pricing can produce a large supply of REDD reductions due to current high rates of deforestation for both timber production and agricultural expansion. What is moderate? Stern (2006: 540) cites estimates of the opportunity cost to forested countries of stopping forest land conversion and of completely eliminating forestry, expressing the results in terms of the cost per tonne of avoided CO₂ emissions. The former are estimated at less than \$5 per tonne, while complete elimination of deforestation would drive the costs up to \$30 per tonne. While it is not argued here that either of these scenarios is either desirable or likely, it is instructive to note that these figures are not outside the reasonably expected range of prices for carbon in a post-2012 world. Enkvist *et al.* (2007) estimate a price per tonne of CO₂-eq of €40 in 2030, assuming the need to limit atmospheric concentrations of CO₂-eq to 450 ppm. For reference, since the EU Emissions Trading Scheme (EU ETS) came into force in 2005, prices for carbon allowances under that scheme have ranged from €1.50 to just under €30 per tonne. One recent study pegs the opportunity cost of avoided deforestation in Brazil, the largest possible source globally, at about \$20 per tonne reduced with a potential supply that is literally in the billions of tonnes (Nepstad, 2007).

5.1.5 What is Canada's perspective?

Canada needs to recognize that bringing REDD into the post-2012 regime will be a complex and time consuming affair. While technical issues will necessarily need to be systematically addressed, it is perhaps the competing interests of the various players, including Annex I, developing and major emitting developing countries that will make progress difficult. Simply put, there is a lot to sort out technically, and many competing interests.

The question then is if Canada should be involved in pushing the agenda forward on the international stage. The answer to this, implicitly explored above, is yes for a number of compelling reasons:

- *REDD provides Canada with an opportunity to access cost-effective reductions that could lessen the domestic costs of mitigation.* Given that domestic abatement costs rise exponentially above reductions well below those

contemplated by either the Canadian Government³⁹ or in the Bali Footnote,⁴⁰ access to additional flexibility mechanisms internationally makes economic sense.

- *REDD promotes development objectives such as poverty alleviation and sustainable development.* One of the reasons that the cost of carbon mitigation from avoided deforestation is so low is that current deforestation practices, such as logging and farming, yield low economic returns. By compensating for the preservation of forested lands the incentive to pursue low yield and highly degrading activities can be removed. This then releases resources to be used elsewhere in higher value pursuits as well as enabling the continuation of more traditional forest uses. The benefits for local communities include poverty reduction, protecting traditional ways of life, and the removal of the incentive to maintain unsustainable farming practices. Thus, the approach holds the added benefit of furthering the development objectives of developing countries and Canada's own development goals.

There are a number of additional issues that are worth mentioning:

- REDD provides a means for the developing nations in particular to tap into the international carbon market, which then rewards more sustainable uses of forest resources;
- baselines will be a challenge, with concern over additionality;
- leakage will be an issue with international flows of one activity to another, and thus a truly global approach is needed to address this issue; and
- governance will be a challenge in developing countries to ensure permanence of reductions.

In all likelihood, Canada will need to forge ahead with a two-track process that includes first, formal efforts to influence Parties to the UNFCCC to include REDD as a mechanism in the carbon market and second, support for bilateral activities (including ODA) that nourishes the growing development and mitigation opportunities associated with avoiding deforestation. Of course movement on REDD will also lead to calls by the major developing emitters to include such reductions towards any future targets for them. This could be an area of common ground where Canada could find an ally to push the formal UNFCCC negotiations forward to gain access to low-cost international reductions.

5.2 Sectoral approaches to mitigation

The rise of sectoral approaches can be traced to concerns over competitiveness and leakage. Essentially, there is concern that regional carbon constraints

39 Canada's *Turning the Corner: A Plan to Reduce Greenhouse Gases and Air Pollution*, calls for reductions of 20 per cent below 2006 or about 35 per cent below the 2020 BAU.

40 25 per cent below 1990 in 2020 is about 50 per cent below the 2020 BAU.

such as those adopted by the EU ETS will unfairly disadvantage those regulated and therefore decrease their international market share and hence profitability. Closely linked is the possible movement of new investments to countries not covered with binding carbon constraints, as well as the movement of production from relatively low emitting facilities to higher emitting facilities in developing countries, especially the major developing emitters.

Another key driver is the recognition that sector specific approaches may be an effective means to encourage mitigation action in developing and major emitting developing countries ahead of any binding national commitments. This section explores the rise of sector-specific approaches and explores how they might be implemented post-2012 and the implications of this for Canadian policy.

5.2.1 Review of the Bali mandate

The Bali Action Plan identifies the need for considering cooperative sectoral approaches and sector-specific actions in any post-2012 climate change agreement, in order to enhance implementation of Article 4, paragraph 1(c) of the UNFCCC, which specifically identifies the sectors of energy, transport, industry, agriculture, forestry and waste management. This generally is interpreted to mean that industry-specific agreements can be pursued and somehow ultimately accounted for in a new agreement. Sectoral approaches or sector-specific actions focus on controlling emissions from particular economic sectors. Again multiple and possibly conflicting interests are at play behind the proposals, with differences in how Annex I countries are compensated in terms of target attainment for any technology transfer or financial contributions, how the developed world is to be compensated for adopting a higher cost yet lower emitting development path, and if the reductions under the sector approaches can be used by major developing emitters towards any future mitigation commitments.

5.2.2 How might sectoral approaches be operationalized in the post-2012 regime?

A number of proposals have been put forward in regard to sector-specific actions, but they generally run along two lines: 1) a market-based instruments approach along the lines of the current CDM; and 2) funding/support elements for technology development and cooperation.

A sectoral crediting mechanism would involve an expanded scope for the CDM, with a focus on mitigation at the sectoral level and a top-down approach that contrasts with the CDM's project-based approach. In one widely discussed formulation of sectoral approaches, developing countries would directly pledge to achieve a voluntary "no lose" GHG intensity target in key emission-intensive industrial sectors such as electricity and cement. Emission reductions achieved beyond the voluntary pledge would be eligible for sale as credits to developed countries. Failure to meet the pledge would not involve

any penalty or requirement to purchase credits from other countries. The program would be linked to a technology finance package that included industrialized countries, MDBs and export crediting agencies. Some have suggested that such programs aim to include the 10 developing countries with the highest emissions in each sector, which would be sufficient to cover 80 per cent of a sector's emissions (Schmidt, 2006; Bosi and Ellis, 2006).

The technology chapter of this book goes into greater detail on this subject; as such, it will be noted here that a key element in sectoral approaches will be technology cooperation. Specifically, sectoral efforts to promote climate change goals for developing countries will need to consider:

- subsidies for private infrastructure investors, altering incentives such that low-carbon technologies are attractive;
- subsidizing developing country acquisition of intellectual property in the area of clean technologies;
- capacity building for regulatory infrastructure to promote low-carbon technologies; and
- financial support for developing country adoption and implementation of climate-friendly technologies (discussed at greater length in the financing and investment chapter).

5.2.3 How would they address the central challenge of mitigation in the context of economic growth?

Sector-specific approaches break down somewhat the tension between growth and mitigation action. How this is accomplished is a matter of perspective. For developing countries, the sector approach offers an opportunity to accelerate the adoption of technology while also providing access to financing. These two themes are the major motivators for the developing world signing on to post-2012 sectoral approaches. The major emitting developing countries have very similar interests, but also will seek to appropriate some of the reductions towards any future mitigation commitments. For the developed world there are a couple of motivators. First, access to lower cost reductions within sectors can obviously reduce mitigation costs and thus there is an opportunity in sector-specific actions. But more importantly perhaps is the ability to seek to minimize competitiveness impacts. By moving sectors towards a technology profile that is more or less similar in emission intensity, concerns over relative cost burdens from mitigation largely fall away. Indeed, the sector-specific approaches may be a way to get real movement on reductions from major emitting developing countries well in advance of any binding mitigation commitments.

5.2.4 What is Canada's perspective?

While most interactions in global climate policy fall under the purview of the federal government, with sector-specific approaches there is also an opportunity for industry. Specifically, industry could engage their counterparts in other parts of the world to see if common approaches can be developed that satisfy concerns over disproportionate cost increases. The incentive for major emitting developing and developing countries to participate in such voluntary sector-specific action would be access to technology and financing.

From a national perspective, Canada has been pushing internationally for binding targets for major emitting developing countries like China and India. Sector-specific approaches in the post-2012 regime provide an opportunity to get movement before binding targets can be negotiated. Given the flexibility in terms of enabling approaches, it may in fact be prudent to start early in key sectors to get movement internationally. The experience of a number of multilateral technology agreements could prove instructive—such as the Cement Sustainability Initiative under the World Business Council for Sustainable Development, and the task force approach of the Asia Pacific Partnership on Clean Development and Climate—although efforts will need to go far beyond those to date.

Canada will need to consider increased support for sectoral approaches beyond ODA, and should engage industry in discussions on a path forward. Canada will need to identify strategic sectors for engagement, considering: where the country can show leadership, where Canada would improve its competitive position, and what sectors offer increased access to lower-cost emission reductions.

While not explicitly addressed in this section, the sectors of agriculture and forestry that are referenced in the Bali Action Plan are also important for Canada. The IPCC notes that there is massive mitigation potential in agriculture—estimated at 5,500–6,000 MtCO₂-eq per year by 2030—and there are a variety of options for reducing emissions in this sector (Smith *et al.*, 2007). Agricultural mitigation measures often have synergies with sustainable development policies; and there are interactions between migration and adaptation in this sector. Agriculture will need to be addressed in the eventual post-2012 agreement, and is an area where Canada could potentially provide leadership.

5.3 Market-based international approaches

There is widespread sentiment in favour of continuity of market-based mechanisms in the post-2012 regime, building on the three mechanisms set out in the Kyoto Protocol: international emissions trading, joint implementation (JI) and the CDM (see Box 1). A post-2012 regime could aim to enhance these existing market mechanisms, as well as include additional mechanisms such as an aviation tax.

Box 1: Kyoto Flexibility Mechanisms

Flexibility mechanisms were included in the Kyoto Protocol in part to assist Annex I countries in meeting their emission reduction commitments in a cost-effective manner:

International Emissions Trading (IET): allows Annex I countries (i.e., industrialized countries and countries with economies in transition, such as Russia, Ukraine, Bulgaria and Romania) to buy and sell parts of each country's assigned amount units (AAUs). This increases the allowable emission in the recipient country and reduces those of the seller country.

Joint Implementation (JI): a project to mitigate climate change in an Annex I country can earn credits (Emissions Reduction Units – ERUs) that can be used by another Annex I Party to help meet its emission limitation commitment. For example, Japan (through the government or a company) could invest in an emissions reduction project in Russia and then use the credits to offset its national reduction target. Only emission reductions taking place between 2008 and 2012 will be credited.

Clean Development Mechanism (CDM): a project or program of activities to mitigate climate change in a developing country can generate credits (certified emission reductions – CERs) that can be used by an Annex I Party to help meet its emission limitation commitment. CDM is the one mechanism for developing countries—which were not subject to binding emission reductions as part of the Protocol—to be involved in the implementation of the agreement and contribute to achieving the objectives of the UNFCCC. The prompt start clause allows credits to accrue from projects from 2000 onward.

The 2006 carbon market was dominated by the EU ETS, the largest market trading system, that included the sale and re-sale of credits valued at nearly US\$25 billion (Capoor and Ambrosi, 2007). There is high likelihood that trading schemes will be established in the United States, Japan, Australia and Canada prior to 2012. As well, the voluntary market grew strongly in 2006, reaching an estimated value of US\$100 million through such trading systems as the Chicago Climate Exchange and the New South Wales Market.

The project-based mechanisms, CDM and JI, grew to a value of about US\$5 billion in 2006, with the CDM seeing the majority of this market activity. The CDM is important as it is the only mechanism that allows developing country participation in the carbon market, and its uptake has encouraged clean investments, with a strong interest in the large developing emitters.

5.3.1 Review of the Bali mandate

The Bali Action Plan calls for consideration of “various approaches, including opportunities for using markets, to enhance the cost-effectiveness of, and to promote mitigation actions, bearing in mind the different circumstances of developed and developing countries.” This is interpreted to mean that market mechanisms will play a key role in a post-2012 agreement, and there could possibly be an expansion beyond the current mechanisms. There are different

views as to what would constitute effective mechanisms, especially in regard to the CDM or other market mechanisms for sustainable development (MMSD) that encourage action on the part of developing countries.

5.3.2 How might market mechanisms work in the post-2012 regime?

Most parties envision a continuation and expansion of the current mechanisms to provide access to cost-effective emission reductions. This section looks at options for post-2012, including emissions trading systems, the CDM and other MMSDs, and possible new mechanisms.

- *Emissions Trading Schemes.* Emissions trading systems will be important to Canada and other developed nations for reducing emissions at the lowest cost. The EU ETS is expected to undergo enhancements for the post-2012 regime, including auctioning of allowances, including more GHGs and including aviation. Emissions trading schemes are expected to be established in a number of Annex I countries before 2012, including Canada, the United States, Japan and Australia. Linking of systems will be of importance in post-2012 to improve liquidity and efficiency across systems to improve overall environmental effectiveness. There may also be a need to pull in major developing emitters, or countries that may graduate to take on targets. In anticipation of such a requirement, South Korea is developing a domestic emissions trading scheme that is being introduced in stages.
- *Enhanced CDM or other MMSD.* There are different views on what would constitute the most effective MMSD(s) for post-2012. There are opportunities to improve the CDM and a number of options have been put forward for making the CDM and/or another MMSD more attractive in a post-2012 regime.

There is discussion of the CDM becoming more oriented to development than to mitigation, serving the needs of the lesser developed countries and comprising a portfolio of projects that achieve high sustainable development benefits, but not the large volumes of credits seen in the major CDM players to date. If this were the case, then a transition mechanism might be needed for the large developing emitting countries that eventually graduate to emissions trading. Promising approaches for a transition mechanism include a sectoral crediting mechanism (discussed earlier) and SD-PAMs with provisions for projects that are implemented under approved policies and measures to be eligible for crediting under the CDM or other MMSD.

SD-PAMs are viewed by some as a stepping stone between countries with quantified emission limitation commitments and those without; and they can provide a framework for official recognition of action in countries without GHG emission targets. Baumert and Winkler (2005) explain that an SD-PAM approach would have large emitting developing countries make voluntary pledges to implement SD-PAMs that would reduce GHG

emissions. There are no binding commitments from developing countries; and developed countries make commitments to support developing country voluntary efforts. Pledges are specified in terms of policies implemented, rather than in terms of GHG emission reductions.

Including SD-PAMs as a market mechanism in a post-2012 regime would require that projects implemented under approved policies be eligible for crediting. Baumert and Goldberg (2006) have suggested action targets as a means to incorporate a quantitative dimension into SD-PAMs. An action target is an obligation to achieve or acquire an agreed amount of GHG emission reductions. The amount of reductions required by the action target is expressed as a percentage of the country's actual emissions during the compliance period. Like countries with emissions targets, a country adopting an action target can comply with its obligation by purchasing Kyoto compliant emission allowances or credits in lieu of (or in concert with) taking domestic action. Likewise, countries can be permitted to sell allowances if they over-comply with their action targets. To promote sustainable development and maximize GHG abatement, the action targets are able to accommodate policies and even private-sector-led initiatives that have a sectoral or national reach—such as renewable energy portfolio standards.

Movius (2007) explored the idea of a dual market approach, where Annex I countries set dual Kyoto and SD-PAMs targets. Developing countries would propose SD-PAMs which Annex I countries would finance in return for emission reductions. A contribution to the atmosphere would be assured by setting aside a portion of the emission reductions; for example, Annex I countries could claim 80 per cent of the reductions associated with SD-PAM measures, with the remaining 20 per cent set aside as a contribution.

Including SD-PAMs as an MMSD in a post-2012 regime would require a decision on which countries would be eligible, what policies and measures would generate tradable credits (i.e., SD-PAMs would not include all policies and measures that help sustainable development, as some policies have GHG impacts that are indirect or difficult to quantify), and how they would be monitored and reported on.

Of course, there is always the option of including SD-PAMs that do not rely on the market for financial flows, being supported with funding through existing channels (e.g., ODA, GEF, multilateral development banks) or through some expressly designed international mechanism (which might coordinate existing funding channels).

- *Other Market Mechanisms.* Other market-based mechanisms that would enhance the cost-effectiveness of mitigation actions have been put forward. While many economists and academics have argued in favour of a global carbon tax because of its simplicity and flexibility to respond to observed climate change impacts, this approach has gained no traction in interna-

tional negotiations, being dismissed for political reasons in a number of countries, most notably the United States. A number of countries have adopted domestic carbon taxes to encourage emissions reductions; and Quebec has implemented such a tax, with a GHG royalty targeting hydro-carbon use in transportation and heating of buildings.

An aviation tax is generating considerable interest for reducing emissions in the sector, which represents three per cent of global GHG emissions. It has been suggested that the revenues be used for adaptation, and there appears to be some political palatability for a tax that supports much-needed adaptation action in developing countries (and nothing precludes using these funds to support mitigation actions, this would be a decision taken at the international level). There is also talk of a similar levy on marine bunker fuels, which along with aviation fuels are not included under the Kyoto Protocol targets. These options are discussed in greater detail in Chapter 5.

5.3.3 How would market mechanisms address the central challenge of mitigation in the context of economic growth?

The central benefit of increased opportunities for market mechanisms is to gain further access to lower cost reductions elsewhere. However, with these mechanisms the developing world will be looking for technology transfer and compensation for altering their development path. And as major developing emitters begin to explore the adoption of mitigation commitments they will seek ways to count reductions towards any future commitments.

Development goals are also of interest with opportunities to link both development and carbon objectives as one means to broaden the pool of international mitigation. But issues of distortion will figure prominently here, with international flows of capital altering investment choices and possibly leading to outcomes that are sub-optimal. One theme that comes to mind is biofuels, where support in this area through emerging market mechanisms could further add to distortions in agricultural and fuel markets.

5.3.4 What is Canada's perspective?

Canada will need access to cost-effective reductions, given that in 2005 the country was 32.7 per cent above its Kyoto target and will not meet this target in the first commitment period. While domestic action is critical, the carbon market can work to reduce costs of meeting international goals and Canada should be supportive of market mechanisms that increase access to cost-effective reductions.

But Canada will need to carefully consider any new MMSDs. While increased access to low-cost credits is desirable for Canada, an expanded version of the CDM could vastly increase the potential for generating credits, perhaps beyond what the market would bear in terms of demand. Ambitious reduction

targets for Annex I countries will fuel the demand for additional CERs, thus negotiations on the shape of future MMSDs need to be closely linked to discussions on emissions reduction targets for Annex I countries.

Canada also needs to consider if it wants to support a market mechanism that continues to represent a forum for profitable investment for large developing emitters such as Brazil, India and especially China, as an improved and more attractive CDM would strengthen arguments in these countries to not take on commitments. A real issue for Canada and other developed countries is the need for a “transition” mechanism for large developing country emitters that might eventually graduate to emissions trading. A key consideration for SD-PAMs as a transition mechanism will be the need to balance the capacity of the mechanism to deliver significant GHG reductions in light of existing alternatives, given the expected resources and time needed to register and evaluate SD-PAMs under the UNFCCC.

If the CDM were to evolve to become more oriented to development than to mitigation, serving the lesser developed countries, Canada might consider allocating new monies toward the purchase of credits from CDM projects with high development dividends in least-developed countries.

6.0 Reflections on a way forward

The economic growth vs. mitigation trade-off is a real concern in Canada, and indeed in all nations—developed or developing. In Canada, climate change policy will need to address the economic and environmental realities of a resource-based economy, and the dominance of the United States as a trading partner and large investor in energy resources.

While dealing with these domestic realities, the adoption of the Bali Action Plan means that over the next two years Canada will join 188 other nations to negotiate a post-2012 agreement that meets global environmental goals. Canada’s lack of demonstrated intent to date to meet Kyoto targets could impact Canadian positions in international negotiations and undermine Canadian explanations about the gap between domestic GHG emission mitigation targets and international expectations.

Canada should move quickly to become a participant in the global carbon market, including setting up its emissions trading scheme as soon as possible. The experience of British Columbia and Quebec, which have both announced the implementation of a carbon tax, and the advice of NRTEE (2008) that recommends an economy-wide emission price signal as the core element of a policy framework, indicate the importance of putting a carbon price in play at the consumption level. Establishing a cap and trade system would show Canadians and the world that the government is ready to become a serious participant in the global GHG mitigation challenge. To facilitate access to cost-effective emission reductions through the market, Canada might explore possibilities to link

with other trading schemes and enable access to international reduction credits through the CDM.

Canada will also need a greater focus on how it will meet its initial target of 20 per cent reductions in emissions below today's levels by 2020. This will include policy clarity, and programs and initiatives to support technology development and deployment in the critical areas of energy efficiency, carbon capture and storage, renewable energy and changes in land use practices. The resource-intensive nature of Canada's economy means that continued economic growth with deep GHG mitigation will require the uptake of new technologies, including CCS, which will likely only be viable in 2015.

In this respect, Canada might want to encourage an international agreement that sets a long-term goal and allows for flexibility at the national level in the short- and medium-term to meet emission reduction targets.

Canada might consider increasing its international profile over the next two years to gain credibility in negotiations. This could include active participation in international climate change-related agreements, such as technology-focused agreements, to gain needed insights into sectoral actions and approaches. Canada will also want to consider making a stronger effort to support developing countries in their mitigation actions. This is especially true for the large developing emitters. If Canada insists that these countries take on commitments (and this is not necessarily a position widely agreed to across Canada), then real money and support will have to be forthcoming to support their efforts. This should include bilateral programs and projects to ensure an effective Canadian presence and Canadian influence (i.e., new efforts to engage developing countries on climate change should not mainly be through contributions to multilateral development banks and international institutions).

Considerations for moving ahead in Canada include an intergovernmental approach to enabling and undertaking mitigation efforts and determining acceptable mitigation targets. Decisions need to be taken with respect to the role of provincial and territorial governments in feeding into international negotiations, identifying where cooperation would be advantageous and how this can best be achieved. Canada will also need to consider how it will engage the private sector in the international negotiations, as well as how it will support the private sector to assist in mitigation efforts in developing countries.

References

- Alcott, B., 2005. "Jevons' Paradox." *Ecological Economics* 54: 9–21.
- Baer, P., 2007. *The Worth of an Ice Sheet: A Critique of the Treatment of Catastrophic Events by the Stern Review*. EcoEquity Discussion Paper.
- Barnett, T.P., J.C. Adam and D.P. Lettenmaier, 2005. "Potential Impacts of a Warming Climate on Water Availability in Snow-Dominated Regions." *Nature* 438 (November 17): 303–309.
- Bataille, C., M. Jaccard, J. Nyboer and N. Rivers, 2006. "Towards general equilibrium in a technology-rich model with empirically estimated behavioral parameters." *Energy Journal* 27: 93–112.
- Baumert, K.A. and D. Goldberg, 2006. "Action targets: a new approach to international greenhouse gas controls." *Climate Policy* 5: 567–581.
- Baumert, K.A., T. Herzog and J. Pershing, 2005. *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy*. Washington, D.C.: World Resources Institute.
- Baumert, K.A. and H. Winkler, 2005. "Sustainable Development Policies and Measures and International Climate Agreements." In Bradley, Rob, and Kevin A. Baumert, *Growing in the Greenhouse: Protecting the Climate by Putting Development First*. Washington, D. C.: World Resources Institute. pp. 15–23.
- Boarini, R., A. Johansson and M. Mira d'Ercole, 2006. *Alternative Measures of Well-Being*. OECD Social, Employment and Migration Working Papers No. 33.DELSA/ELSA/WD/ SEM (2006)2. Paris: OECD.
- Bosi, M. and J. Ellis, 2005. *Exploring Options for Sectoral Crediting Mechanisms*. Paris: OECD/IEA Annex I Group.
- Bovenberg, A. L., and R. A. De Mooij, 1994. "Environmental levies and distortionary taxation." *American Economic Review* 84(4): 1085–1089.
- Bradley, R. and K.A. Baumert (eds.), 2005. "Growing in the Action targets: A new approach to international greenhouse gas controls." *Climate Policy* 5: 567–581.
- Bradsher, K., 2007. "The Price of Keeping Cool in Asia; Use of Air-Conditioning Refrigerant Is Widening the Hole in the Ozone Layer." *The New York Times*, Section C, page 1, February 23.
- Branko, M., 2005. *Global Income Equalities*. Presentation to the Council on Foreign Relations, New York, December 13.
- Brazil, 2006. *Policy Incentives for Voluntary Action in Developing Countries to Address Climate Change: Brazilian Perspective on Reducing Emissions from Deforestation*.

Capoor, K. and P. Ambrosi, 2007. *State and Trends of the Carbon Market 2007*. Washington, D.C.: World Bank.

Chevalier, P., B. Pouyaud and W. Suarez, 2005. *Climate Change Impact on the Water Resources from the Mountains in Peru*. Paper presented at the OECD Forum on Sustainable Development. ENV/EPOC/GF/SD/RD(2004)7/FINAL.

Chiroleu-Assouline, M. and M. Fodha, 2006. "Double dividend hypothesis, golden rule and welfare distribution." *Journal of Environmental Economics and Management* 51(3): 323–335.

Commission of the European Communities (CEC), 2008. "20 20 by 2020: Europe's climate change opportunity." Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Brussels, January 23, 2008, COM(2008) 30 final.

Copeland, B. and S. Taylor, 1994. "North-South Trade and the Environment." *Quarterly Journal of Economics* 109(3): 755–87.

Cosbey, A., 2005. *A Capabilities Approach to Trade and Sustainable Development: Using Sen's Concept of Development to Re-Examine the Debates*. (Commissioned by the Swiss Agency for Development and Cooperation.) Winnipeg: International Institute for Sustainable Development.

Cosbey, A. and D. Murphy, 2007. *Market Mechanisms for Sustainable Development: How Do They Fit in the Various Post-2012 Climate Efforts?* Winnipeg: International Institute for Sustainable Development.

Cosbey, A., D. Murphy, J. Drexhage and J. Balint, 2006. *Making Development Work in the CDM*. (Report of phase II of the Development Dividend Project). Winnipeg: International Institute for Sustainable Development.

Cross, P., 2007. "Year end review: westward ho!" *Canadian Economic Observer*, April, pp. 3.1–3.19.

Cross, P., 2006. "The Year in Review: The Revenge of the Old Economy." *Canadian Economic Observer*. April.

Danish Ministry of Foreign Affairs, 2005. *Danish Climate and Development Action Programme: A Toolkit for Climate Proofing Danish Development Cooperation*.

Dasgupta, S., B. Laplante, C. Meisner, D. Wheeler and J. Yang, 2007. *The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis*. World Bank Policy Research Paper No. 4136. Washington, D.C.: World Bank.

Deutsche Bank, 2007. *The European Union wants to cut Carbon Emissions by 20% by 2020, Deutsche Bank significantly upgrades Carbon Price Forecast*. <http://www.db.com/presse/en/content/press_releases_2007_3588.htm>.

Duncan, J., 2007. *The Municipal Powers Report: Municipal by-laws and best practices for community health and environmental protection in Canada*. Toronto: Sierra Legal Defence Fund.

Ellis, J., R. Baron and B. Buchner, 2007. *SD-PAMs: What, Where, When and How?* Paris: OECD/IEA.

Enkvist, P.-A., T. Naulé and J. Rosander, 2007. "A Cost Curve for Greenhouse Gas Reduction." *The McKinsey Quarterly*, No. 1.

Environment Canada, 2007. *Inventory Report 1990-2005t: Greenhouse Gas Sources and Sinks in Canada*. <http://www.ec.gc.ca/pdb/ghg/inventory_report/2005/2005summary_e.cfm>.

Food and Agricultural Organization (FAO), 2005. *Global Forest Resources Assessment: Progress towards sustainable forest management*.

G8 Summit, 2007. *Chair's Summary: Heiligendamm, 8 June 2007*. <http://www.g-8.de/Content/DE/Artikel/G8Gipfel/Anlage/Abschlusserkd_C3_A4rungen/Chairs-summary,property=publicationFile.pdf>.

Gélinas, J., 2003. *Road Transportation in Urban Areas: Accountability for Reducing Greenhouse Gases*. Opening Statement to the Standing Senate Committee on Energy, the Environment and Natural Resources. <http://www.oag-bvg.gc.ca/internet/English/03nr01_e.html>.

Goulder, L.H. (1995). Environmental taxation and the double dividend: A reader's guide. *International Tax and Public Finance*, 2(2), 157–183.

Government of Canada, 2007a. *Regulatory Framework for Air Emissions*. <http://www.ec.gc.ca/doc/media/m_124/toc_eng.htm>.

Government of Canada, 2006. "Greenhouse Gas Emissions." *Canadian Environmental Sustainability Indicators*. <<http://www.environmentandresources.gc.ca/default.asp?lang=En&n=A85B7F27-1>>.

Hadley Centre, 2006. *Effects of Climate Change in Developing Countries*. London: Met Office.

Intergovernmental Panel on Climate Change (IPCC), 2007a. *Fourth Assessment Report. Climate Change 2007: Synthesis Report*. Geneva: IPCC.

IPCC, 2007b. *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)]. Cambridge and New York: Cambridge University Press.

International Energy Agency (IEA), 2007a. *Key World Energy Statistics 2007*. Paris: IEA.

IEA, 2007b. *World Energy Outlook 2007: China and India Insights*. Paris: IEA.

- IEA, 2006. *World Energy Outlook 2006*. Paris: IEA.
- IEA, 2004. *World Energy Outlook 2004*. Paris: IEA.
- International Institute for Sustainable Development (IISD), 2007. "COP-13 and COP/MOP-3 Highlights: Thursday, 13 December 2007." *Earth Negotiations Bulletin*. Winnipeg: IISD.
- IISD, 2004. *An Environmental Impact Assessment of China's WTO Accession: An Analysis of Six Sectors*. Winnipeg: IISD.
- International Labour Organization (ILO), 2004. *World Employment Report 2004–2005*. Geneva: ILO.
- International Monetary Fund (IMF), 2008. *World Economic Outlook Update: An update of the key WEO projections*. January 29. <<http://www.imf.org/external/pubs/ft/weo/2008/update/01/index.htm>>.
- Jaccard, M., 2005. "Hybrid energy economy models and endogenous technical change." In Richard Loulou, Jean-Phillippe Waaub and Georges Zaccour (eds.), *Energy and Environment*. Springer. pp. 81–100.
- Kjorven, O., 2006. *Climate Change and Achieving the Millennium Development Goals*. Presentation to the 2nd workshop of the Dialogue on Long-Term Cooperative Action to Address Climate Change by Enhancing Implementation of the Convention, November 15–16, Nairobi.
- Magrath, J., 2006. *Africa: Up in Smoke 2*. (The Second Report on Africa and Global Warming from the Working Group on Climate Change and Development) London: New Economics Foundation.
- Malhotra, P. and I.H. Rehman, 2004. *Fire without Smoke*. Delhi: The Energy Research Institute.
- Michaelowa, A. and K. Michaelowa, 2005. *Climate or Development: Is ODA Diverted from Its Original Purpose?* HWWI Research Paper No. 2. Hamburg Institute of International Economics (HWWI).
- Movius, D., 2007. "Sustainable Development Policies and Measures: Making it Attractive for Developed Countries to Contribute?" Presentation to CCAP *Future Action Dialogue*, July 2–4, 2007, London, U.K.
- National Energy Board (NEB), 2007. *Canadian Energy Overview 2006: An Energy Market Assessment*. Calgary: NEB. <http://www.neb-one.gc.ca/energy/EnergyReports/cndnrgyrvw2006_e.pdf>.
- National Roundtable on the Environment and the Economy (NRTEE), 2008. *Getting to 2050: Canada's Transition to a Low-emission Future*. Ottawa: NRTEE. <<http://www.nrtee-trnee.ca/eng/publications/getting-to-2050/Getting-to-2050-eng.pdf>>

NRTEE, 2007. *Interim Report to the Minister of the Environment: Medium- and long-term scenarios for GHG emission and air pollutant reductions*. Ottawa: NRTEE.

NRTEE, 2006. *Advice on a Long-term Strategy on Energy and Climate Change*. Ottawa: NRTEE.

Natural Resources Canada (NRCan), 2007. *Canada top US supplier as scientific research and technological innovation fuels energy sector*. Press release. <http://www.eurekaalert.org/pub_releases/2007-04/nrc-cu041807.php>.

NRCan, 2006. *Canada's Energy Outlook: The Reference Case 2006*. Ottawa: Government of Canada.

Nepstad, D., 2007. *The Costs and Benefits of Reducing Carbon Emissions from Deforestation and Forest Degradation in the Brazilian Amazon*. The Woods Hole Research Center. United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP), Thirteenth session. December 3–14, 2007.

Netherlands Environmental Assessment Agency, 2007. *China Now No. 1 in CO₂ Emissions; USA in Second Position*. NEEA Dossier. <<http://www.mnp.nl/en/dossiers/Climatechange/moreinfo/Chinanowno1inCO2emissionsUSAinsecondposition.html>>.

OECD, 2005. *Bridge over Troubled Waters: Linking Climate Change and Development*. Paris: OECD.

OECD, 1994. *The Environmental Effects of Trade*. Paris: OECD.

Papua New Guinea/Costa Rica, 2005. *Reducing Emissions from Deforestation in Developing Countries: Approaches to Stimulate Action*. Submitted to the UNFCCC with reference to item 6 of the provisional agenda of COP-11, November 11.

Peters, Glen P. and E.G. Hertwich, 2008. "CO₂ Embodied in International Trade with Implications for Global Climate Policy." Forthcoming in *Environmental Science and Technology*.

Prescott-Allen, R., 2001. *The Wellbeing of Nations: A Country-by-Country Index of Quality of Life and the Environment*. Washington, D.C.: Island Press.

Rai, S.C., 2005. *An Overview of Glaciers, Glacial Retreat and Subsequent Impacts in Nepal, India and China*. Kathmandu: WWF Nepal Program.

Rivers, N. and M. Jaccard, 2005. "Combining Top-Down and Bottom-Up Approaches to Energy – Economy Modeling Using Discrete Choice Methods." *The Energy Journal* 26(1): 83-106.

Schmidt, J., N. Helme, J. Lee and M. Houdashelt, 2006. *Sector-based Approach to the Post-2012 Climate Change*. Washington, D.C.: Center for Clean Air Policy.

Sen, A., 1999. *Development as Freedom*. New York: Anchor Books.

Shafik, N. and S. Banyopadhyay, 1992. *Economic Growth and Environmental Quality: Time Series and Cross-Sectional Evidence*. World Bank Working Paper No. 904. Washington, D.C.: World Bank.

Smith, P., D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, B. Scholes, O. Sirotenko, 2007. "Agriculture." In B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds). *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge and New York: Cambridge University Press.

Sokona, Y., 2006. "Development First Approach." Presentation to the *2nd Workshop of the Dialogue on Long-Term Cooperative Action to Address Climate Change by Enhancing Implementation of the Convention*, November 15–16, Nairobi.

Statistics Canada, 2007. "Portrait of the Canadian Population in 2006: Subprovincial population dynamics." *2006 Census: Analysis series*. <<http://www12.statcan.ca/english/census06/analysis/popdwell/Subprov1.cfm>>.

Stavins, R. and K. Richards, 2005. *The Cost of US Forest-Based Carbon Sequestration*. Washington, D.C.: Pew Center on Global Climate Change.

Stern, N., 2006. *Stern Review on the Economics of Climate Change*. London: Her Majesty's Treasury.

United Nations, 2006. *World Population Prospects: The 2006 Revision*. <<http://www.esa.un.org/unpp/p2k0data.sap>>.

United Nations Development Programme (UNDP), 2007. *Human Development Report 2007/2008: Fighting climate change human solidarity in a divided world*. New York: UNDP.

UNDP, 2005. *Energizing the Millennium Development Goals: A Guide to Energy's Role in Reducing Poverty*. New York: UNDP.

UNEP-Risoe Centre, 2008. *CDM Pipeline*. Updated February 1, 2008. <<http://uneprisoe.org>>.

United Nations Framework Convention on Climate Change (UNFCCC), 2007a. *Bali Action Plan*. Decision adopted by COP-13 and CMP 3. December 2007. <http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf>.

- UNFCCC, 2007b. *Emissions Summary for Canada*. GHG emission profiles for Annex I Parties. May 25, 2007. <http://unfccc.int/files/ghg_emissions_data/application/pdf/can_ghg_profile.pdf>.
- UNFCCC, 2006. *National greenhouse gas inventory data for the period 1990–2004 and status of reporting: Note by the secretariat*. Subsidiary Body for Implementation, Twenty-fifth session, Nairobi, November 6–14. FCCC/SBI 2006/26, October 19.
- van Geel, P., 2005. “Energy for Development in the Real World.” *IAEA Bulletin* 47(1): 52–54.
- Venetoulis, J. and C. Cobb, 2004. *The Genuine Progress Indicator 1950–2002 (2004 update)*. Oakland, California: Redefining Progress.
- Weir, E., 2007. “Trade Balances and Jobs: Canada, the US and China.” *Behind the Numbers: Economic facts, figures and analysis* 8(2). Ottawa: Canadian Centre for Policy Alternatives.
- Winkler, H. and S. Thorne, 2002. *Baselines for Suppressed Demand: CDM Projects’ Contribution to Poverty Alleviation*. Paper presented to the Annual Conference of the Forum for Economics and Environment.
- World Bank, 2007. *World Development Report 2007: development and the next generation*. Washington, D.C.: World Bank.
- World Bank, 2006. *Energy Poverty Issues and G8 Actions*. Discussion Paper, February 2. Washington D.C.: World Bank.
- World Bank, 1997. *World Development Report*. Washington D.C.: World Bank.
- World Summit on Sustainable Development (WSSD), 2002. *Plan of Implementation of the World Summit on Sustainable Development*. New York: UN Department of Economic and Social Affairs.

Chapter 3: Adaptation in a Post-2012 Climate Regime

Jo-Ellen Parry, John Drexhage and Frédéric Gagnon-Lebrun

1.0 Introduction

In 1997, when the international community came together to negotiate the Kyoto Protocol, adaptation was viewed largely as a marginal issue. Now 10 years later, the landscape has fundamentally altered. Human-induced climate change is increasingly being observed (IPCC, 2007a) and there is greater confidence in long-term climate projections suggesting that significant, and largely adverse, change will take place within this century (IPCC, 2007b). The growing number of extreme weather events throughout the world in recent years has increased sensitivity to the potentially dramatic social and economic impacts of climate change for all countries. And economic analyses have raised awareness of the substantive additional financing need to prepare for these impacts.

The degree to which the landscape has altered since 1997 is reflected in the Bali Action Plan agreed to in December 2007 at the Thirteenth Conference of the Parties (COP-13) to the United Nations Framework Convention on Climate Change (UNFCCC). Setting the framework for two years of negotiations on the future design of the international climate regime, the Plan identifies adaptation as one of four core pillars of this regime. It calls for an agreement that addresses, at a minimum: international cooperation to support implementation of adaptation actions; risk management and risk reduction strategies; disaster reduction strategies; economic diversification; and ways to strengthen the catalytic role of the Convention.

As with the other three pillars of the planned climate regime—mitigation, technology development and transfer, and provision of financial resources and investment—reaching an agreement on how to address adaptation after 2012 is likely to be demanding. Over and above the differences between Parties that affect negotiation of all climate change matters, though, the adaptation issue faces some unique challenges. For one, relatively few comprehensive analyses of how adaptation could be addressed in a future climate regime have been undertaken.¹ In part, this situation reflects:

1 A sampling of some of the broad proposals that have been put forward by the international community are included in Annex 2.

- *The relative newness of adaptation as a prominent issue at the international level.* Only since about 2001, as the scientific evidence became stronger and space for discussion opened up within the climate negotiations (Schipper, 2006), have adaptation concerns been substantially addressed under the UNFCCC.
- *The complexity and nascent understanding of the issue.* Understanding of how best to undertake interventions across a range of geographic scales, diverse array of sectors and along different timelines is still emerging in all parts of the world.
- *The intimate link between adaptation and development.* This close relationship has particular implications for decisions related to the provision of financial support under a future regime, as it makes it difficult (and sometimes redundant) to tease out the adaptation component of an initiative from its development benefits.
- *Differing expectations related to the provision of financing for adaptation.* While it is recognized that Annex I Parties have a responsibility to support developing countries with their adaptation efforts, the basis upon which this support is provided (assistance or compensation; voluntarily or compulsory) and the level of funding to be provided is a matter of considerable discussion.

Canada has a critical stake in the international community's efforts to overcome these challenges. Climate change is already affecting Canada, particularly in its northern and Arctic regions.² These impacts are a prelude to the significant mean annual temperature increases and associated biophysical impacts projected to affect Canada as climate change progresses. In response, Canadian governments and business leaders are beginning to develop the scientific knowledge, strategies, tools and technologies required to meet their adaptation needs. In doing so, Canadians can benefit from learning from other countries—developed and developing—about their efforts to understand, prepare for, and adapt to climate change.

Like other Annex II Parties,³ Canada also has an obligation under the UNFCCC to take a lead role in helping developing countries meet their adaptation challenges. Canada has a high level of economic development and is a high

2 For example, average temperatures in the Arctic have increased at a rate that is double that of the global average over the past 100 years; annual precipitation has increased in northern Canada, but declined in the Prairies and eastern Arctic; and the vegetation growing season has increased an average of two days per decade since 1950 (Field *et al.*, 2007).

3 Annex II of the UNFCCC lists countries who were members of the OECD in 1992, namely Australia, Austria, Belgium, Canada, Denmark, European Economic Community, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom and the United States of America. These countries are to provide financial support and technological resources to help non-Annex I countries lower their own emissions and cope with the adverse effects of climate change.

emitter of greenhouse gases on a per capita basis. As such, Canada has the capacity and obligation to work with developing countries to counter the impacts of climate change. More practically, Canada has an interest in ensuring that developing countries “remain viable partners for economic growth, global governance and international security” (Kartha *et al.*, 2006: 8). Canada thus has a strong interest in ensuring that the structure and content of an international adaptation regime supports its ability to address its own adaptation needs while also meeting its obligations to developing countries under the UNFCCC.

To contribute constructively to the Bali Action Plan negotiations, Canada needs to develop its own perspective on how adaptation might be addressed in a post-2012 climate regime. There is a need to discuss the preferred structure of this regime; under what conditions and to what level does Canada wish to provide financial assistance; what type of adaptation activities does it want to see supported; and the preferred role of the UNFCCC in comparison to other actors in supporting adaptation efforts by developed and developing countries.

To help frame this discussion, this chapter begins by setting the context in which a multilateral approach to supporting adaptation will be negotiated, focusing on current understanding of what constitutes “adaptation” to climate change; the scale of financial resources that might be needed; and existing obligations under the UNFCCC (Section 2). It then provides an overview of Canada’s historic and ongoing role in supporting adaptation to climate change in an international context (Section 3). The three main questions to be addressed in determining the scope of a post-2012 adaptation regime are then examined in Sections 4–6: the general design of the regime; financing adaptation, particularly in developing countries; and priority areas of support through the UNFCCC and other actors. In each section, an overview of the issue is provided and a preliminary assessment made of a potential Canadian perspective on the matter. The chapter concludes by providing some initial ideas regarding steps Canada could take to enhance its capacity to effectively engage in and influence the design of a post-2012 approach to enabling adaptation to climate change.

2.0 Setting the context

Over the past century, the Earth’s average surface temperature has climbed by almost 0.74°C. The consequences of this alteration are starting to become more visible as climatic conditions and ecosystems begin to change.⁴ This warming trend is projected to continue, rising another 1.1°C to 6.4°C over the

4 Observed changes in the Earth’s climate and ecosystems linked to climate change include: poleward and altitudinal shifts in plants and animal ranges; extending growing seasons in the mid- to high latitudes; rising sea levels; decreases in glaciers and ice caps; reductions in the extent and thickness of Arctic sea ice; increase in intense cyclone activity in the North Atlantic; and more intense and longer droughts, particularly in the tropics and subtropics (IPCC, 2001; IPCC, 2007a).

next 100 years (IPCC, 2007a). At present emission rates, a 2°C rise in temperature is highly probable and possibly inevitable (Stern, 2006). At this level of global average temperature increase, up to 30 per cent of all plant and animal species would be at increasing risk of extinction; most corals would be bleached; cereal productivity in low latitudes is likely to decrease; and millions more people could begin to experience coastal flooding (IPCC, 2007b). Ambitious mitigation efforts in the near future are needed to *lessen*, not avoid, the potential for dramatic changes in the global climate system and their consequent impacts on societies, economies, livelihoods and ecosystems.

If carefully managed, climate change could bring new, beneficial opportunities.⁵ On balance, however, the long-term impacts of climate change are likely to be negative, and potentially devastating. At a global level, the resilience of many ecosystems could be exceeded by the end of this century due to a combination of climate change and other drivers of global change. Morbidity and mortality rates could increase due to a rise in the prevalence of infectious diseases and the frequency and intensity of extreme weather events. Water shortages could affect billions of people (Parry *et al.*, 2001) as climate change compounds existing supply problems and further weakens degraded ecosystems.

Although all countries will be affected by climate change, the poor in developing countries, particularly the least-developed countries (LDCs) and Small Island Developing States (SIDS), are expected to be disproportionately impacted. Limited financial, institutional and human resources, high dependence on ecosystem-dependent economic and livelihood activities (e.g., agriculture, fishing, herding), and existing stressors such as the HIV/AIDS pandemic make developing countries highly vulnerable to the impacts of climate change (IPCC, 2001). In general, the most vulnerable populations are those that have contributed the least to the cause of global warming.

The negotiated agreement on the adaptation component of the Bali Action Plan will need to respond to the scale of impacts taking place today and projected to take place in the short, medium and long term. It will also need to ensure that it addresses the differing needs of all countries, developed and developing. In doing so, the negotiations will also need to respond to and

5 Identification of beneficial opportunities arising from climate change is challenging. For example, the vegetation growing season in North America has already increased by an average of two days per decade since 1950. An increase in agricultural productivity is therefore theoretically possible. However, other climate-related impacts, such as alterations in temperature, precipitation and pest and disease outbreaks, could offset this potential benefit. As well, forest growth in areas historically limited by low temperatures and short growing seasons is slowly accelerating (at a rate of less than one per cent per decade – Field *et al.*, 2007). Yet the prospects for forest fires and pest outbreaks could outweigh this gain (as being witnessed in Canada with the Mountain Pine Beetle epidemic). Similarly, the opening of the Northwest Passage could be beneficial for international shipping, but its long-term impact on the well-being of Northern peoples and ecosystems is uncertain.

respect three important parameters: current understanding of what constitutes adaptation to climate change; expectations regarding the financial resources required to support adaptation; and established obligations under the UNFCCC.

2.1 Understanding adaptation

Human societies have always dealt with climate variability, surviving—or not (as with the Vikings in Greenland)—average and extreme climatic events (such as past ice ages) to establish societies in diverse areas of the world. However, adaptation⁶ to climate change differs from past experiences in two ways. First, the anticipated rapid pace of climate change will likely test the coping and adaptive capacity of human populations. Second, for the first time, scientific capacity enables humans to adapt in *anticipation* of future change as opposed to only reacting to current conditions and engaging in planning based on historical climatic trends and risks.

International understanding of adaptation to climate change has evolved significantly in recent years. Initial efforts to develop adaptation strategies relied upon a top-down process that relied on analysis of future climate scenarios and projected impacts on various ecosystems and sectors. While climate scenarios provide information about general trends, they have been found to be less helpful in providing useful information about projected regional or local impacts. The top-down approach also led to greater emphasis on technological and infrastructure interventions (e.g., sea walls) subject to their own limitations, particularly when they do not take into consideration the socio-economic and ecological context into which they are being introduced (Tompkins and Adger, 2003; Klein *et al.*, 2007).

In response, emphasis has been placed on a bottom-up, vulnerability-driven approach. In this context, vulnerability is understood to be a function of *exposure* to climate change impacts and *adaptive capacity*—the ability of a system (social, economic, political, institutional, ecological) to adjust to change, to moderate potential damage, to take advantage of opportunities, or to cope with the consequences (IPCC, 2007c). It is the capacity of these systems to perform effectively in the face of anticipated and unanticipated conditions.

The vulnerability approach emphasizes the need to address the underlying, non-climatic factors, be they economic, demographic, political or environmental, which limit adaptive capacity and thereby increase vulnerability to change. These factors include weak health systems, degraded ecosystems, poor institutions and underdeveloped economic opportunities. By addressing these

⁶ Adaptation in the context of climate change consists of actions that people take in response to, or in anticipation of, projected or actual changes in climate (Tompkins and Adger, 2003).

underlying factors, resilience is expected to increase, helping to buffer systems from extremes regardless of how climate change manifests itself (Orindi and Eriksen, 2005).

Today it is increasingly understood that effective adaptation requires a combination of top-down, scientific understanding of probable climatic changes and their impacts, and a bottom-up, vulnerability-based understanding of the capacity of communities, economic sectors and countries to absorb and respond to these impacts. Current experience has also led to an understanding that adaptation:

- *Is locally driven.* To a great extent, adaptation is a place-based activity, with planning and implementation of adaptation measures undertaken in response to local circumstances and capacity (e.g., Burton and van Aalst, 2004; Downing *et al.*, 2005). However, this is not to say that actors operating at other scales have no role to play; national governments, for example, have a key role in helping to create an enabling environment that facilitates adaptation, such as through capacity building, removal of barriers, knowledge sharing and financial support (Kantha *et al.*, 2006).
- *Is intimately connected with sustainable development.* In all countries, sustainable development efforts can reduce vulnerability to climate change by tackling the fundamental factors that undermine adaptive capacity (IPCC, 2007b). Resilience to shocks and stresses, including climate change, can be built by strengthening institutions, promoting sound management of natural resources, improving health and education systems and fostering economic growth (AfDB *et al.*, 2003). At the same time, it needs to be recognized that development activities that do not consider the probable impacts of climate change can be put at risk (e.g., introducing new tree crops in areas that will be climatically unsuitable over the long-term). As well, development measures undertaken without the application of an “adaptation lens” can undercut adaptive capacity (Adger *et al.*, 2003; Orindi and Eriksen, 2005). For example, development efforts can encourage people to live in increasingly hazardous areas, or remove supports systems that are relied upon in times of stress.
- *Requires an integrated approach.* Adaptation is a long-term, continual process—one that will involve all sectors of society. This characteristic, combined with its intimate connection to sustainable development, means that adaptation efforts cannot be effectively undertaken separately from ongoing development and governance processes. Integrating consideration of the impacts of climate change into every day decision and policy-making processes is more efficient and effective than addressing adaptation as a stand-alone issue. An integrated approach also is considered to be the most economically efficient way to address the consequences of climate change. By integrating consideration of the implications of climate change into financial and investment decisions, exposure to unacceptable risk can be

reduced. As well, it is less likely that development projects undertaken today will inadvertently increase the vulnerability of communities over the long term (Huq and Burton, 2003; OECD, 2005; World Bank, 2006c; Klein *et al.*, 2007).

To be effective, the post-2012 adaptation regime will need to reflect the place-based nature of adaptation to climate change, its intimate link with development processes, and the need for integrated responses.

2.2 Expected financial requirements

In the absence of mitigation and adaptation efforts, the economic damage caused by climate change will potentially be in the *trillions* of dollars per year. In the near term, a temperature rise of 2°C to 3°C (as is expected to take place within the next 50 years) is projected to result in a permanent economic loss of up to three per cent of global GDP. Under a business-as-usual scenario, economic damage over the next two centuries could rise to five to 20 per cent of global GDP per year (Stern, 2006).

Planned adaptation measures can reduce these costs.⁷ The scale of investment required to undertake these measures, however, is highly uncertain. This uncertainty reflects existing limitations in our knowledge of the type, magnitude and timing of climatic changes and their consequent impacts, as well as the long time horizons involved. However, some initial estimates provide an indication of the expected scale of financing that could be needed:

- The UNFCCC has estimated that in 2030, between US\$49 and \$171 billion dollars in additional investment and financial flows will be needed globally for adaptation; of this amount, US\$28 to \$67 billion will be needed by non-Annex I Parties (UNFCCC, 2007a).
- The estimated additional cost of climate-proofing new infrastructure and buildings in OECD countries could be between US\$15 and \$150 billion per year (or 0.05 to 0.5 per cent of GDP; Stern, 2006).
- The World Bank (2006a) has estimated that approximately 20 to 40 per cent of activities financed by Official Development Assistance (ODA) and concessional finance are sensitive to climate risks and that the annual cost of addressing this risk would be US\$1 to \$8 billion.
- Additionally, the Bank has estimated that between US\$9 and \$41 billion will be needed annually to “climate proof” *new* investments globally (World Bank, 2006a).

⁷ See, for example, Easterling *et al.* (2004), which compares two studies that have analyzed the estimated cost of sea level rise for coastal communities in the United States. The analysis suggests that planned adaptation could reduce damage costs by about three-fifths to three-quarters, compared with no adaptation measures being introduced.

- Oxfam has estimated that US\$50 billion per year will be required each year to assist developing countries with their efforts to adapt to climate change (Oxfam, 2007a).
- The cost of adaptation priority activities identified in 16 of the first 17 National Adaptation Programmes of Action submitted by LDCs to the UNFCCC amounts to US\$292 million (UNFCCC, 2007a).

Although these estimates are generally derived from basic calculations and make a number of assumptions, they suggest that tens of billions of dollars in additional funding will be required each year to help countries prepare for and respond to unavoidable impacts of climate change. These funds will need to be provided through a combination of national and local government expenditures (in developed and developing countries), private sector investments, and the transfer of funds from developed to developing countries.

Current levels of investment in adaptation measures are substantially less than those estimated to be needed in the relatively near future.⁸ This situation includes the provision of financial resources from developed to developing countries to assist them in preparing for and responding to the unavoidable impacts of climate change. Since 2005, the international community has provided approximately US\$11 billion to developing countries for adaptation related activities through funds managed by the Global Environment Facility (GEF) (see Annex 1 for details). Additional bilateral contributions are estimated to have amounted to US\$100 billion between 2000 and 2003 (UNFCCC, 2007a). Recognizing that some development assistance not ear-marked for adaptation can contribute to building adaptive capacity, these official contributions for adaptation still are significantly less than the billions of dollars potentially needed each year.

How to address this gap in financing for adaptation will be a core part of the negotiations on the fourth pillar of the Bali Action Plan, as discussed in Chapter 5 of this document. These discussions will need to lead to the identification of strategies by which to increase the available pool of financial resources available; ensure that they are provided on a predictable and sustainable basis; and that they are delivered in an efficient and effective manner.

2.3 Obligations under the UNFCCC

The international community has long recognized the need to support adaptation to climate change, as indicated by its inclusion in the UNFCCC. The

⁸ However, the number of substantive investments in measures intended to increase resilience to projected climate change impacts is growing, particularly by developed country governments. For example, the Netherlands is investing at least US\$2.9 billion in new flood dykes, and the United Kingdom has committed to spending 178 million Pounds to enhance the London Underground's cooling systems. The United Kingdom is also contemplating investing 20 billion Pounds in an upgrade of the Thames Barrier (Oxfam, 2007b).

objective of the Convention (to achieve “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system...”) implicitly refers to adaptation in that the extent to which the anthropogenic interference can be considered “dangerous” depends inherently on the ability of communities and economic activities to adapt (Klein *et al.*, 2005).

As well, the UNFCCC calls upon all Parties to facilitate adaptation nationally and through international cooperation; to elaborate national plans to address potential impacts in various sectors; and to integrate climate change considerations into policy planning (Art. 4.1). All Parties also are to report on measures, including those related to adaptation, taken to meet their respective obligations under the Convention (Art. 12.3).

In addition, in keeping with the principle of common but differentiated responsibilities, the Convention calls upon developed country Parties, particularly those listed in Annex II (like Canada), to help developing country Parties meet their obligations under the UNFCCC. The Convention therefore obliges developed country Parties to:

- provide “new and additional funding to meet the full cost” of developing countries’ national communications (Art. 4.3), which includes assessing potential impacts of climate change;
- provide the “agreed full incremental costs” of implementing adaptation measures; the provision of these funds is to “take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among the developed country Parties” (Art. 4.3);
- assist developing country Parties that are “particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation” (Art. 4.4); and
- facilitate the transfer of technologies (Art. 4.5).

The Convention recognizes the special needs of particularly vulnerable countries (Art. 4.4), such as SIDS and countries prone to natural disasters and drought (Art. 4.8). It also asks Parties to take into consideration the specific needs and special circumstances of the LDCs with regard to funding and transfer of technology (Art. 4.9). By ratifying the Convention, Annex II Parties (including Canada) have agreed to these legally binding obligations.

To complement the Convention, the Kyoto Protocol includes some obligations for Parties in relation to reporting on adaptation measures (Art. 10b) and to funding adaptation in developing countries (Art. 12.8). Canada’s ratification of the Kyoto Protocol obliges it to also respect these commitments.

How adaptation is defined within the UNFCCC context also sets a parameter that could influence the development of a post-2012 adaptation regime. The

Convention itself does not define “adaptation”; it focuses on responding to the “adverse effects of climate change.”⁹ Today, the UNFCCC Secretariat defines adaptation as the “Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (UNFCCC, 2008). This definition of adaptation is the same as the one used by the IPCC in its Fourth Assessment Report (IPCC, 2007c). It recognizes the need for adaptation by both the natural and human systems, and leaves open whether the “climatic stimuli” is due to climate change or climate variability. The reference to “human systems” also suggests the inclusion of both technical adaptation measures and institutional responses. This broad definition of adaptation and its relationship to climatic stimuli might make it difficult to interpret the obligation of developed countries under the Convention to fund the “incremental costs” of implementing adaptation measures.

Overall, the obligations laid out under the Convention make it clear that developed countries, and in particular Annex II Parties, have a responsibility to help developing countries adapt to the impacts of climate change. The UNFCCC, however, avoids establishing any state-based responsibility for damages caused by climate change (Tol and Verhehen, 2004). Along with the obligation to fund the “incremental cost” of adaptation measures, this situation has implications for determining the degree to which developed countries are obligated to provide financial resources to developing countries.

3.0 Canadian interests and strengths

Canada’s high-latitude location and large landmass means that it is highly exposed to the changes brought about by global warming (Lemmen and Warren, 2004). Average year-round temperatures in Canada are projected to be twice that of the global average (Christensen *et al.*, 2007). Consequences of the at least 1.0°C average temperature increase across Canada that have taken place thus far (Environment Canada, 1997), such as instability of Northern infrastructure due to melting permafrost and the Mountain Pine Beetle epidemic, provide a window on climate change’s implications for Canada’s economy and communities. As a result, concern is growing across Canada regarding the ramification of climate change for water supplies, agriculture, energy production, infrastructure, fisheries, coastal systems, wildlife and human health.

Understanding how to prepare for and respond to climate change thus is a critical issue for Canadians. Various domestic initiatives have begun to build this understanding, but large gaps in knowledge and access to tools and best practices remain. International collaboration could assist Canadians in addressing

9 Under the Convention, “adverse effects of climate change” are defined as “changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare” (Art. 1).

these gaps. Canada therefore has an interest in facilitating collective learning through the sharing of experiences, tools, processes and technologies by developed and developing countries. International cooperation can also foster the emergence of new economic opportunities for Canadian companies that are able to provide expertise and technologies that support adaptation to climate change.

Canada also has an interest in ensuring that developing countries are able to effectively adapt to the impacts of climate change. Assisting developing countries in their efforts to adapt to climate change can help ensure that they remain strong economic partners; protect Canadian investments overseas; reduce the potential for increases in conflict over access to resources (such as water); and help prevent the emergence of millions of environmental refugees and migrants. Early investment in planned adaptation by developing countries can also be more cost effective. For example, the UN has estimated that for every dollar invested in disaster preparedness, seven dollars are saved in disaster response (Simms, 2005).

This section provides an overview of Canada's past, current and potential role in supporting adaptation internationally through the development of knowledge, tools and technology and the provision of financial assistance to developing countries. It lays the basis from which a Canadian position on how adaptation could be addressed in ongoing negotiations on long-term cooperative action could be determined.

3.1 Development of knowledge, tools and technology

Canadians have been active domestically and internationally in developing the scientific knowledge, policy perspectives, tools and technologies needed to support adaptation to climate change. For instance, Canada has been active internationally, particularly with respect to scientific research and systematic observation. Along with contributing to the work of the IPCC and the Arctic Climate Impact Assessments, Canada is a participant in the International Human Dimensions Program, the International Geosphere-Biosphere Program, and the World Climate Research Programme. Health Canada has collaborated with the World Health Organization, the United Nations Environment Programme and the World Meteorological Organization to understand the global health impacts of climate change. Continued involvement in these scientific and health fora ensures that Canada gains from and contributes to international understanding of the probable impacts of climate change and their implications for human well-being (Bruce, 2006).

Within Canada, domestic understanding of climate change impacts and adaptation has largely been led by Natural Resources Canada through its Climate Change Impacts and Adaptation Program (CCIAP). CCIAP is involved in assessing and communicating knowledge of Canada's vulnerability to climate change and in funding research and activities that increase "knowledge of the

risk and opportunities presented by climate change” (NRCan, 2007). Between 2001 and June 2007, CCIAP funded the Canadian Climate Impacts and Adaptation Network (C-CIARN), which facilitated knowledge generation and transfer within and between different geographical regions and sectors on the implications of climate change. CCIAP has also funded a variety of projects that have worked with various stakeholders to build understanding of climate impacts, develop tools and initiate adaptation measures. The knowledge, skills and experience built through implementation of these programs can be shared with stakeholders in other countries facing similar challenges. Through CCIAP and C-CIARN, Canada also has gained experience in understanding how to reach out to and engage diverse stakeholders on the issue of climate change adaptation.

Canadians are also involved in the development of various tools designed to facilitate adaptation to climate change—tools that could be used to assist planners, engineers, municipal governments and project managers in other regions of the world. The Ouranos Consortium has developed tools to downscale climate models and conduct impact assessments at a smaller scale. The Pacific Climate Impacts Consortium is currently preparing an interactive interface that will provide access to maps and data sets for use in understanding projected regional impacts. Efforts to develop protocols for integrating adaptation into engineering practices have been initiated. As well, Natural Resources Canada has worked with the Canadian Institute of Planners (CIP) to determine how scientific information on climate change can be provided to planners in a useable format and assist planners by developing a best practices guide for incorporating climate change into land use planning (CIP, 2007).

At the municipal level, Halifax, Toronto, Vancouver¹⁰ and Iqaluit are integrating climate change considerations into their long-range planning processes. In Halifax, the Regional Municipality has entered into a public-private partnership to develop the Climate Sustainable Mitigation and Adaptation Risk Toolkit (Climate SMART). Climate SMART provides information and decision-making resources that support a wide range of adaptation (and mitigation) initiatives. It also mainstreams climate change impacts and adaptation considerations into the corporate decision-making process. The Halifax Regional Municipality (HRM) has begun to implement targeted adaptation measures using this tool (HRM, 2007).

Specific technologies that mitigate the impacts of climate change are also emerging. Arctic Foundations Canada, for instance, has developed thermosyphons that re-freeze permafrost under existing infrastructure by extracting heat from

10 The City of Toronto undertook the four-part project *Adapting to Climate Change in Toronto* in partnership with Clean Air Partnership, an NGO. In Vancouver, to protect communities from localized flooding, integrated storm water management is being developed (Perkins, Ojima and Correll, 2007).

the ground and sending it out into the atmosphere. This technology has the potential to help stabilize infrastructure in the circumpolar region affected by permafrost melt due to climate change (Redekop, 2007). This and other technologies could be exported to other northern and southern countries, creating a new type of Canadian export.

3.2 Provision of financial support to developing countries

Through bilateral and multilateral contributions, Canada is supporting adaptation to climate change by developing countries. Canada was instrumental in establishing the Least Developed Countries Fund (LDCF)—helping LDCs prepare for the negotiations at COP-7 (2001) and making the first commitment (\$10 million) to the Fund.¹¹ In addition, Canada (through the Canadian International Development Agency [CIDA]) has been a member of the Least Developed Countries Expert Group (LEG) since its establishment at COP-7. More recently, Canada has contributed \$13.5 million to the Special Climate Change Fund, of which \$11.0-million is to support the Fund's work on adaptation.¹² With respect to the Adaptation Fund (AF), indirect contributions by Canadian firms to this fund through the levy on Certified Emission Reductions will be restricted by the planned cap on the use of these credits under Canada's proposed Regulatory Framework. Canada could make a voluntary contribution to the AF once it becomes fully operational.

Canada has committed \$158.9 million to the GEF as part of its Fourth Replenishment (GEF-4) (GEF, 2006a). During the period of GEF-4, approximately 35 per cent of the GEF Trust Fund, or about US\$990 million, will be directed towards its climate change focal area (UNFCCC, 2007d). However, this funding will be directed primarily (and potentially exclusively) toward support for mitigation related projects; there are no plans at present to allocate new funding for adaptation during GEF-4.¹³ The GEF does plan to support integration of adaptation concerns across its focal area programming (UNFCCC, 2007e).

Alongside these contributions, Canada has also provided funding for the Nairobi Work Programme on Impacts, Vulnerability and Adaptation to

11 This contribution to the LDCF was provided through the Canada Climate Change Development Fund.

12 Canada's first contribution to the SCCF, for \$6.0 million, was provided in 2006 (GEF, 2006b). An additional contribution of \$7.5 million was announced during COP-13. Of this amount, \$5.0 million has been allocated to the SCCF's adaptation component; the remainder is to support technology transfer (Source: CIDA representative, personal communication, January 2008).

13 At present, it is proposed that the GEF expend the fund remaining from its 2004 commitment of US\$50 million to its Strategic Priority on Adaptation (approximately US\$23 million). An evaluation will then be undertaken to determine the potential for mainstreaming adaptation into GEF program areas, providing additional resources for adaptation, or withdrawing from work in this area (UNFCCC 2007e).

Climate Change, and is supporting the work of the Consultative Group of Experts on Non-Annex I National Communications (IISD, 2006). Canada also assists developing countries with their disaster preparedness efforts, focusing on capacity building at the country and regional level.¹⁴

The most prominent and largest contribution that Canada has made to supporting climate change efforts in developing countries has been through the Canada Climate Change Development Fund (CCCDF). Established under Budget 2000 and administered by CIDA, the six-year CCCDF provided \$110 million towards “activities to combat the causes and effects of climate change in developing countries, while helping to reduce poverty and promote sustainable development.”¹⁵

Through the CCCDF, \$15.9 million was directed towards 15 projects focused on adaptation to climate change (CIDA, 2005).¹⁶ While experiencing a number of administrative challenges, the Fund increased the capacity of developing countries to participate in the UNFCCC negotiations and address climate change. The CCCDF also enabled Canada to clearly demonstrate how it is meeting its obligations to developing countries under the UNFCCC, and made a significant contribution to building good relations with developing countries—relationships that could be leveraged during the formal negotiation process (Keough and Smedley, 2004). Since the close of the CCCDF, CIDA has largely discontinued its provision of funding explicitly for climate change activities and has been less actively engaged on the issue.

However, as a member of the OECD-Development Assistance Committee (DAC), the Agency has committed itself to integrating climate change into its development assistance activities.¹⁷ To help fulfill this obligation, CIDA is participating in a DAC Task Team to develop guidance on how climate change

14 For instance, for 2004 and 2005, CIDA pledged \$500,000 to the disaster preparedness activities of the International Federation of the Red Cross (IFRC) and \$500,000 to IFRC’s capacity building fund. In addition, CIDA established a \$1 million disaster response fund with the Canadian Red Cross and the IFRC in 2004. CIDA also has a Caribbean Disaster Management Fund that helps disaster management bodies in the region prevent and reduce the impact of recurrent disasters (FAITC, 2007).

15 CCCDF Management Framework and Business Plan.

16 Funding from the CCCDF was allocated to four areas: emissions reduction (nearly \$36.7 million); carbon sequestration (nearly \$14.2 million); adaptation (approximately \$15.9 million); and core capacity building (about \$10.1 million).

17 In its 2006 “Declaration on Integrating Climate Change Adaptation into Development Cooperation,” the OECD member countries committed to working together to, among other things: “Promote understanding of climate change and its impacts within their development co-operation agencies and with partners in developing countries; Identify and use appropriate entry points for integrating adaptation to climate change variability and climate change into development cooperation activities...; Assist developing country partners in their efforts to reduce their vulnerability to climate variability and climate change...; Develop and apply appropriate tools to address climate risks in development activities and to prioritise responses” (OECD-DAC, 2006).

issues should be integrated into Strategic Environmental Assessments. This work is consistent with CIDA's general approach to addressing climate change, which is to systematically integrate environmental sustainability concerns (including climate change across its activities through application of the Canadian Environment Assessment Act and the Strategic Environmental Assessment Cabinet Directive).¹⁸

There is growing concern expressed informally, inside and outside of CIDA, that how the Agency is addressing climate change within its bilateral assistance is inadequate—that CIDA is not considering adaptation to be a development issue and that it is falling behind its counterparts. CIDA has not yet developed a strategy or position paper that clearly lays out the links between its programming and the need to adapt to climate change. Nor has it developed or begun to introduce operational measures (e.g., climate risk assessment tools) to assist its staff and partners to integrate adaptation considerations into their work. As well, the Agency has given almost negligible attention to climate change in its development plans, strategies and projects. In contrast, a growing number of development assistance organizations have (or are in the process of) integrating climate change considerations into their development plans. They are, for example, developing tools to screen projects to determine whether they consider climate risks or address vulnerability to climate variability and change. These agencies include those of Denmark, Germany, Norway, Switzerland and the United Kingdom, as well as the OECD and the World Bank (Klein *et al.*, 2007).¹⁹

Outside of CIDA, the International Development Research Centre (IDRC) is currently working with the U.K. Department for International Development to implement its \$65 million Climate Change Adaptation in Africa Research and Capacity Building Program. Launched in 2006, the goal of this program is “to significantly improve the capacity of African countries to adapt to climate change in ways that benefit the most vulnerable.”²⁰

Canada's numerous development NGOs also have a strong role to play in supporting adaptation internationally. Interest on the part of development NGOs in engaging on the issue of climate change and facilitating adaptation to

18 Source: CIDA representative, personal communication, October 2007.

19 While progress is being made by development assistance organizations in terms of responding to climate change, a recent review by the OECD found that limited progress has been made with respect to integrating climate change concerns in development plans, strategies and projects (Gigli and Agrawala, 2007).

20 IDRC Web site: http://www.idrc.ca/ccaa/ev-96829-201-1-DO_TOPIC.html. Working largely through African research institutes and universities, the program seeks to strengthen the capacity of African scientists, decision-makers and others to facilitate adaptation to climate change; support implementation of adaptation in rural and urban areas through action research; increase the sharing of information between scientists and research institutes; and provide good quality, science-based knowledge that can inform policy processes.

climate change is growing. This energy is reflected in the formation of the Canadian Coalition for Climate Change and Development, which is working in part to develop the knowledge and capacity of the international development community to address the links between climate change and development.²¹ CIDA could play a greater role in supporting the efforts of these organizations through its Partnership Branch.

The Canadian government has played a leading role in supporting adaptation by developing countries in the past, and has the potential to play a prominent role again in the future. At the moment, however, there is a general perception that Canada is rapidly falling behind other developed countries (e.g., the United Kingdom, Denmark) in terms of its commitment and ability to address climate change concerns. Significant effort is needed in the near-term to increase CIDA's role, and by extension the role of the development NGOs that CIDA supports, in assisting its developing country partners in adapting to climate change through its bilateral programming.

4.0 The Bali Action Plan

Three main questions will need to be answered by the international community when determining a long-term approach to supporting adaptation: (1) what will be the general design or framework of the adaptation regime?; (2) how will adaptation be financed, particularly in developing countries?; and (3) which adaptation priorities should be supported and by whom? This section examines the first question regarding the general framework of the adaptation regime. As the Bali Action Plan provides a solid basis from which to see the possible design of this regime, this section begins by providing an initial assessment of the content of this agreement. A few thoughts are then presented regarding the broad objectives of Canada in future negotiations.

4.1 Adaptation in the Bali Action Plan

The final and most significant outcome of COP-13 was the reaching of consensus, after protracted negotiations, on the Bali Action Plan. The Plan sets out the framework for discussions by the newly established Ad Hoc Working Group on Long-term Cooperative Action under the Convention, which is to complete its negotiations by COP-15. These discussions will revolve around four main themes—mitigation, adaptation, technology development and

21 Participants in this emerging coalition include: the Canadian Cooperative Association, Canadian Council for International Cooperation, Canadian Crossroads International, Canadian Foodgrains Bank, CARE Canada, Centre for International Studies and Cooperation, Climate Action Network, CUSO, Evangelical Fellowship of Canada, Farm Radio Network, the International Development Research Centre, the International Institute for Sustainable Development, LEAD Canada, Mennonite Central Committee, Nature Canada, Oxfam, Oxfam Quebec, the Pembina Institute for Appropriate Development, Canadian Red Cross, the United Church, USC Canada, VSO and World Vision.

transfer, and the provision of financial resources and investment. Adaptation issues are addressed under the latter three themes.

The Bali Action Plan, Article 1c, explicitly calls for action on adaptation that includes consideration of:

- (i) “International cooperation to support urgent implementation of adaptation actions...taking into account the urgent and immediate needs of developing countries that are particularly vulnerable to the adverse effects of climate change...
- (ii) Risk management and risk reduction strategies, including risk sharing and transfer mechanism such as insurance;
- (iii) Disaster reduction strategies and means to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change;
- (iv) Economic diversification to build resilience;
- (v) Ways to strengthen the catalytic role of the Convention in encouraging multilateral bodies, the public and private sectors and civil society, building on synergies among activities and processes, as a means to support adaptation in a coherent and integrated manner” (UNFCCC, 2007e).”

The emphasis within this line of the negotiations is on determining how the UNFCCC will continue to support knowledge generation, capacity building and implementation of the array of actions required by all Parties, but particularly by vulnerable developing countries (i.e., LDCs and SIDS), to adapt to climate change. Linkages to these topics can be made to various existing initiatives under the UNFCCC, such as the LDC Work Program (which addresses the “urgent and immediate needs” of LDCs); the SCCF (which supports priority adaptation areas such as disaster reduction strategies); the Adaptation Fund (which is to support concrete adaptation projects and programs); and the Nairobi Work Programme (which facilitates communication between various stakeholders).²² How these existing initiatives will fit into the design of the future regime is likely to form a central part of the planned negotiations.

The technology pillar of the Plan also explicitly calls upon the international community to develop strategies for enhancing technology development and transfer that supports adaptation as well as mitigation efforts. Particular effort will be needed by the international community to ensure that technologies for adaptation are given equitable attention within these negotiations. As well,

²² The UNFCCC also has had a long-standing commitment to addressing the potential role of insurance as a risk reduction strategy, having been acknowledged in Articles 4.8 and 4.9 of the Convention and recognized as an option for meeting the specific needs of developing countries since COP-7. However, progress in this area has been limited.

recognition will need to be given to the unique concerns associated with transferring technologies and tools for adaptation compared to mitigation (Klein *et al.*, 2005; UNFCCC, 2006).

Adaptation also forms an explicit part of the fourth pillar of the Bali Action Plan on the provision of financial resources and investment. Specific reference is made to identification of positive incentives for enhanced implementation of adaptation action; innovative means of funding assistance to particularly vulnerable developing country Parties to meet the cost of adaptation; means to incentivize the implementation of adaptation actions on the basis of sustainable development policies; and enhancing the capacity of developing countries to assess the costs of adaptation. Of interest, although the Plan references mobilization of private-sector funding and investment, it does not explicitly link this activity to financing adaptation.

Overall, the Bali Action Plan firmly roots the development of a post-2012 adaptation regime in the principles and commitments of the UNFCCC, including the principle of common but differentiated responsibilities; and to meeting the specific needs and special circumstances of developing countries.²³ It also strives to support an integrated approach to adaptation, as explicitly indicated in Article 1c(v) of the Plan. The inclusion of this text reflects recognition of the need to weave adaptation considerations into mainstream decision-making, planning and policy development at the local, sectoral, national and international level. The Plan further recognizes the need for immediate action in support of adaptation, reflecting the growing array of climate change impacts being felt. As well, it gives particular attention to the need to assist developing countries, especially vulnerable developing countries, with financing adaptation, gaining access to technologies for adaptation, and undertaking immediate adaptation efforts.

Through references to “strengthening the catalytic role of the Convention” and mobilization of public and private sector funding and investment, the Bali Action Plan also suggests that the future climate regime will foster action in multiple venues. Given the scale of efforts to be undertaken and the diversity of stakeholders that need to be engaged in adaptation efforts, adaptation likely cannot be addressed only or even primarily through the UNFCCC process; multi-actions in multiple venues will be needed. A central question for future negotiations, therefore, will be determining the role of the UNFCCC in comparison to other actors and fora.

23 Article 1a of the draft decision text states that the Plan is to develop a “shared vision for long-term cooperative action... to achieve the ultimate objective of the Convention, in accordance with the provisions and principles of the Convention, in particular the principle of common but differentiated responsibilities and respective capabilities, and taking into account social and economic conditions and other relevant factors” (UNFCCC, 2007e).

Addressing at least two components of the Bali Action Plan under the UNFCCC could be problematic—clause 1c(iii) related to disaster reduction strategies and addressing “loss and damages associated with climate change impacts in developing countries;” and clause 1d(iv) regarding “economic diversification to build resilience.” First, it is difficult at present to differentiate between loss and damages associated specifically with disasters caused by climate change from those due to climate variability. The Bali Action Plan, though, appears to suggest that this type of differentiation will be required. Second, applying the “incremental cost” principle when supporting economic diversification could be challenging. These situations reflect the tension between the formal requirements of the UNFCCC and current understanding of what is required to effectively support adaptation to climate change and enhance responsiveness to unavoidable impacts.

At this time, it is also unclear how the international community will pursue negotiations under the Bali Action Plan so as to ensure consistency and complementarity between decisions made under each pillar. For instance, in sectors like forestry, agriculture and urban environments, simultaneous efforts will be needed to reduce greenhouse gas emissions and adapt to climate change. A post-2012 regime could work to optimize these efforts, recognizing the potential for both trade-offs and synergies. The design of the Plan’s work program, which may or may not be oriented along the four pillars, likely will be critical in determining the degree to which synergies and internal coherence can be achieved.

4.2 Potential Canadian perspective

As suggested in Section 3, Canada is likely to have two broad objectives with respect to adaptation under a post-2012 climate regime: (a) promoting the establishment (or continuation) of effective mechanisms for developing and sharing knowledge, methods, tools, technologies and best practices; and (b) ensuring that Canada is able to fulfill its obligations under the UNFCCC with respect to non-Annex I Parties, including the provision of financial assistance, in an equitable manner. The Bali Action Plan provides a basis from which Canada can pursue these objectives.

A number of the principles explicitly and implicitly embedded in the Plan are consistent with Canada’s historical commitment to multilateralism and understanding of adaptation. These include its re-invigoration of the UNFCCC process, recognition of the need for immediate action on adaptation, support for an integrated approach, and the desire for the UNFCCC to serve a catalytic role. Moving forward, Canada, like other countries, is likely to also ensure that the agreement reached in Copenhagen also is:

- *Politically acceptable.* For any future adaptation regime to be successful, it must be sufficiently acceptable to all Parties for them to take it back to their respective jurisdictions and follow through on their commitments. For Canada, in terms of adaptation, acceptability is likely to be determined by the degree of financial commitment it implies. Provision of increased financial

assistance is more likely if it is economically realistic, can be clearly linked to national economic and security interests, and if developing countries can demonstrate that these resources will be used effectively (Karthan *et al.*, 2006).

- *Cost-effective.* Given the billions of dollars potentially needed each year to prepare for and respond to climate change, and that financial resources are always finite, Canada will likely seek to ensure that its funding commitments are not overly burdensome. It is likely to also emphasize funding for actions expected to have the greatest impact over the long term.
- *Equitable.* Canada likely will seek to ensure that developed countries contribute equally to efforts that assist developing countries in their adaptation efforts. At the same time, while recognizing that impacts of climate change are and will continue to be felt most heavily by peoples and countries that have contributed the least to greenhouse gas emissions, it is unlikely that Canada will favour a regime that characterizes its provision of adaptation funding as compensation.
- *Flexible.* Recognizing the uncertainty and potential for surprises associated with climate change impacts, an international regime designed to provide sufficient flexibility in its structure to respond to changing circumstances could be favoured by Canada.

5.0 Financing for adaptation

The second question that a post-2012 adaptation regime will need to address is how to provide “predictable and adequate”²⁴ funding for adaptation to developing countries. As Chapter 5 of this document focuses on options for generating new financial resources for adaptation, mitigation and technology transfer, this critical issue is not examined here. Instead, the following section provides an overview of several key issues that will likely influence decisions related financing adaptation under the Bali Action Plan. These include:

- addressing the overlap between development and adaptation;
- differing expectations regarding whether funding should be provided as compensation or assistance;
- allocation of responsibility between developed and developing countries;
- ensuring a cost-effective approach;
- deciding the future of the existing adaptation funds;
- determining how future adaptation funds will be managed;
- how to incorporate sub-national governments, the private sector and civil society; and

24 As agreed upon under the Marrakesh Accords: Art.1.b, Decision 7/CP.7.

- how to enhance coordination between the climate, development and disaster communities.

As described below, resolving these issues could prove highly contentious.

5.1 Addressing the overlap between development and adaptation

As described in Section 2.1, the process of adaptation is intimately connected with the process of sustainable development. The degree to which an individual, community, sector or country is vulnerable to the impacts of climate change in large part is a function of their adaptive capacity. In turn, adaptive capacity is strongly determined by development-related factors such as access to economic resources, technology, information and skills and infrastructure, as well as the strength of institutions and the equitable distribution and availability of resources (Smit *et al.*, 2001). Recognising this strong inter-linkage between adaptation and development, it may be useful to portray adaptation to climate change as a continuum of response activities. As described by McGray *et al.* (2007), this continuum ranges from activities that address the general, underlying determinants of adaptive capacity and overlap almost completely with traditional development practice, to those that respond to specific climate change impacts and are outside the range of historical development efforts (see Box 1).

Box 1: A continuum of adaptation activities
(adapted from McGray *et al.*, 2007)

1. Addressing the Drivers of Vulnerability	2. Building Response Capacity	3. Managing Climate Risk	4. Confronting Climate Change
Activities reduce poverty and address other fundamental shortages of capability that make people vulnerable to harm. Very little attention is given to specific climate change impacts but actions can increase resilience to climate stresses and shocks.	These capacity building actions lay the foundation for more targeted adaptation actions and include institution-building and technology sharing efforts familiar to the development community.	Climate information is incorporated into decisions to reduce the negative affects of climatic factors—due to either variability or climate change—on resources and livelihoods	Actions taken respond almost exclusively to impacts known to be caused by climate change.
Examples: micro-credit schemes; immunization programs	Examples: improving communications infrastructure; training in GIS technology	Examples: introduction of drought-resistant crops; emergency response systems	Examples: reducing potential for a glacial lake outburst flood; building sea walls
← Vulnerability Focus		Impacts Focus →	

The challenge for the international community presented by this continuum of activities, particularly with respect to those that fall within the middle of the spectrum, is the desire by multiple actors to ensure that financing for adaptation is clearly distinguished from financing for traditional development. This desire for separation is driven by several factors. For one, the Convention text itself calls upon developed country governments to fund the “incremental cost” of efforts to prepare for adaptation in developing countries (except particularly vulnerable countries, as assistance to them under Article 4.3 of the Convention is not restricted by the incremental cost requirement [Mace, 2003]). Adherence to the incremental cost formula requires determining the additional costs associated with preparing for climate change compared to development efforts that would have taken place in the absence of this global process. In situations where understanding of the projected impacts of climate change is uncertain or proposed activities, such as strengthening local governance structures, increase resilience to both existing climate variability and future climate change, determination of these additional costs can be very difficult.

The Convention also calls upon developed countries to provide “new and additional” funding to help developing countries meet their obligations under the Convention, which includes preparing for adaptation to climate change. The inclusion of this requirement reflects developing countries’ (and development NGOs’) concern that ODA will be diverted from pressing development priorities towards funding for adaptation. To address this concern, development assistance agencies have an interest in ensuring that they are able to track and report on funding for adaptation separately from that provided for development purposes.²⁵ This situation reinforces a tendency to try to differentiate between funding for development and funding for adaptation, despite the clear overlap between the two in practice.

Negotiations on the design of a future adaptation regime will need to reconcile the fact that traditional development practices have an important role to play in facilitating and implementing adaptation actions. Parties will need to determine how the post-2012 climate regime can, particularly in developing countries, contribute to addressing the social, economic and institutional factors that increase vulnerability. Consideration might need to be given to developing new funding mechanisms that support vulnerability reduction efforts along the full continuum of adaptation activities and integration with ongoing development processes.

5.2 Differing expectations regarding whether funding should be provided as compensation or as assistance

A long-standing difference among Parties is their perception of that basis upon which financing for adaptation should be provided. On the one hand,

²⁵ In practice, although tracked separately, development assistance agencies generally count adaptation funding, such as that provided to the Least Developed Countries Fund and the Special Climate Change Fund, as part of their ODA.

developing countries note the historic responsibility of developed countries for the problem of climate change and cite the need for compensation for the damages caused. On the other hand, developed countries have treated their financing of adaptation activities as development assistance unlinked to any explicit notion of direct responsibility. This dichotomy is likely to be a central point of disagreement in the post-2012 adaptation negotiations (see, for example, Schipper, 2006).

Linked to this debate is the desire to ensure greater predictability in the provision of future adaptation funding (as called for under the Bali Action Plan). At present, adaptation funding is provided by developed country governments through bilateral development assistance and contributions to the various climate change funds. The relatively limited funding made available through these channels can be tied to the voluntary basis upon which they are provided. Mandatory contributions, potentially based on historic levels of greenhouse gas emissions, could increase the amount and predictability of adaptation financing. However, tying mandatory contributions to historic or current emission levels implies that compensatory funding is being provided; contributions made on this basis are unlikely to be attractive to donor countries. A negotiated agreement on financing for adaptation will likely need to reconcile the need for predictability through mandatory contributions with a desire to ensure that these contributions continue to be perceived as assistance, not compensation.

5.3 Allocation of responsibility between developed and developing countries

As previously noted, current estimates suggest that tens of billions of dollars will be needed each year to support developing countries' adaptation efforts. It is extremely unlikely that current funding mechanisms will be able to mobilize this level of financial resources (e.g., Bouwer *et al.*, 2004; World Bank, 2006a; Müller and Hepburn, 2006; Müller, 2007), especially as developed countries increasingly realize their own vulnerability to (and the associated costs of) climate change. Even if mandated contributions were introduced, it is unlikely that developed countries will agree to cover all, and likely not even the majority, of developing countries' adaptation costs. The "incremental cost" provision of the Convention (Article 4.3) itself implies that the initial burden for addressing the adverse effects of climate change rests with developing countries, even in situations where it is clear that measures are needed due to the impacts of climate change (Mace, 2003).

Consequently, the significant portion of financing for adaptation might need to be derived from the budgets of developing country governments themselves (which will require integration of adaptation considerations into key domestic decision-making and funding channels). This scenario suggests that underlying future negotiations will be a debate regarding how much responsibility developing countries should bear for financing their own adaptation efforts.

As well, in keeping with the recognition of LDCs and SIDS greater vulnerability to climate change, decisions likely will need to be made regarding the proportion of financing allocated to these countries in comparison to other developing countries.

Difficult negotiations can also be expected regarding the allocation of responsibility for financing between developed countries. While the UNFCCC recognizes “the importance of appropriate burden sharing among the developed country Parties” (Art. 4.3), a process by which to allocate this responsibility has not yet been determined.²⁶ Within the future regime, developed countries likely will need to agree upon how to share the burden of financing adaptation (through official and concessional financing, and potentially innovative financing mechanisms) between themselves in order to achieve the political consensus needed to increase funding to developing countries. Agreeing on the basis upon which to allocate the funding burden will likely be challenging (e.g., on the basis of historic emissions?; emissions since 1990?; current GNI?) (Mace, 2005).²⁷

5.4 Ensuring a cost-effective approach

In shaping the financial regime for adaptation after 2012, the international community will likely also seek to ensure that a cost-effective approach is taken. This desire could influence the priority areas for adaptation supported by Parties. For example, the UN has estimated that for every dollar invested in disaster preparedness, seven dollars are saved in disaster response (Simms, 2005). Given the associated benefits in terms of protecting human lives and economic investments, strengthening emergency response systems is therefore likely to be a priority area for support from the perspective of developed and developing countries.

At the same time, donor countries will want to ensure that the funding they provide through the UNFCCC is used effectively (Kartha *et al.*, 2006). As such, it is possible that developed countries will seek to ensure that their adaptation funding is allocated to developing countries with demonstrated capacity to use it as intended. Unfortunately, the weak governance structures and limited capacity that increase the vulnerability of many developing countries to climate change also limits their capacity to absorb substantial, rapid increases in much needed

26 For example, as of September 2007, the United States had not contributed funding to either the Least Developed Countries Fund or the Special Climate Change Fund. In contrast, contributions to either or both of these funds had been received from 18 other developed countries, as listed in Annex 1 (GEF, 2007b).

27 Oxfam International has developed an Adaptation Financing Index that allocates the burden of financing adaptation in developing countries between all countries based on responsibility (as determined by greenhouse gas emissions since 1992) and capability (as determined by the Human Development Index). Based upon this index and their expectation that US\$50 billion in new financing will be needed each year, Oxfam has called upon Canada to provide US\$2.15 billion of new financing each year to support adaptation in developing countries (Oxfam, 2007a).

adaptation financing. This conundrum reiterates the important role that development assistance needs to play in supporting adaptation to climate change.

5.5 Future of the existing adaptation funds

Four dedicated funds have been established under the current climate regime to support adaptation to climate change:

- The *Least Developed Countries Fund (LDCF)*, which is replenished through voluntary contributions from Annex II countries. The fund was established to support LDCs in the development of National Adaptation Programs of Action (NAPAs)²⁸ and is beginning to finance priority projects identified under these Plans.
- The *Special Climate Change Fund (SCCF)*, which addresses adaptation and technology transfer along with emission reduction projects and economic diversification.
- The *Adaptation Fund*, introduced under the auspices of the Kyoto Protocol, which will support “concrete adaptation projects and programmes” in developing countries that are Parties to the Protocol.²⁹ The AF is funded by a two per cent levy imposed on transactions of certified emission reductions (CERs) from Clean Development Mechanism projects.
- The *Strategic Priority on Adaptation (SPA)*, established by the GEF under its Trust Fund in 2004 at the request of COP-7. The goal of the SPA is to support pilot and demonstration adaptation projects that reduce local vulnerability to climate change and provided global environmental benefits

A post-2012 adaptation regime will need to determine the future of these funds (assuming a desire for the retention of dedicated adaptation funds in the post-2012 climate regime). Given that adaptation funding under the UNFCCC and its Kyoto Protocol is relatively scattered, one option would be to merge the LDCF, the adaptation component of the SCCF, and the Adaptation Fund into a centralized adaptation fund that is directly responsive to the COP. While these funds currently do not support the exact same types of activities, there is sufficient overlap to warrant a merger. Centralization might also facilitate better coordination and continuity between activities.

5.6 Management of future adaptation funds

At present, the GEF serves as the operating entity of the LDCF, the SCCF and the SPA. In contrast, the Adaptation Fund has established a separate Adaptation Fund Board to serve as its operating entity, with the GEF providing secretariat services. The alternative structure of the Adaptation Fund stems

²⁸ NAPAs are “simplified and direct” documents that communicate the “urgent and immediate” adaptation needs and priorities of LDCs.

²⁹ Decision 10/CP.7.

in part from concerns related to the GEF's management of the LDCF and SCCF. These include a concern expressed by developing countries, particularly least-developed countries, that the modalities governing the operation of the LDCF and the SCCF are too heavily influenced by the desires of donors. The co-financing requirements of the LDCF and SCCF, particularly the sliding scales, have also been challenged by developing countries (IISD, 2004; GEF, 2004; IFC, 2005; Mace, 2005a; Müller, 2007). As well, the degree to which the GEF adheres to the guidance it receives from the COP regarding eligibility criteria, priority activities and disbursement criteria, and in turn the extent to which the GEF's Implementing Agencies follow the guidance they receive from the GEF, has been found to need improvement (Möhner and Klein, 2007).

The COP will need to determine if it desires to continue to have the GEF serve as the operating entity for its adaptation funds, or if it would like to pursue a model closer to that of the Adaptation Fund. In assessing this issue, careful attention will need to be given to how the Adaptation Fund evolves, to see if it is able to function effectively and overcome past concerns regarding the management of the LDCF and SCCF.

5.7 How to incorporate sub-national governments, the private sector and civil society

Reflecting the scale of resources needed and the importance of integrating adaptation concerns into decision-making across sectors and jurisdictions, there is a need to leverage adaptation funding through existing financial flows from several sources. To date, efforts to increase funding for adaptation has largely focused on enhancing the availability of official and concessionary financing as well as new funding sources (such as through innovative financing mechanisms). Less attention has been given to "climate-proofing" other existing financial flows, such as those provided by sub-national governments, the private sector and non-governmental development organizations.

As many measures to increase resilience and foster adaptation take place at the local level, municipal and state-level governments have a leading role to play in preparing for climate change. Often these governments influence or are responsible for investment decisions related to, for example, infrastructure development, health care and disaster preparedness. The degree to which these investments are made with the application of a "climate lens" will be critical in influencing the near- and long-term vulnerability of people.

Similarly, in all countries, the private sector could play an important role in adaptation planning and preparations. For example, foreign direct investment constitutes the largest component of external financing to developing countries. A significant portion of these funds is directed towards investments in infrastructure such as roads, bridges and energy installations.³⁰ Climate

30 For example, more than \$680 billion was invested in infrastructure projects in more than 120 developing countries between 1990 and 2000 (Heller and Shukla, 2003).

proofing of these investments could significantly reduce the vulnerability of developing countries to the impacts of climate change.

As well, civil society, including development NGOs, will likely play a critical role in enhancing the adaptive capacity of people and communities. The generally grassroots nature of these groups means that they 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).

A future adaptation regime will likely need to contain specific mechanisms designed to mobilize the efforts and financial resources of sub-national governments, the private sector, and civil society organizations. The regime could include avenues for providing information to these actors regarding the implications of climate change for their operations; developing protocols and other tools for integrating climate projections into infrastructure design parameters and standards; enhancing the ability of these entities to directly access existing or new climate funds; and/or ensuring that these critical players have a greater role in decision-making regarding the design and priorities of the international adaptation regime.

5.8 How to enhance coordination among the climate, development and disaster communities

As previously noted, the development community has a key role to play in helping developing countries reduce their vulnerability to climate change impacts. Along with enhanced coordination between the development and climate communities, a post-2012 adaptation regime will also need to give greater attention to cooperation with the disaster community (as called for under the Bali Action Plan). Disaster relief is likely to be increasingly needed as the frequency and intensity of climate-related disasters accelerates due to climate change. These impacts further undermine the capacity of communities and countries to adapt, particularly those in developing countries. Developing countries already bear the brunt of disaster fatalities³¹ and incur significant economic losses due to climate-related disasters;³² these disasters tend to have an economy-wide impact, on average affecting five per cent of GDP (IMF, 2004).³³ While accelerated investment in emergency planning and disaster preparedness will lower the human, economic and ecological damage caused by these disasters, surprises will take place and some degree of

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

32 For example, during the 2004 hurricane season, the Cayman Islands and Granada experienced economic losses equivalent to 183 per cent and 212 per cent of annual GNP respectively (Bal *et al.*, 2005).

33 Natural disasters have a higher frequency (occurring on average every 2.5 years) and more significant impacts, as a percentage of GDP, than commodity shocks (IMF, 2004).

negative impact cannot be avoided. Increased funding is needed to prepare for these unavoidable impacts, especially as it is widely recognized that existing relief funding mechanisms fall short of what is needed (Freeman *et al.*, 2003; Martin *et al.*, 2005; Sperling and Szekely, 2005; IMF, 2006; World Bank, 2006b).

Coordination of financing efforts between the climate, development and disaster communities will be needed to ensure that gaps and redundancies are avoided (McGray *et al.*, 2007); that interventions are undertaken in a synergistic manner; and that financial resources are used more effectively. This discussion leads to two questions that will require attention in designing the future climate change regime. First, what approaches to financing adaptation and impacts responses would allow the climate change, development and disaster management communities to work effectively in a coordinated manner? Second, considering the scarcity of resources, how should funds be divided between planned adaptation efforts and ad hoc, needs-driven responses to the unavoidable impacts of climate change?

6.0 Support for adaptation

The final question that a post-2012 adaptation regime will need to address is the role of the UNFCCC in supporting adaptation compared to that of other actors, such as development assistance agencies, the private sector, development NGOs and national governments. The wide-range of potential climatic changes and the diversity of local and national circumstances mean that the range of adaptation needs is vast. In contrast, it can be expected that the international community will want to focus on funding provided through the UNFCCC to specified priority areas, particularly given expectations that available financing will be finite.

Within the remainder of this section, an overview of the range of needs that could be financed within a post-2012 adaptation regime is provided. An initial assessment is then made of the potential role of the UNFCCC in helping to meet these needs, including a comparison to the content of the Bali Action Plan. Finally, the possible role of other international, national and local actors in supporting adaptation is discussed.

6.1 Adaptation needs

A significant scaling up of efforts is needed in the near-term to integrate adaptation considerations into policies, plans and projects at the local, national, regional and international level, and to implement adaptation measures on the ground. As described in Annex 3, support for adaptation needs to be provided in areas such as: scientific understanding; governance; information sharing; adaptation plans and strategies; community-based adaptation; education, public engagement and awareness; tools; technologies; natural resources management; health; private sector; infrastructure; disaster and emergency pre-

paredness; migration and resettlement; and transboundary concerns. This list is indicative only; additional adaptation needs can be identified. As well, it is recognized that considerable overlap between needs exists (e.g., community-based adaptation can be enabled through strengthening of local governance capacity and information sharing, and implemented through improved natural resource management).

As illustrated by this truncated list, climate change adaptation needs are diverse. So too are the specific circumstances of communities, sectors and countries. Thus priority adaptation needs will differ between locations and regions depending upon their level of development and adaptive capacity, changing climatic circumstances (e.g., greater risk of drought or floods) and local ecology (e.g., mountain ecosystem or low-lying delta).

However, some common adaptation concerns across all Parties have been identified through efforts such as the Nairobi Work Programme. These include a need to increase research on the costs, benefits and trade-offs of possible adaptation options; ensure that research responds to the needs of end-users; enhance communication regarding good practices; increase engagement by the private sector; and foster the integration of adaptation into development and budgetary planning and policies. Other common priority areas for action that will increase adaptive capacity are strengthening monitoring systems, providing incentives for integrated water resources management, increasing capacity in the health community to respond to climate change, and establishing national frameworks for adaptation (UNFCCC, 2007f).

The specific priorities of developing countries have also been identified. For instance, in a review of initial National Communications, Technology Needs Assessments, NAPAs, submissions under the Nairobi Work Programme, and reports from regional meetings, the UNFCCC (2007a) found that the water supply sector was consistently prioritized by countries in all regions of the world. Developing countries are seeking support for flood and drought monitoring, control and protection systems, integrated water management, improved watershed management, and water conservation. Other adaptation priorities of developing countries include:

- holistic adaptation planning that enables vulnerabilities in several sectors to be addressed simultaneously;
- technologies for adaptation in the following sectors: water conservation, harvesting and management; agriculture (particularly the development and use of tolerant/resistant crop varieties); forestry (such as early warning systems); fisheries (like the development of salt-tolerant fish); and coastal management;
- forest protection, expansion and the preservation of genetic diversity, as well as the prevention of fires, pests and diseases;

- protection of coastal areas such as through coral reef protection, restoration of beach vegetation, building coastal infrastructure and changing development patterns;
- disaster risk reduction and disaster management, such as through efficient warning systems, insurance, and flood protection structures;
- health sector measures such as those that prevent the spread of malaria, increase immunization against common diseases and improve health infrastructure; and
- protection of urban infrastructure, as well as roads, telecommunications and infrastructure associated with critical economic sectors like tourism (UNFCCC, 2007a).

6.2 Possible role of the UNFCCC

At present, support for adaptation under the UNFCCC and its Kyoto Protocol falls into two broad areas:

- Providing financial assistance to enable developing (non-Annex I) countries to prepare for and adapt to the impacts of climate change, as through the LDCF, the SCCF and the Adaptation Fund. As seen in Box 2, these funds support (or will support) a wide-range of adaptation-related initiatives.

Box 2: Funding priorities under the LDCF, SCCF and Adaptation Fund

Under the Marrakesh Funds, funding for developing countries has been directed towards the following activities:

- **Least Developed Countries Fund:** providing support for the development of NAPAs and will be providing partial funding for the implementation of priorities identified through this process.
- **Special Climate Change Fund:** implementation of activities in the areas of water resources management, land management, agriculture, health, infrastructure development, fragile ecosystems, and integrated coastal zone management; monitoring of diseases and vectors affected by climate change; capacity-building for prevention, planning, preparedness and management of disasters relating to climate change; and strengthening existing and, where needed, establishing national and regional centres and information networks for rapid response to extreme weather events (UNFCCC, 2003).
- **Adaptation Fund:** funding will be directed toward “concrete adaptation projects and programmes that are country driven and based on needs, views and priorities of eligible Parties (UNFCCC, 2007b).

-
- Assisting all countries in understanding and sharing perspectives on adaptation, most visibly through the Nairobi Work Programme (NWP). The

UNFCCC is also engaged in synthesizing information on impacts, vulnerability and adaptation; facilitating information dissemination and exchange between Parties; and playing an active role in reaching out to other UN agency and multilateral fora on adaptation issues.

Overall, the UNFCCC has largely played a facilitative role to date, helping countries create the enabling environment needed for effective adaptation.

As the effects of climate change increasingly are felt, some are assuming that the UNFCCC should also become more involved in supporting the direct implementation of adaptation activities. The international community will need to determine the degree to which the UNFCCC should remain largely focused on financing actions that facilitate adaptation to climate change (e.g., capacity building) compared to implementation of adaptation initiatives (e.g., watershed restoration).

Reviewing the possible areas of support for adaptation that could be addressed in a post-2012 adaptation regime, it is perhaps most appropriate that the UNFCCC continue to play a primarily facilitative role. The UNFCCC is a negotiating forum that brings together representatives of national governments; as such, its linkages are at best indirect to citizens, scientists, business leaders and others active in implementing adaptation measures at the community and sectoral level. At the same time, national governments have a critical role to play in supporting adaptation to climate change—by putting in place the structures needed to enable adaptation by others³⁴ and by integrating adaptation considerations into those activities over which they have direct control. The UNFCCC could focus its attention (particularly in the near-term) on assisting national governments in undertaking these activities.

Ideas regarding the future role of the UNFCCC in supporting developing countries, working with all countries, and in reaching out to other constituencies are discussed below.

6.2.1 Support for developing countries

A central part of any discussions regarding the future of the international adaptation regime will be determination of the types of activities undertaken in developing countries that will be supported under the mantle of the UNFCCC. It can be expected that this support will be directed towards activities that facilitate and implement adaptation measures, perhaps with an emphasis on the former. In the near-term, the UNFCCC therefore could focus its assistance to developing countries in four main areas: (a) enabling the

34 Governments have a role to play in: supporting research and distributing reliable information; developing methods, tools and technologies for adaptation; building institutional and risk management capacity; and providing a policy environment that will encourage sound adaptation (Intergovernmental Climate Change Impacts and Adaptation Working Group [ICCIAWG], 2005).

development of national adaptation strategies that are consistent with and supportive of broader development objectives; (b) strengthening national level institutions responsible for addressing climate change, such as climate change focal points; (c) facilitating the development and exchange of the scientific and socio-economic knowledge needed to prepare for climate change; and (d) supporting implementation of priority adaptation projects at the local and sub-national level. As well, as discussed in Chapter 4, it also can be assumed that the UNFCCC will play an active role in supporting the development and transfer of technologies for adaptation.

A. Establishment of national adaptation strategies

At present, through the LDCE, the UNFCCC provides assistance to LDCs with the development of national adaptation plans (or NAPAs). There is a desire by other developing countries for assistance in undertaking similar, holistic adaptation planning efforts (UNFCCC, 2007f). The development of national adaptation frameworks, strategies and plans is key to facilitating coordination of adaptation efforts across government departments, jurisdictions and sectors; identification of adaptation priorities; and determining immediate and long-term response measures.

For national adaptation planning to successfully take place, it will be necessary to enhance capacity in a variety of areas. These include capacity to seek complementarities with development and environment objectives; to engage the right sectoral departments, policy-makers and non-governmental stakeholders (Srinivasan, 2006); encourage political buy-in; and to meet scientific and technical needs. The UNFCCC could support the activities needed, including capacity building, to generate national adaptation plans by all developing countries.

B. Strengthening of national level institutions

The UNFCCC has a continuing role to play in building the capacity and skills of national level institutions responsible for facilitating and implementing adaptation activities—helping to ensure that developing countries are able to effectively respond to the potential impacts of climate change. Institutional strengthening is also needed to provide donor countries with the assurance they require to feel confident that any adaptation funding they provide will be used effectively (Kantha *et al.*, 2006).

Strong national focal points (and potentially adaptation focal points³⁵), for example, are needed to assist with integration of adaptation across governmental activities and engage in education and raising awareness. The capacity

35 At the 2007 meeting on Adaptation Planning and Practices, it was suggested that national adaptation focal points be established. The primary role of these focal points would be initiate establishment of the national level architecture (institutions, national adaptation strategies, action plans, legal frameworks) needed to enable adaptation (UNFCCC, 2007f). Establishment of these focal points could be explored as part of the Bali Action Plan negotiations, emphasizing their role in facilitating adaptation in an integrated manner.

of focal points could be enhanced in particular with respect to their ability to facilitate integration of climate change adaptation into policies and processes. Assistance could be provided with respect to engagement of relevant ministries, including finance ministries, and other stakeholders, such as the media (UNFCCC, 2007f); the identification and analysis of policies affected by climate change; integrated policy formulation, planning and coordination; and integrated policy implementation, evaluation and modification (Kimenyi *et al.*, 2004). The capacity of focal points also could be increased in areas such as conducting vulnerability and adaptation assessments (Srinivasan, 2006); and technical capacity and planning skills (Burton *et al.*, 2006). These efforts will need to be undertaken in a manner that complements other ongoing efforts to enhance governance in developing countries.

C. Facilitating the development and exchange of the scientific and socio-economic knowledge

Preparing for climate change requires access to a variety of information sources and databases—some of which are either under-developed or absent in developing countries. Building upon the experience and understanding gained through such processes as preparation of their National Communications and NAPAs, the UNFCCC could continue to support efforts by developing countries to generate and share the information needed to effectively engage in adaptation planning. In this context, support could be given to strengthening meteorological networks to ensure effective provision of weather forecasts and monitor trends; developing downscaled climate models; and communicating weather and climate forecasts to end-users (farmers, fishers, health officials) in the most appropriate format and language.

Parties could also consider applying a broader understanding of the information needed for adaptation. This includes the collection, management and monitoring of data related to, for example, pest and disease outbreaks, above- and below-ground water levels, cropping patterns, sea levels and census data. It also includes economic analysis of projected costs associated with anticipated climate impacts and identified response measures. Attention could also be given to building the capacity needed for information and knowledge generation and use, such as training in the use of geographical information systems and enhancing communication between information generators and users (IISD, 2007b; McGray *et al.*, 2007).

D. Supporting implementation of priority adaptation projects

A strategic approach will need to be determined by Parties regarding how to respond effectively to the increasingly urgent need in developing countries, particularly LDCs and SIDS, to implement adaptation measures at the local level. This approach will need to respect the varying needs of developing countries and also the obligations of developed countries vis-à-vis developing countries, particularly vulnerable developing countries, given the overlap

between traditional development efforts and actions that reduce vulnerability to climate change. Identification of priority areas for implementation support could be tied to the content of national adaptation plans.

6.2.2 Support for all countries

Adaptation to climate change is a new phenomenon, and there is a need in all countries to improve understanding of the possible consequences of this process from a scientific and socio-economic perspective; and how best to reduce vulnerability to these projected climate change impacts. As such, all countries could benefit from cooperative action to share knowledge, tools and best adaptation practices. The UNFCCC could facilitate this process by continuing to organize workshops, develop outreach materials, and host Web portals. These actions could continue to be done through a centralized manner out of the UNFCCC Secretariat in Bonn, or through regional hubs.

The Nairobi Work Programme (NWP) on impacts, vulnerability and adaptation to climate change provides an interesting model for how the UNFCCC could play an ongoing catalytic role in engaging and assisting all Parties in their adaptation efforts. Agreed upon at COP-12 (2006), the NWP seeks to assist countries to “improve their understanding and assessment of impacts, vulnerability and adaptation”; and to “make informed decisions on practical adaptation actions and measures to respond to climate change on a sound, scientific, technical and socio-economic basis, taking into account current and future climate change and variability” (UNFCCC, 2007c). Through work in nine focus areas,³⁶ the NWP is bringing together experts from developed and developing countries, and from inside and outside of government, to create a network for disseminating information and experiences, enhancing capacity and increasing cooperation. The NWP also seeks to catalyze action pledges by participants, either by integrating adaptation into their work or by aligning their work so that it addresses identified gaps. The NWP is not intended to support practical implementation of adaptation measures.

The NWP has only begun to undertake its work program, with plans for a second phase to begin in 2009. Based on an assessment of its contribution to supporting and enabling adaptation efforts, consideration could be given to incorporating a similar, continuing information sharing and capacity building structure into the design of a post-2012 adaptation regime.

6.2.3 Outreach and engagement

The pervasive consequences of a changing global climate, and the need for adaptation efforts to be integrated into a wide range of activities, means that

36 The nine areas in which the NWP is carrying out activities are: methods and tools; data and observations; climate modelling; scenarios and downscaling; climate related risks and extreme events; socio-economic information; adaptation planning and practices; and economic diversification.

adaptation (like mitigation) must be understood and incorporated into the decision-making practices of numerous stakeholders. The UNFCCC Secretariat has a role to play in reaching out to other constituencies, to act as an “extension agent” on climate change and adaptation. It needs to engage communities of practice outside the climate change community to increase their awareness and provide access to the ideas and information required to engage in adaptation activities. This includes linking to other UN and multi-lateral processes, such as the Conventions on Biodiversity and Desertification, but also to the UN Security Council and the World Trade Organization—building upon past efforts. As well, it means reaching out more strongly to other critical constituencies, like the World Business Council for Sustainable Development, the World Mayors Council on Climate Change, the International Energy Agency, and numerous development NGOs. In particular, there is a need to enhance engagement with the private sector, to ensure that they are well-informed of potential adaptation strategies and approaches.

6.2.4 Comparison to the Bali Action Plan

Under the Bali Action Plan, the international community has set a framework for negotiations around increasing international cooperation to support implementation of adaptation actions; risk management and risk reduction strategies; disaster reduction strategies; economic diversification; and ways to strengthen the catalytic role of the Convention. Under the call for urgent implementation of adaptation actions, the Plan specifically identifies support for “...vulnerability assessments, prioritization of actions, financial needs assessments, capacity-building and response strategies, integration of adaptation actions into sectoral and national planning, specific projects and programmes, means to incentivize the implementation of adaptation actions, and other ways to enable climate-resilient development and reduce vulnerability of all Parties...” Along with the need for risk management and risk reduction strategies, the actions identified support for measures that facilitate (rather than implement) adaptation to climate change. As well, although not explicitly stated, the measures appear to favour actions undertaken at the national level. An interesting absence from the list is specific reference to support for community-based adaptation, although this could be included under support for specific projects and programs.

Particularly with respect to the final three action items it identifies, the Plan also reflects recognition of the need for the UNFCCC to collaborate with other actors. Clause (iii) on disaster reduction strategies, particularly in referring to the need to identify “means to address loss and damage associated with climate change impacts”³⁷ in vulnerable developing countries, suggests a desire for

37 The inclusion of specific reference to “climate change impacts” in this context could be problematic given the inherent difficulty of differentiating between disasters caused by climate change as opposed to those that could be due to normal climate variability.

collaboration with the disaster risk reduction community. As well, “economic diversification to build resilience” implies a strong linkage to actions undertaken in the context of traditional development efforts. As well, the Bali Action Plan reiterates the catalytic role of the UNFCCC in providing support to all countries in sharing knowledge, tools and best practices, and in undertaking outreach and engagement with various constituencies inside and outside of the UN system. As such, the Plan reflects the proposed roles for the UNFCCC identified above.

6.3 Possible role of other actors

Alongside the UNFCCC, numerous other actors will also need to support adaptation efforts if the vast array of needs and circumstances globally are to be effectively addressed. An inclusive approach is required in large part because of the recognized appropriateness of taking an integrated approach to adaptation. It also provides an opportunity to leverage existing financial flows to help finance adaptation to climate change.

The need to engage others also stems from the intimate link between adaptation and development. This link implies that the most effective way to build adaptive capacity is to address the underlying factors that increase vulnerability to climate change. These factors include weak institutions and governance structures, poorly developed internal and external markets, overburdened health systems, and unsustainable use of ecosystems. In the absence of good development practices, it is unlikely that adaptation efforts will be successful.

Consequently, actors that have a strong influence over development processes and are best placed to reach the local level must be actively engaged in facilitating and implementing adaptation efforts. These actors include other UN agencies, development assistance agencies, international financial institutions, multilaterals like the OECD, the WTO and NATO, the private sector, local or municipal governments, development NGOs, community-based organizations (CBOs) and national governments. These organizations need to integrate adaptation considerations into their policies, programs and projects, and deliver support to specific areas reflective of their individual mandates, assets and capacities.

6.3.1 Agencies of the United Nations

Agencies such as UNDP, UNEP, UNITAR, UNHCR, WHO and the FAO, as well as development assistance agencies and international financial institutions (IFIs), primarily have a role to play in facilitating knowledge development/information provision and the implementation of on-the-ground adaptation efforts. By integrating the need to adapt to climate change into their individual mandates, UN Agencies and IFIs could enhance existing efforts to (for example):

- build international and national understanding of the projected impacts of climate change and developing the capacity in developing countries to

monitor and project climatic changes (e.g., UNEP, World Meteorological Organization);

- undertake research and build knowledge within specific communities of practice, such as health, forestry, fisheries, and agriculture;
- bring the international community together in negotiations to build peace and prevent conflict (e.g., UN Security Council);
- develop and promote the use of innovative financial mechanisms that help reduce the vulnerability of the private sector and the poor to the impacts of climate change (e.g., the World Bank, UNEP-FI);
- promote disaster prevention and emergency preparedness (e.g., the UN Office for the Coordination of Humanitarian Affairs—OCHA); and
- facilitate information sharing, such as through the Adaptation Learning Mechanism³⁸ being developed by UNDP.

In undertaking all of these actions, careful attention will need to be given to coordination of efforts to ensure that actions complement and do not overlap too significantly with those being undertaken by the UNFCCC and actors outside the UN process.

6.3.2 Development assistance organizations

Through their provision of ODA, development assistance organizations have a strong role to play in helping developing countries create the enabling environment necessary at the national and local level to facilitate adaptation to climate change. While the UNFCCC focuses its attention on building capacity within climate change (and/or adaptation) focal points and encourages integration of adaptation across policy processes, the success of these efforts will depend in large measure on broader governance capacity.

Moreover, donors, development NGOs and the private sector are more likely to provide financial assistance for adaptation if there is confidence that the funds provided will be used efficiently and effectively. This requires ensuring the presence of effective institutions and mechanisms for delivering financial resources; equitable and open governance structures; and sufficient capacity to effectively use the funds received (Kantha *et al.*, 2006). Development assistance organizations can help to create the circumstances needed for effective policy implementation, rapid response in times of emergency, and efficient use of financial resources.

Along side these activities, development assistance organizations have a critical role to play in funding on-the-ground projects that reduce vulnerability to

38 The Adaptation Learning Mechanism is intended to foster collaborative learning through the establishment of an open-source knowledge network. This knowledge is intended to encourage incorporation of adaptation into planning as well as promote best practices (GEF, 2005).

current climate variability and long-term climate change (as do some UN organizations, like UNDP and FAO). The development of national adaptation plans and strategies (with the assistance of the UNFCCC) can assist these organizations in working with national governments to direct support to priority areas of need.

6.3.3 Private sector

Engagement of the private sector in adaptation efforts is particularly needed to mobilize the resources needed to, for example, develop the tools and technologies needed for adaptation; provide insurance and develop risk transfer mechanisms; and ensure that infrastructure investments are climate-proofed. Building adaptation considerations into the sizable financial resources controlled by the private sector should help address the adaptation financing gap, particularly in developed countries. However, engaging the private sector on these issues is challenging due to concerns about competitiveness and intellectual property rights (UNFCCC, 2007c). Negotiations on the future of the adaptation regime will need to identify means to overcome these challenges and assist the private sector in becoming a positive force in adapting to the adverse effects of climate change. It has been suggested, for instance, that a business charter on adaptation be established to encourage the private sector to highlight good practices in integration adaptation into their operations (UNFCCC, 2007f).

6.3.4 Non-governmental organization, community-based organizations and local governments

It can be expected that direct implementation of adaptation measures will largely be undertaken by development NGOs, CBOs and local governments. Development NGOs and CBOs already work directly with rural farmers to provide training on the use of drought-tolerant seeds, erosion control structures and water conservation strategies; with refugees to assist in their resettlement; with victims of disasters in rehabilitation activities, etc. A number of these organizations are beginning to actively incorporate adaptation concerns into their planning and project implementation—efforts that need to be ramped up in the near future if the growing impacts of climate change are to be addressed.

Local governments also need to be supported in their efforts to prepare for climate change. They need to engage in urban planning and infrastructure development in a manner that enhances resilience to climate change. They also need to address the social consequences of climate change, such as changing economic opportunities, the arrival of new immigrants, and modification of health risks. To successfully take on this responsibility, local governments need access to information, tools and technologies in order to bring adaptation considerations into their day-to-day planning and activities. They, like development NGOs and CBOs, also need better access to the financial resources needed to take on the additional costs associated with adapting to climate change.

A key issue for the design of a post-2012 adaptation regime will be determining how best to reach out to and incorporate these other actors into the system. When enhancing coordination and collaboration between these different communities of practice, attention will need to be given to overcoming different approaches and understandings, and ensuring that varying strengths of these different groups are optimized.³⁹ With respect to the latter, it would be helpful to undertake a comprehensive and realistic assessment of the strengths of the UNFCCC in comparison to priority adaptation needs, and then determine whether the UNFCCC or other actors are best placed to meet these needs. Greater opportunity also needs to be provided for other actors to participate directly in adaptation decision-making at the international level, access information tailored to their needs, and tap into financial resources. A possible model that might be pursued to fulfill these objectives is outlined in the following section.

7.0 Reflections on a way forward

Global understanding of how to effectively respond to the complex socio-economic and ecological impacts that will result from climate change is growing. More ideas are being put forward regarding the interaction between adaptation and development; how to put appropriate knowledge, capacity, tools and technology into the right hands; how to generate the financial resources required for effective adaptation; the mechanisms by which these funds could be delivered; and the types of concrete interventions required. The agreement reached in 2009 on the future of the international climate regime will need to build upon these ideas while also addressing gaps in understanding and enabling a significant scaling up of adaptation funding and implementation.

Within this final section, some initial ideas are put forward regarding the possible design of the adaptation regime that could emerge out of the negotiations of the Ad Hoc Working Group on Long-term Cooperative Action. An assessment is also made of how such a regime could complement Canadian interests. The chapter concludes by identifying potential actions Canada could take internationally and domestically to enable it to engage more effectively and influentially in the forthcoming negotiations. These ideas are put forward to stimulate discussion; greater dialogue with Canadian stakeholders is needed to shape a national approach to this important issue.

39 For example, development practitioners use risk assessments to gauge the extent to which climate risks should be integrated into projects. Disaster management specialists, on the other hand, use needs assessments as a starting point. Adaptation work under the UNFCCC also has taken a more “needs assessment” approach (O’Brien *et al.*, 2006).

7.1 Possible design of a post-2012 adaptation regime

In putting forward the following ideas, it is assumed that the negotiation of the future adaptation regime will continue to take place under the auspices of the UNFCCC, in conjunction with and integrated into discussions regarding mitigation, technology development and transfer, and financing and investment. It is recognized, however, that particular components of this regime will need to be negotiated outside the UNFCCC process. The involvement of multiple venues for agreement reflects in part the multi-dimensional nature of climate change impacts and the need for an integrated approach. It also assists in overcoming some of the limitations imposed by the UNFCCC itself related to financing adaptation—such as the need to provide new and additional financial resources when vulnerability reduction efforts are so intimately connected to traditional development activities.

It is also assumed that development of a future adaptation regime will be guided in large part by the following principles: recognition of Annex I Parties' obligation to assist developing countries, particularly the LDCs and SIDS, in their efforts to adapt to the impacts of climate change; seeks to be cost effective; facilitates integration of adaptation considerations into decision-making across sectors and jurisdictions; and favours the expedient emergence of an international agreement. It is also assumed that any agreement will need to be politically acceptable to both developed and developing country Parties.

Given these parameters, it is suggested that the future adaptation regime consist of three main components as described below: a continued, defined role for the UNFCCC in facilitating adaptation; introduction of a Climate-wise Development agreement negotiated outside but complementary to the UNFCCC; and establishment of a consolidated adaptation fund that is supported by innovative financing mechanisms. In general, the proposed adaptation regime will assist Canada in meeting its objectives. It continues to place the UNFCCC at the centre of international efforts to support climate change adaptation; supports action through multiple venues; retains opportunities to develop and share knowledge, tools and technologies; and aims to provide financial assistance to developing countries in a cost-effective manner while meeting obligations under the UNFCCC.

7.1.1 Role of the UNFCCC

As described in Section 6, it is suggested that the UNFCCC continue to play a primarily facilitative role with respect to its support for adaptation by developed and developing countries. As such, the UNFCCC's assistance to developing countries could focus on supporting the development of national adaptation strategies; strengthening national climate change focal points; enhancing the capacity of developing countries to develop and exchange the scientific and socio-economic knowledge needed to prepare for climate change; and implementation of priority adaptation projects by vulnerable countries. With

respect to the latter, the UNFCCC could concentrate its efforts on financing measures that clearly are linked to the impacts of climate change—i.e., measures along the continuum of adaptation activities (see Box 1) that have a strong impacts focus such as management of coral reefs in response to widespread coral bleaching or addressing salt water intrusion of wells caused by sea level rise (McGray *et al.*, 2007).

The UNFCCC also has a strong role to play in bringing together developed and developing countries, along with stakeholders from a cross-section of interests (e.g., finance, development, trade, disasters, cities), to share successes, overcome barriers and identify gaps in knowledge and capacity. The unfolding Nairobi Work Programme provides a useful model for how the UNFCCC could enable such a mutual learning process to continue to take place. Lessons learned through implementation of this program should be used to guide the development of the UNFCCC's future role as a key knowledge broker.

The knowledge gathered through the NWP also should contribute to the UNFCCC taking on a larger extension role—to taking the lead in catalyzing dialogue between various constituencies inside and outside of the UN system, raising their awareness of the impacts of climate change, best practices and the tools and techniques needed to implement practical adaptation measures. These actions could be undertaken in partnership with national focal points, UN agencies and multilateral associations such as those that bring together business and municipal leaders.

In a post-2012 adaptation regime, consideration could therefore be given to establishing a permanent body under the UNFCCC responsible for (a) facilitating the exchange of knowledge and ideas regarding adaptation between multiple stakeholders through workshops, Web-based communication mechanisms, targeted publications, etc.; and (b) providing recommendations to Parties regarding key gaps in research and the implementation of adaptation measures. As has been suggested by others, such a body could be led by a cross-sectoral panel of adaptation experts (e.g., Burton *et al.*, 2006; IISD, 2007c).

To fulfil these roles, the UNFCCC will require predictable and increased funding. Provision of these funds could be provided on an annual, mandatory basis by Annex II Parties. Such a mandatory contribution could be tied to a particular marker (e.g., current levels of GDP) or a negotiated agreement between donors (as is done to replenish the GEF).

The proposed role of the UNFCCC is consistent with Canada's expected interests. Prominence is given to the UNFCCC primarily playing a facilitative role and to the continuation of something similar to the Nairobi Work Program—enabling the sharing of knowledge and ideas, promotion of tools and technologies, and identification of gaps that could be addressed through action at the national or international level. It recognizes that both developed and developing countries have a strong need to prepare for and respond to climate change.

7.1.2 Climate-wise Development Agreement

Reflecting the intimate link between development and adaptation, and recognizing that in the absence of good development practices it is unlikely that adaptation efforts will be successful, it is suggested that an international agreement be negotiated outside the auspices of the UNFCCC (such as through the OECD) that will lead to the establishment of a “Climate-wise Development Agreement.” Although it is anticipated that this agreement would primarily be between current Annex II Parties, it is suggested that participation also include newer members of the OECD⁴⁰ and emerging leaders like China and India. These countries are, or will be, increasingly involved in the provision of development assistance to lesser developed countries.

The suggested establishment of Climate-wise Development Agreement builds upon the *Orchestra of Treaties Proposal*⁴¹ put forward by Sugiyama and Sinton (2004). Within this proposal, Sugiyama and Sinton suggest that a Climate-wise Development Treaty be established that commits participants to revising their development assistance policies and practices to ensure that they support adaptation to climate change (as well as climate-friendly development and the transfer of technologies). Such an approach could be seen as an option for increasing the binding nature of the 2006 OECD-DAC commitment to integrating climate change into development planning and assistance. Here it is suggested that a less formal agreement, rather than a treaty, be pursued in the interest of timeliness. A multilateral treaty, as a binding formal agreement, normally requires formal ratification by a specified number of governments before it can come into effect.⁴² This process likely would take considerably longer than an agreement between countries and is less likely to secure participation by key countries, such as the United States.

A Climate-wise Development Agreement could be structured on a “pledge and review” basis with explicit commitments being made with respect to (a) actions that integrate adaptation considerations into development assistance and (b) increased levels of development finance. With respect to action pledges, national governments could explicitly state how they are or intend to support adaptation by developing countries through their development assistance—such as how they are or plan to integrate climate change considerations into their development planning, processes and projects, and develop the knowledge, strategies and tools needed to achieve this objective. Action pledges

40 These countries are: Czech Republic, Hungary, Korea, Mexico, Poland, and the Slovak Republic.

41 Sugiyama and Sinton’s *Orchestra of Treaties Proposal* includes three components established outside the UNFCCC: a Group of Emission Markets; Zero Emission Technology Treaty; and a Climate-wise Development Treaty. The UNFCCC would serve as a venue for exchanging information, providing funding and act as a political focal point.

42 Source: Encyclopaedia Britannica.com. Accessed at: <<http://www.britannica.com/eb/article-9073266/treaty>>.

could also indicate particular bilateral or multilateral programs or funds that will be supported; how countries are responding to knowledge gained through the NWP and recommendations from the COP; and priorities identified by developing country partners through their NAPAs and national adaptation strategies.

In terms of financial pledges, a minimum target should be to contribute 0.7 per cent of Gross National Income (GNI) by 2015, as already achieved or pledged by several EU countries.⁴³ Concern has been expressed, though, that these targets will not be achieved.⁴⁴ Reflecting the urgency of the need for increased financial assistance with adaptation and its connection with addressing the drivers of vulnerability, a stronger commitment to meeting and exceeding these targets should be required.

The establishment of a Climate-wise Development Agreement recognizes that at its most basic level, as illustrated in Box 1, vulnerability reduction is functionally equivalent to sustainable development, and as such the provision of significantly more, and climate-proof, ODA is an essential part of adaptation to climate change. It also could help provide a concrete and transparent demonstration of developed countries' commitment to assisting developing countries in their efforts to adaptation to climate change.

For Canada, while interest might be expressed in the idea of a Climate-wise Development Agreement, acceptance of its proposed financial targets could be problematic. In 2005, the government agreed to increase its provision of ODA by 12–15 per cent annually with the objective of providing 0.5 per cent of GNI by 2010 and 0.7 per cent by 2015 (Pistor, 2007). Meeting this target requires a significant increase from current ODA levels. In 2006, Canada provided 0.29 per cent of its GNI to ODA (OECD, 2007). Moreover, it is forecasted that Canada's contribution will reach 0.33 per cent in 2006–07 and 0.32 per cent in 2007–08 (Pistor, 2007). In addition, the “climate proofing” emphasis of proposed agreement could be challenging given the limited progress Canada, through CIDA, has made in terms of integrating climate change considerations into its development assistance policies, programming and projects.

7.1.3 Consolidated fund for adaptation

As a third component of a post-2012 adaptation regime, it is suggested that a consolidated fund for adaptation be established. This fund would provide a

43 At the June 2005 meeting of the Group of Eight, France and the United Kingdom announced that they would reach their 0.7 per cent of ODA/GNI targets by 2012 and 2013 respectively; that the EU would reach its target by 2012 with an interim target of 0.56 per cent by 2012; that Germany and Italy would also reach their 0.7 per cent of ODA/GNI by 2012 (U.K. Treasury, 2005). Norway, Denmark, Sweden, the Netherlands and Luxembourg already allocate 0.7 per cent of their GNI to development assistance (OECD, 2007).

44 Oxfam International estimates that donor countries will fall US\$30 billion short of their 2015 targets (Oxfam, 2007a).

large, flexible, single window accessible to various stakeholders (national, sub-national and municipal governments, development NGOs, private sector entities, research organizations, etc.) from developing and developed countries. Financing provided through this fund could be directed primarily towards measures that increase capacity to respond to climate variability and climate change. Such a fund could focus its attention on building response capacity and improving management of climate-related risks (as reflected in Box 2).

A consolidated fund for adaptation could be established under the direction of the UNFCCC, potentially through an expansion of the existing Adaptation Fund; it also could incorporate the LDCF and the adaptation component of the SCCF. Alternatively, a consolidated fund could be established outside of the UNFCCC, which might enhance its flexibility with respect to the types of activities it could support and increase opportunities for collaboration with the development and disaster communities. If established outside of the UNFCCC system, the fund could, for example, increase flexibility with respect to financing activities viewed as being more consistent with traditional development efforts; direct financing towards disaster relief and rehabilitation efforts;⁴⁵ and diversify the recipients of financial support to include vulnerable populations in developed countries. In determining the design of such a fund, a review of lessons learned thus far in the operation and management of the LDCF, SCCF and Adaptation Fund, as well as other large funds delivered by the UN and others (such as the Bill and Melinda Gates Foundation), could provide guidance.

Whether established inside or outside of the UNFCCC, it is assumed that a consolidated fund for adaptation would be supported through the use of innovative financing mechanisms, such as those described in Chapter 5. This reliance on innovative financing mechanisms reflects an expectation that the billions of new dollars needed annually to support adaptation to climate change in developing countries cannot come solely from national budgets—reflecting the political challenge of allocating tax dollars away from domestic needs to assist other countries (Müller, 2006). Provision of financing through these innovative financing mechanisms would likely require addressing private sector concerns and the issue of burden sharing between donor countries.

The degree to which Canada might support the establishment of a consolidated fund for adaptation is difficult to assess given its current general design. Canada's support for its establishment will likely depend on the degree to which the government becomes more accepting of innovative financing mechanisms; the fund's positioning inside or outside of the UNFCCC system, with the latter likely to be favoured; the type of activities that it supports; and the design of its management structure.

45 For example, funds collected in the consolidated fund for adaptation could be directed towards supporting OCHA's Central Emergency Response Fund or the IMF's Exogenous Shocks Facility.

7.2 Canadian actions

The Bali Action Plan sets forth what will likely be a demanding series of negotiations leading up to COP-15 in Copenhagen. Decisions regarding how adaptation is addressed in the future climate regime will be critical not just in their own right but also in terms of their potential to influence agreement on how to significantly reduce greenhouse gas emissions. To help ensure that Canada is able to influentially participate in the development of an international adaptation regime, a number of actions could be taken in the short term—both on the international stage and domestically.

7.2.1 Canada on the international stage

To be fully effective, concerns related to climate change adaptation need to be placed in a broader policy context—to be integrated into discussions related to security and trade, for example, in addition to those related to development assistance. Through its involvement with various multilateral fora, Canada could work to increase awareness of the implications of climate change, champion an integrated approach, and promote collaboration at the global, regional and national levels.

Canada needs to continue to engage with international partners in strengthening scientific understanding of the projected physical and socio-economic impacts of climate change through its involvement with the IPCC, International Human Dimensions Program, Geosphere-Biosphere Program, etc. Canadians also could become more actively engaged in the NWP, such as by bringing together leading researchers active in the Program's various themes to share lessons learned and develop common inputs into the international process.

Actions in the areas of international diplomacy and security also need to be pursued. The April 2007 debate on climate change within the United Nations Security Council and the awarding of the 2007 Nobel Peace Prize to Al Gore and the IPCC illustrate the growing international concern about the links between climate change and security. As changing climatic conditions aggravate existing levels of environmental degradation, accelerate resource scarcity and drive distress migration, an increase in crime, social unrest and potentially open conflict could take place. In light of these expectations, a greater appreciation of the security implications of climate change could be integrated into Canada's existing work with key international bodies such as the UN Security Council, the Arctic Council, the UN High Commission for Refugees and the North Atlantic Treaty Organization.

Furthermore, consideration of adaptation linkages might be brought into international trade discussions, such as those under the World Trade Organization. In this context, Canada could explore the particular avenues through which vulnerability reduction efforts could be brought into the international trade regime. Attention could be given to implications of tariff and

non-tariff barriers, intellectual property, and the regulation of finance and investment for the adaptive capacity of developing countries (South Centre, 2007). As a starting point, greater effort could be made to resolve the current impasse in negotiations related to the Doha Development Agenda. Achievement of a resolution that provides developing countries with clear development gains would improve their economic well-being, and in turn reduce their vulnerability to climate change (Drexhage, 2007).

Increased linkages are also needed with the international disaster community, such as through the Hyogo Framework for Action. The Framework supports integration of disaster reduction and climate change adaptation policies (Kok *et al.*, 2006) and has created impetus for international organizations and others to pay greater attention to building resilience and preventing disasters. The Secretariat of the UN International Strategy for Disaster Reduction and the Red Cross/Red Crescent Centre on Climate Change and Disaster Preparedness are strong advocates of greater integration of climate change risks into the work of the disaster preparedness community. Greater cooperation with these organizations on climate risk reduction would build upon Canada's existing commitments to the international disaster community.

Finally, Canada could work with member countries of The Commonwealth and the Organisation internationale de la Francophonie to build capacity and share tools and knowledge with other members of these organizations.

7.2.2 Domestic actions

In conjunction with efforts at the international level, there are a variety of actions that Canada could undertake at home to increase its ability to play an effective role in addressing adaptation on the international stage. These relate to the development of strategies, tools and technologies to be shared with others, as well as support for adaptation by developing countries.

Canada needs to strengthen its own capacity to respond to climate change—primarily to ensure that it is able to address the impacts of climate change that will be felt within its own borders but also to effectively demonstrate to the international community that Canada sees adaptation as a critical issue. Greater effort should be made to determining an intergovernmental approach to enabling and undertaking adaptation efforts. Decisions need to be made with respect to the role of the federal government in facilitating and implementing adaptation in comparison to other jurisdictions; and to identifying where cooperation between jurisdictions would be advantageous and how this can best be achieved. Canada's approach to adaptation should ensure capacity to identify risks and opportunities at an early stage; promote the development of effective response strategies; and build the capacity of Canadian governments and other stakeholders to prepare for and respond effectively to the impacts of climate change. It also should promote and coordinate the development of processes, tools and technologies for domestic use and international export, creating new economic

opportunities for Canadians. Facilitating greater effort in Canada to prepare for the impacts of climate change also affords an opportunity to gain experience and develop best practices that could be shared with other countries facing similar climate risks (like mountainous, coastal, semi-arid and Arctic areas).

Canada could also make a stronger and more transparent commitment to assisting developing countries in their adaptation efforts. Within CIDA, attention to climate change concerns needs to be substantially increased. CIDA's efforts could include strongly incorporating climate change considerations into an updated environment policy for the Agency;⁴⁶ integration of vulnerability reduction efforts into development plans, strategies and projects; and development of in-house tools to assist development officers in integrating adaptation into these plans, strategies and projects. Reflecting the increasingly recipient-country driven nature of development assistance, CIDA could also work with its partners in developing country governments to ensure that climate change is integrated into documents such as Poverty Reduction Strategy Papers and budgetary support for agriculture, health and local governance. Lack of understanding in key ministries (e.g., Finance) regarding the implications of climate change means that adaptation issues are not often identified as a concern in these development planning processes (Ulsrud and Eriksen, 2006). In undertaking these actions, lessons should be derived from the experience of other, leading development assistance agencies.⁴⁷

Furthermore, CIDA could take advantage of its close working relationships with Canadian development and disaster-relief NGOs and foster a dialogue between the development, disaster and climate communities within Canada. This dialogue could be undertaken in partnership with the emerging Canadian Coalition for Climate Change and Development. Improved dialogue between these communities could help Canada contribute constructively to similar discussions at the international level.

A stronger commitment by Canada will also need to be made to the provision of increased funding for development assistance, particularly in countries highly vulnerable to the impacts of climate change. Canada should ensure that it at least meets—if not exceeds—its commitment to providing 0.7 per cent of GNI as ODA by 2015. Complementing Canada's \$7.5 million contribution to the SCCF announced during COP-13, increased support could be given to the

46 CIDA's current policy for the promotion of environmental sustainability was introduced in 1992. An update of this strategy was developed for use within CIDA in 2006 (CIDA representative, personal communication, October 2007).

47 For example, the U.K. Department for International Development, a leader on integrating climate risks into its development planning, now gives a high priority to reducing vulnerability to disasters and climate change. The Danish Development Agency has also initiated a program to address climate risks to their development projects, while the World Bank has also been experimenting with managing climate change risks in some of its projects and programs (Klein *et al.*, 2007).

LDCF to enable implementation of activities identified in the increasing number of completed NAPAs; and to the Adaptation Fund (particularly in light of the limited contributions expected to be provided by Canadian firms due to a limit on the use of CERs for compliance under the proposed emissions trading regulation). Canada also could explore the potential for engaging in innovative financing mechanisms to augment its financing for adaptation. For instance, should Canada introduce a carbon tax, a portion of the finances raised could be allocated to support adaptation in developing countries.

Consideration also needs to be given to the development of innovative ways to work with the Canadian private sector to raise its awareness of the implications of climate change for its operations, and support efforts to reduce its exposure to these impacts when investing in developing countries. Significant financial resources are directed from Canada to developing countries through foreign direct investment and export crediting agencies.⁴⁸ Integration of adaptation considerations into the investment screening processes used by financial lenders, insurance companies and export crediting agencies could be an effective risk management strategy for Canadian companies and for recipient countries.

Finally, the Canadian government could play a role in informing Canadians about the implications of climate change for developing countries, and Canada's potential role in assisting them in coping with projected impacts. In time, Canada will need to rationalize domestically the need to provide greater financial resources to developing countries. Outreach now could lay the foundations for greater public support for this effort.

Canada has a long standing, positive reputation for its commitment to multi-lateral processes and diplomacy. It has played a prominent role historically in bringing adaptation concerns into the international process, most notably with respect to the establishment of the LDCF. As well, the substantial changes to Canada's landscapes, economic systems and social relationships that are projected to occur as a result of climate change mean that it has a deep, personal stake in ensuring the successful creation of a supportive international adaptation regime. By acting now, Canada can establish itself as an influential leader in shaping the future of this regime and help to bring negotiations under the Bali Action Plan to a successful conclusion.

48 Export crediting agencies provide approximately \$70 billion in annual funding for developing countries to buy goods and services—almost five times the financing provided by the World Bank Group (WRI, 2005).

Annex 1: Estimated status of funding for adaptation under the current climate regime

Name of the Fund	Funding source	Total funds mobilized (US\$)	Operational criteria	Main activities of support
I. Funds established under the Convention (Articles 4.1, 4.3, 4.4, 4.5, 4.8, and 4.9)				
(a) Special Climate Change Fund (SCCF)	Voluntary contributions from 13 developed countries (Canada, Denmark, Finland, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom)	US\$70.0 M ⁴⁹ (Pledges Outstanding: 2.4 M Paid: 59.8 M Unpaid: 7.8 M) as of September 30, 2007	<ul style="list-style-type: none"> • Additional cost of adaptation measures • Sliding scale for co-financing 	<ul style="list-style-type: none"> • Addresses adaptation as one of the four funding priorities
(b) Least Developed Countries Fund (LDC Fund)	Voluntary contributions from 18 developed countries (Australia, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom) as of September 30, 2007)	US\$163.3 M ⁵⁰ (Pledges Outstanding: 59.5 M Paid: 67.3 M Unpaid: 36.5 M) as of September 30, 2007	<ul style="list-style-type: none"> • Guiding principles: country-driven approach, equitable access by LDCs, expedited support and prioritization of activities • Provision of full cost funding for adaptation increment as identified and prioritized in NAPAs • Sliding scale for co-financing 	<ul style="list-style-type: none"> • Implementation of NAPAs (all projects for the preparation of NAPAs in 44 countries approved with a budget of US\$9.6 M)
II. Fund established under the Kyoto Protocol (Article 4.10)				
(a) Adaptation Fund	2% Share of proceeds from CDM	Not yet operational – projected to levy between US\$160 M and US\$190 M until 2012 ⁵¹ (The World Bank estimates that the financing is likely to total between US\$100 M and US\$500 M until 2012 ⁵²)	<ul style="list-style-type: none"> • Guiding principles: country-driven and a “learning-by-doing” approach, sound financial management and transparency, separation from other funding sources 	<ul style="list-style-type: none"> • Concrete adaptation projects and programs identified in decision 5/CP7

49 GEF, 2007b.

50 *Ibid.*

51 Müller, 2007.

52 World Bank, 2006a.

Name of the Fund	Funding source	Total funds mobilized (US\$)	Operational criteria	Main activities of support
GEF-managed funds established in response to guidance from the COP				
(a) Global Environment Facility Trust Fund	GEF	US\$3.8 Billion ⁵³ (Funds available for Council Allocation: US\$503 M) as of September 30, 2007.	<ul style="list-style-type: none"> • Incremental cost to achieve global environmental benefits 	<ul style="list-style-type: none"> • Vulnerability and adaptation assessments as part of national communications and enabling activities
(b) Strategic Priority on Adaptation (SPA)	GEF	US\$50M initially allocated (approximately US\$23 M remaining as of July 2007) ⁵⁴	<ul style="list-style-type: none"> • Incremental cost guidance with some flexibility, especially for Small Grants Programme 	<ul style="list-style-type: none"> • Pilot and demonstration projects on adaptation • Small Grants Programme (\$5 M) to support community-based adaptation

53 GEF, 2007c.

54 GEF, 2007a.

Annex 2: Examples of existing proposals for addressing adaptation in a post-2012 climate regime

In response to the increased prominence of adaptation as an issue at the international level, a wide array of ideas have been put forward with respect to critical components of an adaptation regime—how to provide funding and how to build resilience and adaptive capacity among different groups, sectors and regions. However, few proposals put these ideas together into a coherent approach that lays out a potential way forward for supporting adaptation at the international level. Some of the more comprehensive proposals put forward to date are summarized below.

A. Sao Paulo Proposal. Put forward by the BASIC project, this detailed proposal builds upon to the current structure of the Kyoto Protocol. It suggests addressing adaptation through a three-pronged approach that would consist of:

- establishing a permanent Adaptation Committee of Experts to provide advice to bodies under the UNFCCC; act as a linkage between the Protocol and international and national bodies focused on development and disaster reduction; and undertake a review of progress every five years;
- a five-year pilot program, “Adaptation Activities Implemented Cooperatively” focused on immediate implementation of demonstration projects, programs and policies in order to facilitate rapid learning about adaptation best practices;
- a commitment by Parties to periodic review and revision of infrastructure and equipment design parameters and standards to ensure that they address climate change impact projections;
- adoption of a legal instrument by 2010 to manage risk and provide compensation for extreme weather events, such as an insurance or other risk transfer mechanism; and
- guidance on the use of vulnerability and adaptation tools and techniques to better target vulnerable human populations and natural ecosystems.

Funding for these efforts would be provided through the existing two per cent levy on Certified Emission Reduction credits; a similar levy on a new type of credits called Voluntary Emission Reduction units; auctioning of allowances for international bunker fuels; and a mandated funding provided by developed countries (BASIC, 2007).

B. Broadening the Climate Regime Proposal. In conjunction with a multi-stage mitigation regime, Torvanger *et al.* (2005) have suggested introducing an Adaptation Protocol. The Protocol would be designed to secure the

transfer of funds and technology to countries that are 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 low-emission development pathways while increasing their adaptive capacity.

Interest in the establishment of an Adaptation Protocol was also expressed in a recent survey of Asian perspectives on the content of a post-2012 climate regime. Participants recommended that such a protocol be based on the polluter pays principle linked to historical responsibility. Four possible components of an Adaptation Protocol were identified: “a policy framework for mainstreaming adaptation in development with specific targets; capacity building of various actors involved; mechanisms for financing adaptation efforts, and options for development, transfer and deployment of adaptation technologies” (Srinivasan, 2006).

C. North-South Dialogue Proposal. The principle adaptation-related elements of this proposal are: 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).

D. Global Framework Proposal. This proposal suggests that the future climate regime consist of 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. 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 enable countries to be involved in both the Adaptation Track and the Greening Track and, as appropriate, the Kyoto Track (CAN, 2003).

Annex 3: Description of Adaptation Needs

To support a significant scaling up of adaptation efforts, support in the following areas, along with others, will need to be provided:

- A. Scientific understanding.** Information gaps in the scientific knowledge base needed by decision-makers to prepare for climate change remain. For example, better data and modelling are needed to develop refined climate change projections at the regional, national and sub-national level (Agrawala, 2005). To support the gathering of this scientific knowledge, there is also a need to enhance monitoring capacity. Monitoring key indicators and their rate of change—such as changes in habitat, hydrologic conditions, disease vectors and sea level—will help managers identify potential vulnerabilities and assess adaptation options appropriately. Effective monitoring can also be used to determine the success of implemented adaptation measures.
- B. Governance.** Through the establishment of policies and legal frameworks, implementation of programs, and removal of barriers and perverse incentives, governments can play a critical role in building adaptive capacity. However, particularly in developing countries, weak institutional and governance structures are a key constraint on the planning and implementation of current development activities (Orindi and Eriksen, 2005). These existing constraints make addressing adaptation more challenging, particularly given its strong need for coordination between ministries, sectors and stakeholders engaged in climate change, development and disaster risk reduction.

As adaptation measures typically respond to local circumstances, stronger institutions and governance structures are also needed at the sub-national and local level. More autonomy and potentially increased and more predictable financing might be required by local governments to enable them to address immediate and longer term priorities (Orindi and Eriksen, 2005).

- C. Adaptation plans and strategies.** The development of adaptation plans and strategies at the national, sub-national, municipal and sectoral level is critical to facilitating a coordinated response to climate change impacts. They are needed to elaborate how priority concerns will be addressed, information needs will be met, and actions will be coordinated across ministries and sectors and between levels of government (Mitchell *et al.*, 2006; Srinivasan, 2006). Adaptation plans and strategies also provide a benchmark against which to measure progress in supporting adaptation to climate change.

However, few countries—developed or developing—have thus far prepared comprehensive national adaptation strategies⁵⁵ (Gagnon-Lebrun and

55 A survey of National Communications submitted by Asian countries, for example, found that little attention was given to adaptation policies and measures, and mostly focused on projected biophysical impacts (Srinivasan, 2006).

Agrawala, 2006; Srinivasan, 2006). Adaptation planning at the sub-national, municipal and sectoral level is also limited. The 21 LDCs⁵⁶ that have completed development of their NAPAs provide useful insight into this process.

- D. Community-based adaptation.** Adaptation to climate change will primarily take place at the local level—by communities, businesses, municipal governments and other actors working independently and collaboratively to reduce their risk to climate change. A massive up-scaling in support for adaptation at the local level will be required in the near future if vulnerable communities are to cope with climate change impacts (Klein *et al.*, 2007).
- E. Education, public engagement and awareness.** To facilitate efforts that promote adaptation to climate change, understanding of the potential scale of the problem now and in the future and suitable response strategies is needed by decision-makers from those in the highest public offices to farmers working in their fields. The development of educational materials and communication vehicles will likely be an ongoing need.
- F. Tools.** Policy-makers, project implementers and other stakeholders require various information and tools to assist them in designing and implementing appropriate adaptation strategies. For example, tools are needed to: assess exposure to climate risks and prioritize responses (Agrawala, 2005); support adaptation in key sectors such as agriculture and coastal resource management (Srinivasan, 2006); undertake economic valuation of climate change impacts (OECD, 2005) and of the costs of adaptation at the sectoral and regional level (UNFCCC, 2007a); assess the cost, effectiveness and distributional impacts of integrating adaptation measures into development planning and across different sectors (Agrawala, 2005; Burton *et al.*, 2006); and monitor and evaluate adaptation actions (Kiminyi *et al.*, 2004; Willems, 2005). There is a need to mobilize existing tools so that they can be used in new circumstances or locations, and also the development of new tools.
- G. Technologies.** New, modified and existing technologies that support adaptation to climate change, including soft as well as hard technologies, also need to be developed, disseminated and deployed. Development of these technologies is challenging due to the ubiquitous need for adaptation across sectoral, geographical and political scales. Barriers to the sharing of appropriate technologies already available within developing countries need to be overcome (UNFCCC, 2006). The transfer of technologies for adaptation, compared to those for mitigation, also faces some unique barriers; successful transfer of these technologies depends more on the buy-in and involvement of an expanded stakeholder community; and financing for enabling the transfer of these technologies is more challenging to access (Klein *et al.*, 2005).

56 As of October 2007. See: <http://unfccc.int/adaptation/napas/items/2679.php>.

- H. Information sharing.** A broad cross-section of people and organizations will increasingly be seeking to integrate climate impact considerations into their projects, plans and policies. Providing these groups with the information they require is becoming increasingly important. For example, there is a need to increase access to and utilization of climate data (IISD, 2007c). The challenge is not only the compilation of this information but the development of mechanisms for delivering information in an understandable format that meets the target audiences' needs. Achieving this objective requires greater understanding of how information is already being used by different stakeholder groups (Orindi and Eriksen, 2005; Mitchell *et al.*, 2006). Better processes also are needed to disseminate appropriate information to as many people as possible.
- I. Natural resources management.** The future well-being of billions of people depends in part on how well key resources like water, agriculture, fisheries, forestry and coastal resources are managed in light of changing climatic conditions. Measures related to water supply such as that conserve its use, protect its quality and ensure its efficient distribution will increasingly be needed. As too will be soil conservation, habitat restoration and fire prevention measures; the development of resistant seeds and fast-growing trees; restoration of coral reefs and mangrove forests; and improvement of integrated management resources.
- J. Health.** As climate change progresses, the health status of millions of people are likely to be affected by (among other factors) increases in malnutrition; morbidity and mortality due to extreme weather events; and changes in the distribution of some infectious disease vectors. In response to this reconfiguration and intensification of risks to human health, improvements in health care and public health initiatives will be needed (IPCC, 2007b). These include strategies to control disease vectors; vaccination programs, monitoring of risk groups, health alert information systems, and raising awareness among medical personnel (UNFCCC, 2007a).
- K. Business.** A variety of economic enterprises will need to integrate consideration of climate change impacts into their day-to-day activities and long-term planning in order to reduce their risks and potentially identify new opportunities. To do so, they require greater understanding of how they could be affected by climate change and the processes, tools, technologies supportive policy environment to enable adaptation.
- L. Infrastructure.** Critical infrastructure such as transportation corridors, buildings, water supply structures, flood protection structures and communications and telecommunications systems could be adversely affected by climate change. Existing infrastructure will need to be either strengthened or replaced; and new infrastructure built in light of forecasted climatic conditions rather than historical norms.

M. Disaster and emergency preparedness. As the frequency and intensity of extreme weather events increases, the need for strong disaster and emergency preparedness systems grows. These systems need to be established in those regions where they are currently absent, and strengthened through the inclusion of climate change lens on their activities in those regions where they do exist.

N. Migration and resettlement. As agricultural productivity declines, rising seas consume low-lying lands and water resources become more scarce, people will increasingly migrate (legally and illegally) within and across national boundaries. Along with strategies to minimize the potential need for migration, there shall be a need to assist these new environmental refugees with settling in new locations. These resettlement efforts will need to be well planned to minimize the potential for conflict and adverse economic and environmental impacts.

O. Transboundary concerns. Greater coordination of data collection, monitoring and policies at the regional level are needed to support effective management of transboundary impacts (Agrawala, 2005). For example, as climate change increasingly influences the availability of water in critical rivers like the Nile, the Danube, the Mekong and the St. Lawrence, joint management of these systems becomes of greater importance to ensure equitable access and avoidance of conflicts.

References

- Aalst M., van and M. Helmer, 2004. *Preparedness for Climate Change*. The Hague: Red Cross/Red Crescent Climate Centre.
- Adger, W.N., S. Huq, K. Brown, D. Conway and M. Hulme, 2003. "Adaptation to climate change in the developing world." *Progress in Development Studies*. 3(3): 179–195.
- Adger, N.W., N.W. Arnell, E.L. Tompkins, 2005. "Successful Adaptation to Climate Change across Scales." *Global Environmental Change*. 15(2): 77–86.
- African Development Bank (AfDB), Asian Development Bank, Department for International Cooperation, United Kingdom, Directorate-General for Development, European Commission, Federal Ministry for Economic Cooperation and Development, Germany, Ministry of Foreign Affairs – Development Cooperation, The Netherlands, Organisation for Economic Co-operation and Development, United Nations Development Programme, United Nations Environment Programme and The World Bank, 2003. *Poverty and Climate Change: Reducing the Vulnerability of the Poor through Adaptation*. <[http://lnweb18.worldbank.org/ESSD/envext.nsf/46ByDocName/PovertyandClimateChangeReducingtheVulnerabilityofthePoorthroughAdaptation/\\$FILE/PovertyAndClimateChangeReportPart12003.pdf](http://lnweb18.worldbank.org/ESSD/envext.nsf/46ByDocName/PovertyandClimateChangeReducingtheVulnerabilityofthePoorthroughAdaptation/$FILE/PovertyAndClimateChangeReportPart12003.pdf)>.
- Agrawala, S., 2005. "Executive Summary." In S. Agrawala (ed.), *Bridge over Troubled Waters: Linking climate change and development*. Paris: OECD.
- Agrawala, S., 2004. Adaptation, Development Assistance and Planning: Challenges and Opportunities. *IDS Bulletin* 35(3): 50–54.
- Anisimov, O.A., D.G. Vaughan, T.V. Callaghan, C. Furgal, H. Marchant, T.D. Prowse, H. Vilhjálmsson and J.E. Walsh, 2007. "Polar regions (Arctic and Antarctic)." In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.), *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press. pp. 653–685.
- Bals, C., I. Burton, S. Butzengeiger, A. Dlugolecki, E. Gurenko, E. Hoekstra, P. Höppe, R. Kumar, J. Linnerooth-Bayer, R. Mechler and K. Warner, 2005. *Insurance related options for adaptation to climate change: Executive Summary*. The Munich Climate Insurance Initiative.
- BASIC Project, 2007. *The Sao Paulo Proposal for an Agreement on Future International Climate Policy*. Revised version, September 2007. Paper 17 of the BASIC project.

Bouwer, L.M., K. Dorland, J.C.J.H Aerts, and J. Gupta, 2004. Adaptation and funding in climate change policies. In Kok, M.T.J. and H.C. de Coninck (eds.), *Beyond Climate: Options for Broadening Climate Policy*. RIVM report 500019001 and NRP-CC report 500036/01.

Bruce, J. 2006. Personal communication.

Burton, I., E. Diringer and J. Smith, 2006. *Adaptation to Climate Change: International Policy Options*. Prepared for the Pew Center on Global Climate Change.

Burton, I. and M. van Aalst, 2004. *Look Before you Leap: A Risk Management Approach for Incorporating Climate Change Adaptation into World Bank Operations*. Washington, D.C.: World Bank.

Canadian Institute of Planners (CIP), 2007. Planning for climate change Web page. <http://www.cip-icu.ca/english/aboutplan/nrc_intro.htm>.

Canadian International Development Agency (CIDA), 2005. CCCDF Current projects and funding. Originally at: <http://www.acdi-cida.gc.ca/cida_ind.nsf/AllDocIds/D85A9049FB410B4885256D64004BF1F3?OpenDocument#emissions>; no longer available.

Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R.K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C.G. Menéndez, J. Räisänen, A. Rinke, A. Sarr and P. Whetton, 2007. Regional Climate Projections. In Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge and New York: Cambridge University Press.

Climate Action Network, 2003. *A Viable Global Framework for Preventing Dangerous Climate Change*. CAN Discussion Paper, COP-9, Milan, Italy, December 2003. <http://www.climateactionnetwork.org/docs/CAN-DP_Framework.pdf>.

Department for International Development, 2004. *Taking Initial Steps Towards Adaptation*. Paper #9. <<http://www2.dfid.gov.uk/pubs/files/climate-change/9initialsteps.pdf>>.

Danida, 2005. *Danish Climate and Development Action Programme*. Ministry of Foreign Affairs, Denmark.

Dessai, S., N.W. Adger, M. Hulme, J. Turnpenny, J. Köhler and R. Warren, 2003. "Defining and Experiencing Dangerous Climate Change." *Climatic Change* 64: 11–25.

- DFID, 2006. *Eliminating World Poverty: Making Governance Work for the Poor*. White Paper on International Development. London: Department for International Development. <<http://www.dfid.gov.uk/wp2006/>>.
- Drexhage, J., 2008. "Climate Change and Global Environmental Governance." in S. Bernstein, J. Bruneel, D.G. Duff and A.J. Green, *A Globally Integrated Climate Policy for Canada*, Toronto: University of Toronto Press.
- Easterling, W., B. Hurd and J. Smith, 2004. *Coping with Global Climate Change: The role of adaptation in the United States*. A report prepared for the Pew Center on Global Climate Change.
- Environment Canada, 1997. Canada Country Study: A window on climate change in Canada. <http://www.ec.gc.ca/Science/sandedec/article1_e.html>.
- European Commission (EC), 2003. *Climate Change in the Context of Development Cooperation*. European Commission, COM (2003) 85 (final).
- European Community, 2005. *Adaptation and sustainable development*. Supporting material for the presentation by Finland on behalf of the European Community and its Member States at the Seminar of Government Experts, Bonn, Germany, May 16–17, 2005.
- Field, C.B., L.D. Mortsch, M. Brklacich, D.L. Forbes, P. Kovacs, J.A. Patz, S.W. Running and M.J. Scott, 2007. "North America." In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.), *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press. pp. 617–652.
- Food and Agriculture Organization (FAO), 2004. *The State of Agricultural Commodity Markets 2004*. <<ftp://ftp.fao.org/docrep/fao/007/y5419e/y5419e00.pdf>>.
- Foreign Affairs and International Trade Canada (FAITC), 2007. *Canada and the World Conference on Disaster Preparedness*. Web page. <http://www.dfait.gc.ca/foreign_policy/human-rights_clf1/Canada_world_conference-en.asp>.
- Freeman, P.K., M. Keen, and M. Mani, 2003. "Being Prepared." *Finance and Development* 40(3).
- Gagnon-Lebrun, F. and S. Agrawala, 2006. Progress on *Adaptation to Climate Change in Developed Countries: An analysis of broad trends*. ENV/EPOC/GSP(2006)1/FINAL. Paris: OECD.
- Gigli, S. and S. Agrawala, 2007. *Stocktaking of Progress on Integrating Adaptation to Climate Change into Development Cooperation Activities*. Paris: OECD.

- Global Environment Facility, 2007a. *Focal Area Strategies and Strategic Programming for GEF-4*. July 25, 2007. <<http://www.gefcountrysupport.org/docs/200.pdf>>.
- GEF, 2007b. *Status support of the Climate Change Funds as of September 30, 2007*. GEF/LDCF.SCCF.3/Inf.2. November 9.
- GEF, 2007c. *Trustee Report*. GEF/C.32/Inf.3. October 20.
- GEF, 2006a. *Report of the GEF to the Twelfth Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change*. October 13.
- GEF, 2006b. *Status Report on the Climate Change Funds*. GEF/C.28/4/Rev.1. May 19.
- GEF, 2005. *Medium Sized Project Proposal: Adaptation Learning Mechanism: Learning by Doing*. <http://www.gefweb.org/Documents/Medium-Sized_Project_Proposals/MSP_Proposals/Global_-_Adaptation_Learning_Mechanism.pdf>.
- GEF, 2004. *GEF Assistance to Address Adaptation*. GEF/C.23/Inf.8/Rev.1.
- Germanwatch, 2005. *Insuring the Uninsurables. Preliminary thoughts regarding the basic structure of an insurance related mechanism (IRM)*. Internal report.
- Greene, W., 2004. "Aid fragmentation and proliferation: Can donors improve the delivery of climate finance?" *IDS Bulletin* 35(3): 66–75.
- Halifax Regional Municipalities (HRM), 2007. *Climate SMART: Be cool – reduce global warming & climate risks*. <<http://www.halifax.ca/Climate/index.html>>. Last accessed October 8, 2007.
- Heller, T. and P.R. Shukla, 2003. "Development and Climate: Engaging Developing Countries." In *Beyond Kyoto: Advancing the International Effort Against Climate Change*. 111–140. Prepared for the Pew Center on Global Climate Change.
- Huq, S. and I. Burton, 2003. "Funding Adaptation to Climate Change: What, who and how to fund?" *Sustainable Development Opinion*.
- Huq, S. and H. Reid, 2004. "Mainstreaming Adaptation in Development." *IDS Bulletin* 35(3): 15–21.
- IFC Consulting, 2005. *Third Overall Performance Study of the Global Environment Facility*. <http://thegef.org/MonitoringandEvaluation/MEPublications/MEPOPS/C.25.ME.4-OPS3_Executive_Version_Final_Draft.pdf>.

Intergovernmental Climate Change Impacts and Adaptation Working Group (ICCIAWG), 2005. *National Climate Change Adaptation Framework: Final Draft*. unpublished.

Intergovernmental Panel on Climate Change (IPCC), 2007a. "Summary for Policymakers." In Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge and New York: Cambridge University Press.

IPCC, 2007b. "Summary for Policymakers." In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.), *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press, pp. 7–22.

IPCC, 2007c. "Appendix 1: Glossary." In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.), *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press, pp. 869–883.

IPCC, 2001. *Climate Change 2001. Impacts, Adaptation and Vulnerability*. Chapters 10, 11, 17 and 18. Contribution of Working Group III to the Third Assessment Report of the IPCC.

International Federation of Red Cross and Red Crescent Societies (IFRC), 2002. *World Disaster Report 2002 – Focus on Reducing Risk*. Geneva: International Federation of Red Cross and Red Crescent Societies.

International Institute for Sustainable Development (IISD), 2007a. Summary of CRiSTAL. Available at: <http://www.iisd.org/pdf/2007/brochure_cristal.pdf>

IISD, 2007b. UNFCCC Workshop on Adaptation Planning and Practices under the Nairobi Work Programme: September 10–12, 2007. *Earth Negotiations Bulletin*. 12(340).

IISD, 2006b. *Earth Negotiations Bulletin*. 12(318). November 20.

IISD, 2004. *Earth Negotiations Bulletin*. 12(260). December 20.

International Monetary Fund (IMF), 2006. *The Exogenous Shocks Facility (ESF)*. International Monetary Fund Factsheet, August.

IMF, 2004. *The Fund's Support of Low-Income Member Countries: Considerations on Instruments and Financing*. prepared by the Finance and Policy Development and Review Departments, International Monetary Fund, Washington, D.C., February.

- Kartha, S, P. Bhandari, L. van Schaik, D. Cornland and B. Kjellén, 2006. *Adaptation as a Strategic Issue in the Climate Negotiations*. ECP Report No.3.
- Keough, N. and B. Smedley. 2004. *Canada Climate Change Development Fund Mid-Term Evaluation: Final Report* (Draft). Prepared for the Canadian International Development Agency. unpublished.
- Kimenyi, M.S., H. Nyangito and K. Kulindwa, 2004. *Mainstreaming environment into development planning*. A paper presented at the workshop Integrating Vulnerability and Adaptation to Climate Change into Sustainable Development Policy Planning and Implementation in Southern and Eastern Africa, Nairobi, Kenya, September 4. <http://www.unep.org/themes/climate-change/Focus_Areas/workshop.asp>
- Klein, R.T, W.W. Dougherty, M. Alam, and A. Rahman, 2005. *Technology to Understand and Manage Climate Risks*. Background Paper for the UNFCCC Seminar on the Development and Transfer of Environmentally Sound Technologies for Adaptation to Climate Change, Tobago, June 14–16.
- Klein, R.J.T., L.F. Schipper, and S. Dessai, 2005. *Integrating mitigation and adaptation into climate and development policy: three research questions*. 8 (6): 579–588.
- Klein, R.T., S.E.H. Eriksen, L. O. Næss, A. Hammill, T.M. Tanner, C. Robledo and K. L. O'Brien, 2007. "Portfolio Screening to Support the Mainstreaming of Adaptation to Climate Change into Development Assistance." *Climate Strategies*. forthcoming.
- Kok, M.T.J. and H.C. de Coninck (eds.), *Beyond Climate: Options for Broadening Climate Policy*. RIVM report 500019001 and NRP-CC report 500036/01.
- Kok, M.T.J., B. Metz, A. Verhagen and S.N.M. van Rooijen, 2006. *Integrated Development and Climate Policies: How to realize benefits at national and international level?* Policy Brief prepared for Development First conference, Paris, September 20–22.
- Lemmen, D. and F. Warren (eds). 2004. *Climate Change Impacts and Adaptation: A Canadian Perspective*. Ottawa: Natural Resources Canada.
- Linnerooth-Bayer, J., M.J. Mace and R. Verheyen, 2003. *Insurance Related Actions and Risk Assessment in the Context of the UNFCCC*. A background paper commissioned by the UNFCCC. <http://unfccc.int/files/meetings/workshops/other_meetings/application/pdf/background.pdf>.
- Mace M.J., 2005a. Funding for Adaptation to Climate Change: UNFCCC and GEF Developments since COP-7. *RECIEL* 14(3): 225–246.

- Mace, M.J., 2005b. *Issues of consideration in CAN Adaptation Strategy*. Background paper prepared for the CAN Adaptation Workshop, Montreal, Canada.
- Mace, M.J., 2003. *Adaptation under the UN Framework Convention on Climate Change: The legal framework*. Presented at “Justice in Adaptation in Climate Change,” University of East Anglia, September 7–9.
- Martin, M., H. Bargawi and A. Johnson, 2005. *Investigation into the International Architecture for Economic Shocks Financing*, Report to the U.K. Department for International Development, London.
- McGray, H., A. Hammill and R. Bradley, 2007. *Weathering the Storm: Options for framing adaptation and development*. Washington, D.C.: World Resources Institute Report.
- Mitchell, T., T. Tanner and E. Wilkinson, 2006. *Overcoming the Barriers: Mainstreaming climate change adaptation in developing countries*. R. Roach and S. Boyd (ed.). Tearfund Climate Change Briefing Paper 1.
- Möhner, A. and J. Klein, 2007. *The Global Environment Facility: Funding for adaptation or adapting to funds?* Climate Change and Energy Working Paper, Stockholm Environment Institute.
- Müller, B., 2007. Nairobi 2006: Trust and the future of adaptation funding. Oxford Institute for Energy Studies report EV 38.
- Müller, B., 2006. *Adaptation Funding and the World Bank Investment Framework Initiative*. Background Report prepared for the Gleneagles Dialogue Government Working Groups Mexico, June 7–9.
- Müller, B., 2002. *An FCCC Impact Response Instrument as part of a Balanced Global Climate Change Regime*. A paper presented at the IIED Special Event at FCCC SB 16, Bonn, June 11.
- Müller, B. and C. Hepburn, 2006. *IATAL: An outline proposal for an International Air Travel Adaptation Levy*. Oxford Institute for Energy Studies paper EV 36.
- Natural Resources Canada (NRCan), 2007. Climate Change Impacts and Adaptation Program Web site: <http://adaptation.nrcan.gc.ca/index_e.php>. Accessed October 8, 2007.
- O’Brien, K., R. Leichenko, U. Kelkar, H. Venema, G. Aandahl, H. Tompkins, A. Javed, S. Bhadwal, S. Barg, L.P. Nygaard and J. West, 2004. “Mapping vulnerability to multiple stressors: Climate change and globalization in India.” *Global Environmental Change* 14: 303–313.
- O’Brien, G., P. O’Keefe, J. Rose, and B. Wisner, 2006. Climate Change and Disaster Management. *Disasters* 30 (1): 64–80.

Organisation for Economic Co-operation and Development (OECD), 2005. *Conclusions of the Chair*. Global Forum on Sustainable Development on Development and Climate Change, November 11–12, 2004, Paris, France. ENV/EPOC/GF/SD/RD(2004)15/FINAL. <<http://www.oecd.org/dataoecd/60/7/34393852.pdf>>.

Organisation for Economic Co-operation and Development-Development Assistance Committee (OECD-DAC), 2006. Declaration on integrating climate change adaptation into development cooperation. <<http://www.oecd.org/dataoecd/44/29/36426943.pdf>>.

OECD, 2007. *Statistical Annex of the 2007 Development Co-operation Report*. <<http://www.oecd.org/dac/stats/dac/dcrannex>>.

Orindi, V. and S. Eriksen, 2005. *Mainstreaming Adaptation to Climate Change in the Development Process in Uganda*. Ecopolicy Series 15.

Ott, H., H. Winkler, B. Brouns, S. Kartha, M. Mace, S. Huq, A. Sari, J. Pan, Y. Sokona, P. Bhandari, A. Kassenberg, E. La Rovere, and A. Rahman, 2004. *Proposal: Towards an adequate and equitable global climate agreement*. South-North Dialogue on Equity in the Greenhouse. <http://wupperinst.org/download/1085_proposal.pdf>.

Oxfam, 2007a. *Adapting to climate change: What's needed in poor countries, and who should pay*. Oxfam Briefing Paper 104.

Oxfam, 2007b. *Financing adaptation: Why the UN's Bali Climate Conference must mandate the search for new funds*. An Oxfam Briefing Note.

Parry, M., N. Arnell, T. McMichael, R. Nicholls, P. Martens, S. Kovats, M. Livermore, C. Rosenzweig, A. Iglesias and G. Fischer, 2001. "Millions at risk: Defining critical climate change threats and targets." *Global Environmental Change* 11: 181–183.

Perkins, B., D. Ojima and R. Correll, 2007. *A Survey of Climate Change Adaptation Planning*. Washington, D.C.: H. John Heinz III Center for Science, Economics and the Environment. <http://www.heinzctr.org/NEW_WEB/PDF/Adaptation_Report_October_10_2007.pdf>.

Pew Center on Global Climate Change, 2005. *International Efforts Beyond 2012: Report of the Climate Dialogue at Pocantico*. Washington, D.C.: Pew Center on Global Climate Change.

Pistor, M, 2007. Official Development Assistance Spending. *In Brief*. PRB 07-10E. Library of Parliament. <<http://www.parl.gc.ca/information/library/PRBpubs/prb0710-e.pdf>>.

Redekop, B., 2007. "Ice men freeze the Far North: Local engineers prevent buildings from sinking in permafrost." *Winnipeg Free Press*. September 22: B8.

Schipper, E.L.F., 2006. Conceptual History of Adaptation in the UNFCCC Process. *RECIEL* 15(1): 82–92.

Schipper, L. and M. Pelling, 2006. Disaster Risk, Climate Change and International Development: Scope for, and Challenges to, Integration. *Disasters* 30(1): 19–38.

Simms, A., 2005. *Up in Smoke: Africa*. Working Group on Climate Change and Development. London: new economics foundation.

Simms, A., J. Magrath and H. Reid, 2004. *Up in Smoke? Threats from, and responses to, the impact of global warming on human development*. London: new economics foundation.

Smit, B., O. Pilifosova, I. Burton, B. Challenger, S. Huq, R.J.T. Klein and G. Yohe, 2001. “Adaptation to climate change in the context of sustainable development and equity.” In J.J. McCarthy and O.F. Canziani (eds). *Climate Change 2001: Impacts, Adaptation and Vulnerability*.

Smith, J.B., R.J.T. Klein and S. Huq, 2003. *Climate Change, Adaptive Capacity and Development*. London: Imperial College Press.

South Centre, 2007. *Integrating Development in Climate Change: A framework policy discussion paper on key elements for the development of the post-2012 global climate policy regime*. Special Policy Discussion Paper.

Sperling, F., and F. Szekely, 2005. *Disaster Risk Management in a Changing Climate*. Discussion Paper prepared for the World Conference on Disaster Reduction on behalf of the Vulnerability and Adaptation Resource Group.

Srinivasan, A., 2006. Adaptation to Climate Change. In Ancha Srinivasan (ed.). *Asian Aspirations for Climate Regime Beyond 2012*. Institute for Global Environmental Strategies. pp. 77–100.

Stern, N., 2006. *Stern Review on the economics of climate change*. Prepared for the Prime Minister and the Chancellor of the Exchequer on the Economics of Climate Change. Cambridge: Cambridge University Press. Accessed: October 31, 2006. <http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm>.

Sugiyama, T., J. Sinton, O. Kimura and T. Ueno, 2004. *Orchestra of Treaties: A Future Climate Regime Scenario with Multiple Treaties among Like-minded Countries*. CRIEPI Working Paper Y03013. Central Research Institute of Electric Power Industry (CRIEPI).

Tanner, T.M., D. Conway, A. Hassan, M. Alam, N. Islam, A.U. Ahmed and R. Mechler, 2007. *ORCHID: Piloting Climate Risk Screening in DFID Bangladesh*. Research Report. Sussex: Institute of Development Studies.

Tol, R.S.J. and R. Verheyen, 2004. "State Responsibility and Compensation for Climate Change Damages – A Legal and Economic Assessment." *Energy Policy* 32 (9): 1109–1130.

Tompkins, E. L. and W. Neil Adger, 2003. *Building resilience to climate change through adaptive management of natural resources*. Tyndall Working Paper 27.

Tompkins, E.L. and W. N. Adger, 2005. "Defining Response Capacity to Enhance Climate Change Policy." *Environmental Science & Policy* 8: 562–571.

Torvanger, A., G. Bang, H. Kolshus and J. Vevatne, 2005. *Broadening the climate regime: Design and feasibility of multi-stage climate agreements*. CICERO Report 2005: 02. <http://www.cicero.uio.no/publications/detail.asp?publication_id=3604&lang=en>.

Ulsrud, K. and S. Eriksen, 2006. Summary of the Norad/GECHS workshop on climate change and development, Oslo, January 9–10 2006. GECHS project and Department of Sociology and Human Geography, University of Oslo. <<http://www.gechs.org>>.

United Nations Environment Programme Finance Initiative, 2005. "The Clean Development Mechanism: The Financial Sector Perspective." *CEO Briefing*. January 2005.

United Kingdom Climate Impact Programme (UKCIP), 2004. *Costing the impacts of climate change in the UK*, Oxford U.K.

United Kingdom Treasury, 2005. G8 Finance Ministers' Conclusions on Development, London, 10–June 11. <http://www.hm-treasury.gov.uk/otherhmtsites/g7/news/conclusions_on_development_110605.cfm>.

United Nations Development Program (UNDP), 2006. *Adaptation-Definitions*. New York: UNDP. <<http://www.undp.org/gef/adaptation/climate/03b.htm>>.

United Nations Development Programme, 2006. Availability of funds Web page: <<http://www.undp.org/gef/adaptation/funds/04a.htm>>.

United Nations Framework Convention on Climate Change (UNFCCC), 2008. Glossary of climate change acronyms. <http://unfccc.int/essential_background/glossary/items/3666.php>.

UNFCCC, 2007a. *Report on the analysis of existing and potential investment and financial flows relevant to the development of an effective and appropriate international response to climate change*. Dialogue working paper 8. Dialogue on long-term cooperative action to address climate change by enhancing implementation of the Convention, Fourth Workshop, Vienna, August 27–31.

UNFCCC, 2007b. *Report of the Subsidiary Body for Implementation on its twenty-sixth session*, held at Bonn, May 7–18, 2007. FCCC/SBI/2007/15. June 20. <<http://unfccc.int/resource/docs/2007/sbi/eng/15.pdf>>.

UNFCCC, 2007c. *The Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change* (booklet).

UNFCCC, 2007d. *Financial Cooperation under the Convention and its Kyoto Protocol*. <http://unfccc.int/files/cooperation_and_support/financial_mechanism/application/pdf/financial_cooperation_under_the_convention_and_its_kyoto_protocol.pdf>.

UNFCCC, 2007e. *Report of the Global Environment Facility to the Conference of the Parties*. FCCC/CP/2007/3. <<http://unfccc.int/resource/docs/2007/cop13/eng/03.pdf>>.

UNFCCC, 2007f. *Report on the workshop on adaptation planning and practices*. FCCC/SBSTA/2007/15. October 25.

UNFCCC, 2006. *Application of environmentally sound technologies for adaptation to climate change*. (FC/TP/2006/2), May 10.

UNFCCC, 2003. Decision 5/CP.9: Further guidance to an entity entrusted with the operation of the financial mechanism of the Convention, for the operation of the Special Climate Change Fund. In *Report of the Conference of the Parties on its Ninth Session, held at Milan from 1 to 12 December 2003: Addendum. Part Two: Actions taken by the Conference of the Parties at its Ninth Session*. FCCC/CP/2003/6/Add.1. April 22. <<http://unfccc.int/resource/docs/cop9/06a01.pdf#page=11>>.

Verheyen, R., 2002. "Adaptation to the impacts of anthropogenic climate change: The international legal framework." *RECIEL* 11(2): 129–143.

Walker, W.E., S.A. Rahman, and J. Cave, 2001. "Adaptive Policies, Policy Analysis, and Policy-making." *European Journal of Operational Research* 128: 282–289.

WBGU, 2007. *New impetus for climate policy: making the most of Germany's dual presidency*. Policy Paper 5, German Advisory Council on Global Change. <http://www.wbgu.de/wbgu_pp2007_engl.pdf>.

Willems, S., 2005. *National Approaches to Adaptation: Some lessons learnt from recent OECD and UNFCCC workshops*. OECD Environment Directorate and International Energy Agency. COM/ENV/EPOC/IEA/SLT (2005)2. <<http://www.oecd.org/dataoecd/22/16/34878199.pdf>>.

World Bank, 2006a. *An Investment Framework for Clean Energy and Development: A Progress Report*. Prepared for the Development Committee. <[http://siteresources.worldbank.org/DEVCOMINT/Documentation/21046509/DC2006-0012\(E\)-CleanEnergy.pdf](http://siteresources.worldbank.org/DEVCOMINT/Documentation/21046509/DC2006-0012(E)-CleanEnergy.pdf)>.

World Bank, 2006b. *Hazards of Nature, Risks to Development, An Evaluation of World Bank Assistance for Natural Disasters*, IEG Report, CODE2006-0020, March 7.

World Bank, 2006c. *Managing Climate Risk: Integrating Adaptation into World Bank Group Operations*. Washington, D.C.: The World Bank.

Chapter 4: Technology's Role in the Emerging Post-2012 Climate Regime

Deborah Murphy, John Drexhage and John Van Ham

1.0 Introduction

Technology is critical to achieving the goal of the United Nations Framework Convention on Climate Change (UNFCCC) (Article 2) to achieve “stabilization of greenhouse gas concentrations in the atmosphere at a level that could prevent dangerous anthropogenic interference with the climate system.” A safe level has not yet been defined by the international community, but the IPCC (2007b: 90) reports that under most equity interpretations, developed countries will need to reduce their emissions significantly by 2020 (10 to 40 per cent below 1990 levels) and to still lower levels by 2050 (45 to 90 per cent below 1990 levels) for low to medium stabilization. These reductions will need to take place while population increases, economies grow and increasing numbers in developing nations gain access to electricity.

A fundamental challenge of the climate issue is how to promote a technology revolution on a global scale that would enable, at acceptable costs, the steep reductions required to stabilize atmospheric greenhouse gas (GHG) concentrations at a safe level. Attaining these global emission reductions will require a significant transformation in the capital stock of energy producing and consuming businesses and households around the world. Almost every major societal function results in GHG emissions—transportation, agriculture, space heating, manufacturing, forestry—and reducing emissions will require a massive change in the way we live and do business. The critical question is how best to engage countries in a long-term effort that will mobilize the technologies to protect the climate while sustaining economic growth.

Technology is expected to play a major role in the post-2012 climate regime—both as a means to attract action from major emitters, including large developing nations and those not currently party to the Kyoto Protocol, and to ensure that countries have the necessary tools to put their economies on a clean development path. Technology will dictate what is possible in regard to emission reductions; and technology development and transfer is identified as one of four pillars in the Bali Action Plan, the negotiating mandate agreed to at COP-13.

Canada will be interested in ensuring that domestic technology strengths and interests are accounted for in an international post-2012 regime. Canada is already a global supplier of energy and looking to become an even bigger sup-

plier—but to become a supplier of “clean” energy will require new technologies and know-how, and increased efforts in energy efficiency, clean carbon-based fuels and clean electricity. Increased support is required for research, development and dissemination (RD&D) in key sectors to allow Canadians to undertake necessary action at home, and for strategic engagement in global technology cooperation efforts to position Canada to become a global leader by advancing Canadian know-how and Canadian market share.

A Canadian perspective on technology in a post-2012 regime is needed. This could include a preferred structure or approach for support to technology cooperation, how and under what conditions Canada wishes to provide financial assistance, and the preferred role of the UNFCCC and other actors in supporting technology efforts in both developed and developing countries. This chapter aims to help frame this discussion by: (1) identifying key approaches and actions, both domestic and international, needed to overcome barriers and stimulate real action on technology; and (2) evaluating the opportunities offered by these approaches to address Canadian technology strengths and interests in a post-2012 climate change regime.

To help frame this discussion, Section 2 provides an overview of the issue, defining technology cooperation, looking at obligations under the UNFCCC, briefly examining actions to date and setting out expectations for technology in a post-2012 regime. Section 3 examines the state of play in Canada on climate change technologies, providing an overview of Canada’s support to technology cooperation in an international context and identifying areas of strength and interest. Section 4 discusses financing requirements for technology cooperation and examines important considerations for successful technology advancement. Section 5 provides reflections on a way forward, looking at initial ideas for a Canadian response to technology cooperation in a post-2012 climate regime, accounting for Canadian interests and what approaches best advance these interests.

2.0 Technology in a post-2012 regime: setting the context

Technology cooperation efforts to date have focused on energy use because 61 per cent of global GHGs and almost 75 per cent of all carbon dioxide (CO₂) stem from energy-related activities with the large majority from fossil fuel combustion (Baumert *et al.*, 2005: 41). The focus on energy use is particularly important in Canada, where 82 per cent of 2004 GHG emissions were directly related to the production and consumption of fossil fuels (Environment Canada, 2007: 6). To reduce emissions while meeting growing energy needs will require the acceleration of technological advancement and a reduction of costs to encourage the wide uptake of zero- or low-emission technologies at the national and international level. Efforts will require the widespread use of all existing technologies and major efforts in energy efficiency, as well as continued efforts to lead to technology breakthroughs (e.g., nuclear fusion, new

methods for hydrogen storage, new energy storage devices and new technologies for improving energy efficiency). Discovery and innovation in the energy sector is still capable of yielding unanticipated rewards in regard to GHG emission reductions.

While energy technologies have been at the forefront, there have been efforts to cooperate on technologies to deal with non-energy emissions such as CO₂ from industrial processes; CO₂ from land use, land-use change and forestry (LULUCF); methane and nitrous oxide emissions from agricultural practices; and methane from solid waste landfills.

Climate change monitoring technologies are important to increase understanding of the climate system, how it operates, how it might change and how we can adapt to it. Adaptation technologies are also a large part of the picture and will be dispersed across all socio-economic sectors—including water, health, agriculture and infrastructure—and will involve a variety of stakeholders. The approach to technology cooperation for adaptation will likely differ from the approach to mitigation, largely because the issues involved are different and technology needs of countries are varied, as discussed in Chapter 3 of this report. The UNFCCC (2006: 33) has noted that there are important distinctions between the processes of mitigation and adaptation that should be considered in technology cooperation: “(i) adaptation is not new in the way that mitigation is new, (ii) the sectors that need technology for adaptation are ubiquitous, (iii) many technologies for adaptation are already readily available in developing countries and (iv) the most needed technologies for adaptation are probably not likely to be as capital intensive as those for mitigation.” Climate change is already being acutely experienced in Canada’s North, offering the opportunity to bring attention to the impacts of climate change and the need for adaptation technologies.

A post-2012 framework will need to encourage the wide availability of all types of technologies in both developed and developing countries. Efforts to support technology RD&D in developing countries will need to include policy and technical assistance, and financial support that allows for domestic research and innovation, and the ability to adapt transferred technologies to make them appropriate to both national development and climate change needs and priorities.

2.1 Obligations under the UNFCCC

The UNFCCC has entertained active negotiations on technology transfer since its inception and requires Parties (UN, 1992: Article 4.1c) “to promote and cooperate in the development, application, diffusion, including transfer, of technologies, practices, and processes that control, reduce, or prevent anthropogenic emissions of greenhouse gases.”

Article 4.5 of the Convention establishes the goal of climate change technology transfer by stating that “The developed country Parties...shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties,

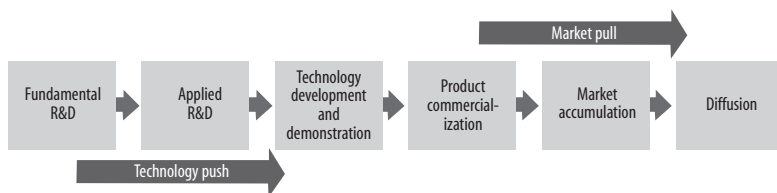
particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties.” Article 4.3 indicates that Parties are to provide financial resources for the transfer of technology.

Similar provisions are made in Article 10c of the Kyoto Protocol (UN, 1997), which states that Parties shall “Cooperate in the promotion of effective modalities for the development, application and diffusion of, and take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies, know-how, practices and processes pertinent to climate change, in particular to developing countries, including the formulation of policies and programs for the effective transfer of environmentally sound technologies that are publicly owned or in the public domain and the creation of an enabling environment for the private sector, to promote and enhance the transfer of, and access to, environmentally sound technologies.”

Actions and discussions to date under the UNFCCC have focused on technology transfer, but this has proven to be a controversial topic. The controversy stems from the differing perceptions of what drives technology transfer; developing countries have called on developed countries to increase financial and technical support, focusing on the removal of intellectual property rights (IPR) and the creation of a new fund to buy patents. Developed countries have argued that the intellectual property does not belong to governments, but to the private sector, and have pointed to the need for incentives for private companies that own the technologies.

This chapter looks at a wider perspective than technology transfer and uses a modification of the IPCC (2000) definition to expand the discussion to “technology cooperation,” which refers to the broad set of processes covering the flow of know-how, experience and equipment of technology among and within countries. Figure 1 illustrates the stages of technology development that can be influenced by technology cooperation efforts. It is important to note that technology cooperation efforts can include both the movement of “hard” technologies (e.g., equipment and processes) as well as the exchange of knowledge, expertise and experience (e.g., best practices in public policy, regulation and capacity building).

Figure 1: Stages of technology development



Source: Grubb, 2005; Sustainable Development Technology Canada, 2005.

2.2 Actions to date: UNFCCC and other multilateral processes

Much work has been done to promote technology transfer within the UNFCCC regime, and technology has been recognized in the Bali Action Plan as one of four pillars to be addressed in a post-2012 agreement. The plan, agreed to at COP-13 in 2007, calls for action to remove barriers to financing and technology transfer and uptake in developing countries, accelerate the deployment and diffusion of environmentally sound technologies, promote cooperation on R&D for new and innovative technologies, and determine the effectiveness of mechanisms and tools for technology cooperation. The action plan calls for measurable, reportable and verifiable mitigation commitments from developed countries; as well as “nationally appropriate mitigation actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measureable, reportable and verifiable manner” (UNFCCC, 2007a: 1).

The bulk of work on technology transfer to date has taken place under the Subsidiary Body for Scientific and Technical Advice (SBSTA) and the Expert Group on Technology Transfer (EGTT), which was formed to enhance the implementation of the technology transfer framework that was agreed to at COP-7. The key themes of the framework are needs assessments, technology information, enabling environments, capacity building and mechanisms for technology transfer. The EGTT had its mandate extended for five years at COP-13, and has been asked to pay particular attention to financial support for technology initiatives, and to work on performance indicators for monitoring and evaluating progress on the development, deployment and transfer of environmentally sound technologies.

At COP-13, technology transfer was added to the agenda of the Subsidiary Body for Implementation (SBI), a move supported by many developing countries that viewed this addition as recognition of the need for financial support for technology transfer initiatives, i.e., the need to move beyond needs assessments and capacity building to “hard” technology transfer action. Governments agreed to develop a strategic program to scale up the level of investment for the transfer of both the mitigation and adaptation technologies to help meet developing country needs. The program aims to encourage concrete demonstration projects, create more attractive environments for investment, and provide incentives for private sector involvement in technology transfer. The Global Environment Facility (GEF) will work with multilateral development banks (MDBs) and representatives of the private financial sector to elaborate the program.

The GEF is the financial mechanism for the UNFCCC, and allocates and disburses about US\$250 million per year in projects in energy efficiency, renewable energy and sustainable transportation. It also manages two Convention Funds—the Least Developed Country Fund (LDCF) and the Special Climate

Change Fund (SCCF), the latter of which supports projects related to technology transfer, as well as adaptation. The GEF has also assumed secretariat services for the Adaptation Fund.

The Clean Development Mechanism (CDM), defined in Article 12 of the Kyoto Protocol, has also resulted in a flow of funds for technology development. Developing countries supplied 475 million tCO₂-eq of credits for a total market value of US\$5.2 billion in 2006 (Capoor and Ambrosi, 2007: 20). Coninck *et al.* (2007: 16) analyzed CDM projects as of January 2006 to clarify the extent of technology transfer, and found that a significant share of the projects used technology from outside the host country, notably in large-scale non-CO₂ GHG projects and in wind energy. The CDM is providing a foundation for the major technology shifts that will be required to effectively reduce GHG emissions, in that it has accelerated learning by doing, built institutional capacities, and enhanced goodwill between developing countries and the private sector. While there is considerable potential under the CDM, the administrative complexity of the mechanism may restrict its ability to bring about a major technology shift in developing nations.

Outside of the UNFCCC, a number of multilateral processes also promote technology cooperation. G8 (2007: 2) discussions with emerging economies in Heiligendamm resulted in a statement that noted energy efficiency and technology cooperation will be crucial elements of follow-up dialogue, and underlined “the crucial role of economic incentives, in particular by carbon markets, for the necessary investments in climate-friendly technologies at large scale,” and that a future agreement will need to include “enhanced technology cooperation and financing.” Technology cooperation outcomes of the G8 Gleneagles Dialogue on Climate Change, Clean Energy and Sustainable Development, initiated in 2005, include the World Bank Group’s *Clean Energy for Development Investment Framework* with a focus on increasing access to modern energy in Sub-Saharan Africa and providing a significant buy-down of the incremental costs of a transition to a low-carbon economy; the International Energy Agency (IEA) Gleneagles Programme that promotes energy-sector innovation, better practice and use of enhanced technology, focusing on energy efficiency and clean coal; and the Gleneagles Industry Partnership Project that encourage public-private discussions to develop recommendations for reducing GHG emissions.

The Asia-Pacific Partnership on Clean Development and Climate (APP), which Canada joined in October 2007, is a voluntary framework for international cooperation to accelerate the development and deployment of clean energy technologies and practices. Public-private sector task forces focus on expanding investment in trade in clean energy technologies in eight key industrial sectors.

The 2007 APEC (Asia Pacific Economic Cooperation) *Sydney Leader’s Declaration on Climate Change Energy Security and Clean Development*

(APEC, 2007) set out agreed-to elements for a post-2012 international climate change arrangement, that included “the important role for low and zero emissions energy sources and technologies,” noting the need for joint research and the importance of energy efficiency and diversification of energy sources and supplies. The 2007 action plan includes the establishment of networks to strengthen collaboration in energy technology, and sustainable forest management and rehabilitation.

The United States has stressed a technology approach in its climate change programs and has been a driving force in the establishment of a number of multilateral technology agreements (i.e., APP, Carbon Sequestration Leadership Forum [CSLF], Generation IV [GENIV] on nuclear energy systems, Global Nuclear Energy Program [GNEP], International Partnership for the Hydrogen Economy [IPHE] and Methane to Markets [M2M]). Other multilateral technology agreements include ITER, IEA Implementing Agreements, and the Renewable Energy and Energy Efficiency Partnership [REEEP]. These agreements are briefly described in Appendix 2.

Technology cooperation is also promoted through bilateral agreements to promote technology (e.g., EU-China Partnership on Climate Change, 2006 U.S.-Russia framework for bilateral cooperation in the development of nuclear energy technology and deployment), and through bilateral Official Development Assistance (ODA) projects. Japan is the most significant donor of bilateral aid for energy, having provided 69 per cent of all bilateral aid for energy during the period 1997–2005, followed by Germany at 12 per cent and France at 3.4 per cent (Tirpak and Adams, 2007: 3).

Business organizations are increasingly involved in technology cooperation, being partners in many of the agreements mentioned above. The World Economic Forum and the World Business Council for Sustainable Development (WBCSD) have hosted workshops on clean energy financing. WBCSD members have explored policy frameworks to encourage technology development and dissemination, and under the Cement Sustainability Initiative, members have developed climate change mitigation strategies including a protocol for measuring and reporting CO₂ emissions in the cement sector. The aluminum industry has undertaken a similar initiative focusing on perfluorocarbon emissions. Members of the International Iron and Steel Institute (2007) endorsed a common approach to addressing climate change in October 2007 that focuses on expanding the use of efficient technologies to minimize CO₂ emissions and promoting recycling in the short term, and boosting R&D investment to develop “breakthrough, new steelmaking technologies” in the long term.

Clean energy technology is a growing business; a response to high oil prices, increasing energy demand and the need for action on climate change. The Sustainable Energy Finance Initiative and New Energy Finance (2007: 11) report that investments in sustainable energy (renewable energy and energy

efficiency) are rapidly increasing to meet the needs of a low-carbon society, with investments totalling US\$70.9 billion in 2006, an increase of 43 per cent over 2005. This growing investment reflects the sector's shift into the mainstream, which is underpinned by real demand and growing regulatory support. The report concludes that companies and consumers are beginning to support the roll out of a new energy infrastructure and a change in behaviour.

The increasing sustainable energy investments and growing international technology cooperation to deal with climate change are laudable, yet there is much work to do. In practical terms, very little transfer of hard technologies has taken place and technology cooperation agreements to date have not yielded substantial results (Ott, 2007; Murphy *et al.*, 2005; Republic of South Africa, 2006)—certainly not enough to kick-start the deep reductions needed to stabilize CO₂ emissions at a safe level. Much remains to be done to promote the development and diffusion of climate-friendly technologies and an effective post-2012 agreement will need to include provisions to stimulate technology RD&D in developed and developing countries that goes far beyond what has taken place to date.

3.0 Canadian strengths and interests related to technology

There are many facets to climate change technology cooperation in Canada that need to be taken into account when considering post-2012 policy options. This section examines Canadian participation in technology initiatives at the international level, and priority technology areas for Canada to consider promoting within a global technology framework.

3.1 Canada and technology cooperation

Canada's Fourth National Report on Climate Change (Environment Canada, 2006: 169–184) outlines the country's support to fulfil its obligations under international technology transfer efforts. From 2000 to 2005, Canada provided multilateral support through the GEF, World Bank, United Nations (UN) programs and other international institutions. In addition, Canada provided bilateral support through the Canadian International Development Agency (CIDA), the CDM & JI Office of the Department of Foreign Affairs, Natural Resources Canada (NRCan) and other departments. Canada's estimated funding for programs and activities in developing countries and countries with economies in transition related to the implementation of the UNFCCC in 2004–05 totalled \$28.77 million, with two-thirds directed to mitigation activities and the remainder to adaptation projects. This was a significant drop from the previous four years, when support to climate change activities averaged \$44.17 million per year. The most prominent initiative to support climate change activities in developing countries was the Canada Climate Change Development Fund (CCCDF), a \$100 million initiative that was administered

by CIDA and ran from 2000 to 2006. In 2007, Canada provided \$7.5 million for the SCCF, with \$2.5 million being allocated for technology transfer.

International efforts also include participation in technology cooperation with like-minded countries. Canada is a member of the APP, CSLF, IPHE, Methane to Markets, REEEP, GENIV and the Climate Technology Initiative under the IEA.

Canada also has domestic programs and measures at the federal and provincial levels that both promote the dissemination of existing technologies and processes, and the development of new mitigation solutions, many of which are described in Canada's national communication to the UNFCCC. A number of recent programs to promote technologies have been developed to help meet the federal government's long-term goal of reducing GHG emissions, relative to 2006 levels, by 20 per cent by 2020 and 50 to 70 per cent by 2050 (Government of Canada, 2007). Programs have been introduced in the areas of renewable fuels, renewable electricity, energy efficiency and an eco-energy technology initiative will fund the RD&D of clean energy technologies. Sustainable Development Technology Canada (SDTC), which was established by the Government of Canada in 2001 to finance and support the development and demonstration of clean technologies including those that provide solutions to the issue of climate change, will manage the new next-generation renewable fuels fund.

The Government of Canada's (2007) *Regulatory Framework for Air Emissions* will promote technology development in two ways: 1) developing regulations that set mandatory and enforceable reduction targets for GHG emissions from major industrial sources; and 2) establishing the technology fund as a compliance mechanism for large emitters. The Canadian government has set mandatory and enforceable reduction targets for GHG emissions from major industrial sources, with emission-intensity reduction targets for each sector based on an improvement of 6 per cent each year from 2007 to 2010, and a two per cent continuous emission intensity improvement each year thereafter, resulting in an industrial emission-intensity reduction of 26 per cent by 2015. Ideally, firms will meet obligations through energy-reducing technologies (such as deployment of carbon capture and storage (CCS) or improved energy management systems), but there will be access to compliance mechanisms including emissions trading with an offset system and limited access to the CDM, and credit for early action. Companies also will be able to contribute to a technology fund as part of their regulatory obligations to reduce GHGs at a rate of \$15 per tonne of CO₂-eq from 2010 to 2012, and \$20 per tonne in 2013. Thereafter, the rate will escalate yearly at the rate of growth of nominal GDP until the fund ends in 2018. The fund will be used primarily to finance investments in technology and infrastructure deployment that have a high likelihood of resulting in GHG emission reductions in the short term, such as CCS. A small component of the fund equivalents to 5 Mt per year will help

finance projects contributing to the development of new technologies that have the potential for significant reductions in the medium to longer term, such as emerging clean energy technologies.

Most provincial governments have introduced initiatives to promote climate-friendly technologies. These include technology funds, pilot and demonstration projects, renewable portfolio standards and consumer incentive programs. For example, British Columbia has introduced a Clean Energy Fund to support commercialization of clean technologies, adopted California tailpipe emissions standards and established a five per cent renewable fuel standard for diesel by 2010. Alberta has established a pilot project to produce electricity from municipal solid waste and an energy innovation fund to support R&D activities. Ontario has introduced feed-in tariffs in its Renewable Energy Standard Offer Program, Nova Scotia has a new renewable energy standards regulation and Prince Edward Island has a renewable portfolio standard of 15 per cent by 2010. Quebec has announced that it will adopt California's GHG standards for new light-duty vehicles, having them come into effect between 2010 and 2016, and is the first province to establish a carbon fund, the proceeds of which will be used to reduce emissions through transportation and other measures.

The Canadian private sector is increasingly active in technology partnerships. BC Hydro and Alcan participate in the Gleneagles partnership program, which also includes a number of companies that have a significant presence in Canada: Alcoa, CH2M Hill Companies, Deloitte and Duke Energy. Alcan, BC Hydro, Petro-Canada and Suncor are members of the WBCSD. Statistics Canada's (2005) study on GHG technologies reported that Canadian firms are increasingly making inroads selling technologies to reduce GHG emissions, with sales of fuel cell and alternative fuel technologies, solar and wind energy systems, and landfill gas recovery technologies increasing between 2000 and 2002. Approximately 38 per cent of GHG technology revenues were earned in international markets in the areas of fuel cells and alternative fuel technologies (73 per cent of total sales of \$139.5 million) and renewable energy and energy efficiency (27 per cent of total international sales). The study noted that the GHG technologies market offers room for growth for Canadian firms.

3.2 Canadian technology strengths and interests

Canadian climate change technology strengths and interests, discussed below, are of critical importance in shaping a Canadian response for international technology cooperation strategies, and helping to identify key issues for Canada in the negotiation of a post-2012 framework. Technology decisions and policies are important in Canada and can stimulate technology markets at home and abroad.

There have been recent calls for clear and consistent policy signals to stimulate technology development, with the Canadian Council of Chief Executives

(2007) urging the government to focus on investment in technologies that can strengthen the domestic economy as well as move into export markets, and calling for a focused technology strategy to stimulate appreciation of effective technologies and RD&D for advanced technologies in the future. The Canadian policy framework is developing rapidly, as noted in section 3.1, but certainty at the international level is required to maintain momentum.

New technologies, processes and approaches are needed for strategically important sectors such as energy, transportation, manufacturing, agriculture and forestry. These sectors supply essential products and services to meet national needs and contribute to Canada's growing trade surplus with international partners like the United States, EU countries, and Asian and other foreign markets. The need for ample and affordable stores of energy resources is a common thread that runs through each of these vital Canadian sectors. Energy powers factories, provides inputs into industrial processes and moves people and products from one place to another. As a result, developing, demonstrating and disseminating energy technology is of primary national importance.

Energy should not only be viewed in the context of industrial needs; it is equally important to recognize the role energy plays as a building block of sustainable development. In all regions and countries, energy is a fundamental requirement for providing essential elements of life such as food, water, shelter and clothing. Without energy, society would not be able to maintain or improve living standards, meet the basic needs of its citizens, nor maintain the socio-economic infrastructure necessary for political and economic stability.

Canada's role in global energy markets has changed, and the country is increasingly viewed as a major supply centre for North America and the world. The current domestic energy situation provides some geopolitical advantage as other nations look to Canadian markets to provide stable and secure supplies of energy (oil, natural gas, coal, uranium and produced electricity). Canada is currently perceived as one of a few places for solid investments in energy, and is the only OECD country with the capacity to greatly enhance energy production. Canada is viewed by many as the only oil-exporting nation that can promise secure supplies of energy in the decades to come. Energy from the Middle East is becoming increasingly mired in the political instability in that region; and Venezuela, Russia and other major suppliers have provided mixed signals regarding access to gas and oil supplies.

Against this backdrop the government promotes Canada as an "emerging" energy superpower—in an attempt to attract investment capital in the energy industry. Much of the focus is on the oil sands (and other fossil fuel industries), but other forms of energy also receive attention. Canada's vast hydro resources have been known for some time but the country's other renewable resources (such as biomass, wind and ocean-wave) are also being tapped. High uranium prices have led to an unprecedented exploration rush to tap rich domestic deposits in Canada, which is the largest supplier in the world.

More recently, the government expressed interest in branding Canada as a “clean” or “green” energy superpower to reflect the increased profile of the environmental file in domestic politics.¹ While Canada has the potential to be a global supplier of clean energy, key issues must be confronted and dealt with. First, the country needs to broaden its traditional energy supply routes (which typically run north-south) so that they also run east-west and connect to the rapidly growing foreign markets, particularly in Asia. To date, most Canadian energy stays within the continent; but broadening beyond the traditional North American market base is essential if Canada is to be considered a global energy supplier. Second, Canada needs to develop novel approaches and technologies that enable the extraction, production, and use of energy in an environmentally acceptable way. Canada is a leader in a number of energy technology fields (discussed below), but more needs to be done in the oil sands and coal-fired power generation sectors to be regarded as a global supplier of clean energy. Even the regions that currently produce clean energy (the hydroelectricity producing provinces) could produce and transmit energy much more efficiently, and energy efficiency should be viewed as another source of energy. Third, the country needs a strategic approach for the development of technology, processes and know-how to bring Canada’s best energy opportunities to markets in clean and environmentally responsible ways. New technology and know-how are needed to truly become a clean energy superpower.

3.2.1 Priority technological solutions

In its advice on a long-term strategy on energy and climate change, NRTEE (2006) noted Canada’s ability to make significant GHG reductions by mid-century, but stated that these could only be achieved through targeted investments in energy efficiency and in reducing the carbon intensity of the economy. Ultimately, investments are required today in a balanced portfolio of technology areas in order to ensure large-scale demonstration and deployment over the coming years and decades.

Both the NRTEE (2006) and the National Advisory Panel on Sustainable Energy Science and Technology (SEST, 2006) conducted analysis to identify technologically feasible and economically viable options for making deep GHG emissions reductions in Canada by 2050. The two reports offered differing, but complementary perspectives: NRTEE examined near-term actions to implement existing technology over the long term, while the SEST looked at a long-term science and technology (S&T) portfolio that would result in future benefits. Both reports emphasized the importance of energy efficiency; cleaner fossil fuel production and use; clean electricity generation, transmission and distribution; and CCS.

1 See, for example, the speech of the Minister of Natural Resources at the launch of the new ecoENERGY Technology Initiative, found at http://www.nrcan.gc.ca/media/newsreleases/2007/200701_e.htm; and the speech of the Prime Minister in Germany in June 2007, found at <http://www.pm.gc.ca/eng/media.asp?id=1681>.

The NRTEE report followed the “stabilization wedges” approach which was first developed by Pacala and Socolow (2004). The Advisory Panel to the SEST report, which included a number of leaders in the energy sector, arrived at priorities by balancing the simultaneous pursuit of economic, environmental and social outcomes while keeping in mind areas where Canada had a realistic chance of becoming a leading innovator. Both the NRTEE and SEST reports noted that whatever approach Canada takes, it needs to be rooted in a clear assessment of national interests related to the economy, the state of the natural environment, and the quality of life of Canadians—an assessment of what is both desirable and doable for Canadians. Both reports identified key Canadian interests and together provided a balanced view of priorities for Canadian investment. Three broad areas, discussed below, where the country is recognized for its expertise and with continued support can remain or become a global leader are:

- clean electricity generation, transmission and distribution (T&D), and storage;
- clean carbon based fuel production, refining, transmission, and export/use; and
- energy efficiency in all energy systems.

3.2.2 Clean electricity infrastructure and systems

Rather than focusing on any single energy source for electricity generation, a number of common issues can be addressed across the spectrum of clean electricity generation, T&D, and storage. All three components are essential to Canada’s energy future and will help to address the challenges noted in the SEST report: the need for new energy infrastructure and systems; the intermittency of renewable energy sources; the impacts of weather on current energy systems; and increasing expectations related to power quality.

Canada is known worldwide for its large hydro assets. Breakthrough opportunities are not expected in large-hydro S&T, but areas to explore include the integration of hydro systems with other electrical infrastructure, such as smart electricity systems that make use of interconnectivity to fully maximize the energy storage opportunities in large hydro facilities. Maximizing synergies across each component of infrastructure opens up areas of great possibility across all parts of the electrical grid. For example, a large area of opportunity exists for wind-hydro hybrid systems in which pumped hydro can be used as an energy store when the wind capacity exceeds grid demand.

Canada is also a leader in mining and extracting uranium ore, which is used around the world for power generation. In fact, uranium is Canada’s largest energy export in terms of energy content, surpassing both oil and gas in this regard (SEST, 2006). Canada also has expertise in fission-based nuclear technology and Atomic Energy of Canada Limited recently engineered an

Advanced CANDU Reactor. Saskatchewan is pursuing interests in adding value to the uranium ore prior to export. Several jurisdictions are interested in building new reactors, including Ontario and the oil sands region of Alberta. An important consideration in Alberta is whether nuclear facilities can be designed for the somewhat unique load profile in the region, which has a high demand for heat, steam and hydrogen in addition to electricity.

Fossil fuel generators face similar issues when it comes to grid integration and infrastructure needs. However, thermal generators also face significant environmental challenges due to the carbon intensity of the fuel source. The technological options available to address these issues are noted in the next section on clean carbon-based fuels.

Smart T&D systems, especially for storage, are even more important for smaller renewable electricity options such as wind, small hydro, biomass, ocean/wave, solar and geothermal. One of the greatest barriers facing renewables is their intermittency. Technologically feasible and economically viable storage solutions would have greater benefit for smaller renewable and distributed energy industries than larger-scale options.

Co-generation is an area for improvement and one in which Canada could adopt and adapt technological solutions (from the EU, Japan and elsewhere) to best suit the domestic context.

Progress is being made on building stronger east-west grid infrastructure. Federal funding under the ecoTrust fund is supporting work on an east-west transmission interconnect between Manitoba and Ontario, and Quebec and Ontario have signed an electricity deal involving an interconnection. There are separate projects to improve linkages between British Columbia and Alberta. There is talk of eventually building a national grid that spans the country. The development of an effective and robust national grid would require a number of innovations in the way we currently manage electricity (including regulatory innovations).

In addition to the previous priority areas, the SEST (2006) report recognized the following requirements in regard to T&D and storage:

- smart electricity transmission and control technologies to facilitate the optimal deployment of base load, peaking, intermittent and distributed sources of electricity while increasing overall power quality;
- control technologies that enable safe integration of distributed energy sources into the grid while also allowing for higher system capacity; and
- electricity storage technologies that reduce grid vulnerability and instability, and which enable the integration of intermittent energy sources into the electrical grid.

3.2.3 Clean carbon-based fuel infrastructure and systems

Canada is in the position of having some of the largest fossil fuel resources in the world. The oil sands alone put Canada on any map of global energy resources, but the resource base is much broader. It includes very large conventional and unconventional gas resources, a large but rapidly maturing conventional oil resource and a large supply of coal.

In addition to fossil fuels, Canada has significant potential from another carbon-based energy source—biomass. Despite the recent interest in bio-ethanol and bio-diesel, there are a limited number of realistic biomass opportunities when all costs are accounted for (i.e., economic and environmental costs associated with the biomass growth, extraction and refining). The best Canadian opportunities might be in waste biomass resources, such as forestry and agricultural residues, and animal and human waste products. Canada can also claim some technological leadership when it comes to pyrolysis and cellulosic ethanol production.

Other and much larger areas of technological opportunity exist in the fossil fuel sectors, which are a large and rapidly expanding part of the Canadian economy. The oil sands are the fastest growing sector in Canada, as well as being the fastest growing source of GHG emissions. Currently, natural gas is used to generate heat, power and hydrogen (an important input in the upgrading process), and opportunity exists to replace high-cost natural gas with lower-cost feedstock or other energy sources. Other opportunities include finding new ways to extract and refine the bitumen product before it enters the upgrading facility.

New technology can be used to gasify oil sand residues; thus taking a current waste product and using it to provide electricity, heat and hydrogen for upgrading bitumen. Coal could also be gasified to produce similar end products. Using gasification technology would also enable a relatively simple process for capturing CO₂, which could then be transported to other locations for industrial use, enhanced oil and gas recovery or simply for CO₂ storage. Several Canadian companies have applications before regulators in which they propose using gasification technology in the oil sands.

Conventional oil reservoirs are seen as obvious recipients of captured CO₂, in order to boost oil production in mature reservoirs like the Western Canadian Sedimentary Basin (WCSB). Enhanced oil recovery (EOR) using CO₂ injection is already a commercial business in Saskatchewan and Alberta (and in many parts of the United States) and other provinces are looking at using CO₂ to enhance recovery of their own resources (both conventional oil and unconventional natural gas). Saline aquifers can also be used to store CO₂, which opens the possibility of storage in other sedimentary basins in Canada and along its coastal regions. Canada is home to one of the world's largest global CO₂ storage projects, the IEA Greenhouse Gas Weyburn Monitoring and Storage Project.

Other than enhanced recovery, most techniques for extracting and using conventional oil and gas are relatively mature. In fact most of the future opportu-

nities for natural gas are actually in the frontier regions and with unconventional resource types. To open up access to frontier gas a variety of equipment and techniques are needed for operation in remote and climatically extreme locations (for example, in Canada's North and in the iceberg-laden waters off the shores of Newfoundland).

Canadian unconventional gas opportunities include the following sub-types; coal bed methane, tight gas, shale gas, and methane hydrates. Although each of these resources has its own specific technological needs, a technology roadmap by the Petroleum Technology Alliance of Canada (2006) notes that these S&T needs can be grouped under one of three headings; characterization and modelling, drilling and completions, and lift technology and infrastructure.

The United States has been producing coal bed methane, tight, and shale gas for several years now. The industry is beginning in Canada, and North America is recognized as a leader in these sectors. Gas hydrates are being researched by a number of countries including Japan, the United States, several EU countries and Canada. The most prominent and successful gas hydrate research project in the world to date is the Mallik project in Northern Canada. Hydrates scientists from all over the world have come to this location to conduct research at this international test site.

A number of regions are testing different technologies in a race to build the first clean coal facility in Canada, with some proponents assessing the use of gasification for Alberta's sub-bituminous coal. The CANMET Energy Technology Centre in Ottawa is a global leader in developing and testing a combustion process that takes place in an oxygen-enriched environment (an "oxy-fuel" environment) which results in the generation of a concentrated CO₂ flue gas stream that can be captured for storage. Others are working to clean the coal prior to it entering the combustion/gasification process to remove the most harmful pollutants at the front end of the process rather than capturing them at the back end. The high costs associated with clean coal technologies can be a barrier to development; SaskPower has moved away from plans to construct a clean-coal power plant citing high costs, rather than the technology, as the limiting factor. Project capital costs of the project rose from \$1.7 billion to \$3.8 billion. SaskPower will re-examine the project in 2009.

Low or zero-emission clean coal technologies include thermal power configurations that have large carbon-capture ready industrial infrastructure. The prospect of capturing emissions from Canada's largest CO₂ sources (such as power generators, oil sands upgraders, refiners, smelters, petrochemical manufacturers, cement manufacturers) is driving a strong debate over the role of CCS in Canada. This discussion is important because CCS is one area where Canada can claim some technical leadership, especially in the areas of EOR and geological storage. Canadian scientists are some of the leading researchers in CCS, and work with international experts through such initiatives as the CSLF.

One of the most significant pieces of infrastructure being debated in Canada is the development of a CO₂ pipeline or network of pipelines to connect CO₂ sources with CO₂ storage sites across the WCSB. The pipeline network would operate much like oil or gas pipelines, by connecting buyers and sellers via an intricate network designed to move large volumes of product over great distances. Building the infrastructure does not require any novel technical capabilities; but a signal on the price of carbon is needed and the price will have to ensure that the infrastructure development is viable. The critical areas for new technology and approaches are in the equipment, components and expertise at both the front end and back end—the suite of capture techniques (including absorption, adsorption and membranes) and storage approaches (such as reservoir engineering, storage monitoring, leak prevention and storage verification) being pursued by international consortia. To date, Canada has been known more for its expertise on the storage side.

Another category under carbon-based fuels is for the most novel of energy carriers—produced hydrogen. This is considered a carbon-based fuel because most experts agree that at least for the foreseeable future (next decade or two) virtually all hydrogen used in fuel cells, combustion engines or hybrids will be produced from hydrocarbon feedstock (oil or natural gas derivatives). Canada is considered a leader in a number of technological areas in the hydrogen and fuel cell sectors, such as fuel cell development and testing, hydrogen production, storage and transportation and fuel cell systems integration.

Canadian fuel cell manufacturers (such as Ballard Power) are recognized worldwide, but the scope of hydrogen and fuel cell applications in Canada is much broader than simply the proton exchange membrane technology. There are many opportunities in mobile, hand-held and stationary power applications for which technology is being developed. In addition, there is a whole suite of enabling technologies being developed. The Vancouver region has a number of innovative technology developers but clusters of expertise also exist in Alberta, Ontario and Quebec.

A fairly large hydrogen economy already exists in Canada. The oil and gas industry and, in particular, the oil sands, require large volumes of hydrogen to upgrade bitumen into crude oil which can be used in refineries and petrochemical facilities. If all of the proposed gasification facilities in Alberta are actually built over the coming years, the region will become one of the largest hydrogen economies in the world. This means Canada will develop even stronger capabilities in the areas of hydrogen generation (whether using gasifiers or reformers), transportation and distribution, storage and end use.

3.2.4 Energy efficiency across all sectors

Since the oil shocks of the 1970s, Canada (like most developed nations) has made significant energy efficiency gains. However, opportunities remain to improve energy efficiency, especially in Canada and other countries where end

use energy (such as electricity, gasoline or diesel) is relatively low-cost. In places with higher energy prices, the case for energy efficiency (or in some cases fuel switching) becomes more compelling.

Energy efficiency technology has an advantage over other energy technology in that there is rarely debate over what to deploy, instead the question is, how to deploy them all? The number of technologies and variety of energy efficiency measures and processes makes this a difficult task. As a result, energy efficiency efforts have typically been drawn along sectoral lines: industrial energy efficiency, the built environment (commercial and residential), transportation and infrastructure.

The diversity of Canadian industry means that there is no single solution approach to energy efficiency. Most equipment and components used in Canadian industry are manufactured by large multinationals which precludes any direct opportunities for the Canadian government in efficiency measures. At the same time, Canadian industry has a lot to gain from greater efficiency, simply because energy-intensive heavy industry is so important to the Canadian economy and because Canadian industry is somewhat inefficient compared to global competitors.² Several government-industry research groups, such as the Canadian Industry Program for Energy Efficiency are targeting investment in industrial energy efficiency research. A real and significant opportunity lies in the installation of more co-generation facilities to capture the process heat and use it in the industrial process.

Building stock is one of the longest-lasting parts of Canadian energy infrastructure. Sixty-six per cent of the buildings that will be standing in 2050 have already been built (NRTEE, 2006), highlighting two major opportunities for energy efficiency in the built environment: renovations to existing buildings, and improved building codes and standards for new ones. Programs like ecoENERGY Retrofit initiatives and the R-2000 Standard have been widely recognized for their innovativeness and success, but other countries have similar programs and have been much more successful with energy efficiency programs than Canada.

City and regional planning in Canada has improved, but the country still tends to build sprawling urban centres that require large infrastructure (electrical networks, roads and railways, water and sewage systems) which means more energy use. Homes and commercial buildings are also larger than in other countries resulting in greater demand for space heating in the winter and air conditioning in the summer. While cities and regions are finding novel ways to reduce energy use, these gains are often lost to new developments being built with more floor space, appliances and equipment.

2 The IEA (2007) reports that the Asian OECD countries, Japan and Korea, have the highest level of manufacturing industry energy efficiency, followed by Europe and then North America.

Transportation is another important area for energy efficiency gains. This sector faces similar issues to the built environment in that energy efficiency gains are surpassed by Canadians travelling further, driving larger vehicles and flying more frequently. Freight transportation is also increasing as Canadian exports continue to grow, especially for bulky products and natural resources. One area where Canada has strong expertise is in long-haul rail transportation (in addition to expertise in long-haul pipeline transportation and electricity transmission).

Canada is in a somewhat unique situation when it comes to the built environment (i.e., building stock, municipal and regional infrastructure, and transportation networks) as the northern location and large land mass present a number of challenges. While Canada is not viewed as a global leader in developing new energy efficiency technology, it is very good at adapting and delivering equipment and technology from elsewhere to the harsh operating environment of a remote, northerly country. This specialized expertise in materials science and in engineering could be applied to all freight vehicles, pipelines and electrical grids, and other parts of the built environment. As well, while an energy efficiency technology taker, Canada excels at adopting and engineering new configurations that are applicable to the local situation, a useful skill in technology transfer and cooperation initiatives.

A focus on the three areas of S&T options (clean electricity, clean carbon-based fuels and energy efficiency) would result in efforts that account for regional differences in terms of fuel choice. This is an important outcome considering the large differences in the regional resource base and the fact that provinces have jurisdiction over natural resource development and use. Undertaking research in these priority areas would mean that provinces like Quebec can focus on technology that applies to their natural advantage (a vast area of land covered with large and remote stores of wind and hydro energy) while fossil-fuel based provinces like Alberta can focus on the clean development of the oil sands, coal and other fossil fuel resources.

3.2.5 Concluding comments

Canada's positioning on a post-2012 strategy will need to account for technology strengths and interests discussed in the previous sections, as well as the desire for the country to be a technology leader in specific areas and a desire to increase access to export markets. Canadian technology priorities lie in the areas of clean electricity, clean carbon-based fuels and energy efficiency. Canada might choose to pursue leadership in areas where the country is known as a technology leader, including clean coal technologies: CCS; long-range transmission of electricity and transportation of solid, liquid and gaseous fuels; hydroelectricity generation; and adapting equipment and components to remote applications and harsh operating environments (cold, offshore, etc.). Canada also has had some success in the export of alternative fuel cell and alternative fuel technologies, solar and wind energy systems, and land-

fill gas recovery technologies; and could build on these areas to access new markets.

But there is still much work to be done in Canada. Statistics Canada (2005) noted that between 2000 and 2002 financial support for R&D to develop GHG technology originated mainly from the federal government, with a small proportion from the business community. This is inconsistent with overall R&D expenditure patterns, where 46 per cent of R&D funding came from the business sector as compared to 18 per cent from the federal government (Statistics Canada, 2006). The SEST (2006) called for a stronger emphasis on energy innovation in Canada, to encourage reliance on domestic technologies and create technological breakthroughs at home. This will require overcoming barriers, including a lack of financing and the high cost of developing new technologies. A policy framework is needed that encourages businesses to invest in and adopt GHG technologies, as well as increase RD&D expenditures.

Ideally, technology cooperation under a post-2012 agreement will encourage expenditure in areas of Canadian expertise and interest. If Canada strategically selects technology areas in which to offer global leadership and expertise, it could expect to leverage these actions and resources to help Canadian firms improve their competitive position, as well as allow the country to be a recipient of knowledge in other areas.

4.0 Advancing technology cooperation

Technology is expected to be an element in a post-2012 agreement, building on requirements set out in the UNFCCC and Kyoto Protocol in regard to technology transfer, as well as building on international cooperation efforts, discussed in section 2.2. Despite the overwhelming evidence that human activities are impacting on the climate, there is no guarantee that clean technologies will be chosen. A number of barriers work against technology uptake including lack of capital, banking and legal regimes that explicitly or implicitly work against new technologies, lack of IPR, lack of RD&D in developing nations, inappropriate policies and regulations (e.g., taxes, subsidies), lack of human resources and lack of institutional capacity.³ Despite recognition of these barriers, overcoming them is difficult and a post-2012 framework will need to include significant measures to ensure that the development and uptake of appropriate climate-friendly technologies takes place.

A number of approaches for a post-2012 climate regime that include technology have been put forward and are summarized in Appendix 1. These propose a number of actions to overcome barriers and stimulate cooperation including joint R&D programs, establishment of technology standards and targets, industry network formation, demonstration projects, technology funds and

3 See for example, IPCC (2000); UNFCCC (2004); Lempert *et al.* (2004); Jaccard and Mao (2002); Kline *et al.* (2004).

funding commitments for developing nations. Moving forward will require that a number of factors that influence technology cooperation be taken into account, be it under the UNFCCC or under complementary initiatives: adequate financing, implementing both “push” and “pull” measures; setting a price for carbon; identifying major technologies to advance through cooperation; recognizing the importance of technology decisions taken over the next 10 years; encouraging public-private partnerships; building on existing technology cooperation; supporting a variety of technology agreements; and using new forms of cooperation.

4.1 Financing technology cooperation

Estimates suggest that billions of dollars will be required to assist countries in technology efforts. UNFCCC’s (2007b: 92) analysis estimates that additional investment and financial flows of US\$200–210 billion are needed globally for mitigation to return CO₂ emissions to current levels by 2030. A technology approach to reducing fossil fuel emissions outlined in IEA’s Energy Technology Perspectives Report (2006 in Stern, 2006: 234) estimates a total net cost of US\$100 billion over the next 45 years to bring energy-related emissions down near to current levels by 2050. Stern (2006: 370) also suggested that, in addition to a carbon price, deployment incentives for low-emission technologies should increase two to five times globally from current levels of approximately US\$33 billion per year; and that global government energy R&D budgets need to double to US\$20 billion per year to ensure the development of a diverse portfolio of technologies. These figures, consistent with a 500 ppm CO₂-eq stabilization level, are considered to be modest when compared with predicted overall levels of investment in energy supply infrastructure up to 2030. In all cases, the absolute costs are high, although the Stern Review notes that mitigation costs will vary according to how and when emissions are cut. Without early action, the costs of mitigation will be greater.

A post-2012 regime will need to include provisions for financial resources for technology cooperation, especially resources from developed countries to help developing countries. While there are financing programs for climate-friendly technologies established under the UNFCCC and multilateral organizations, the current levels of funding will not be sufficient. The GEF (2006), as the operating entity of the financial mechanism of the UNFCCC has allocated over US\$3.3 billion to projections addressing climate change since 1991, mainly in the areas of renewable energy and energy efficiency. The SCCF, which supports programs for technology transfer and adaptation, had US\$2.7 million available for technology transfer programs in April 2006.⁴ As noted earlier, the CDM CERs had a total market value of US\$5.2 billion in 2006.

4 Canada and 10 other donors have contributed to the SCCF. The majority of funds, US\$34 million, are allocated to adaptation projects. See GEF (2006).

Multilateral development banks (MDBs) also contribute financially, with the World Bank (2006: 19) reporting that over the five year period to 2005, the World Bank Group (WBG), the African Development Bank, the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), European Investment Bank (EIB) and the Inter-American Development Bank invested over US\$17 billion in projects that directly or indirectly contribute to lowering carbon emissions in the developing countries and the EIB has invested close to US\$30 billion in similar projects in the EU, European Free Trade Association and the EU accession countries. The World Bank notes that this is still a small portion of the overall resources required for clean energy.

Tirpak and Adams (2007) report that there is a considerable gap between current public funding and projected financing requirements for energy technology. While most of this gap may be filled by private capital, public funding, particularly grants, will be needed to reduce the risks associated with the introduction of new technologies and to encourage developing countries to implement more environmentally friendly, but more costly options. A technology fund to support the development of clean technologies in developing countries will likely be given strong consideration in post-2012 negotiations. The work led by the GEF to develop a strategic program to scale up investment for technology transfer will feed into these discussions.

At the G7 meeting in Japan in February 2008, the United States, United Kingdom and Japan agreed to create a new clean technology fund. The Finance Ministers for the three countries noted that the fund responds to demands to get a head start on technologies for a low-carbon future, and aims to support progress on post-2012 negotiations. The fund, administered by the World Bank, will support publicly and privately financed projects that deploy technologies that can reduce emissions, increase efficiency and save energy. The United States has committed US\$2 billion over three years. The three countries are asking other governments to contribute to the fund, and Japan, as host of the 2008 G8 summit, will put climate change on the agenda (Paulson, Darling and Nukaga, 2008).

Funding for specific action on CCS has also attracted recent attention, with the Organization of the Petroleum Exporting Countries (OPEC) nations of Saudi Arabia, Kuwait, Qatar and the United Arab Emirates contributing US\$750 million to a research fund for CCS. OPEC stated that it would be willing to contribute to develop the technology alongside developed countries (Reuters, 2007).

The creation of a Multilateral Technology Acquisition Fund, originally put forward at the South African Indaba on Climate Action in 2006 and elaborated by the G77/China at COP-12, had generated considerable discussion and debate. The proposed fund would sponsor joint R&D of environmentally friendly technologies; buy out IPR to put technologies in the public domain; and assist

in providing export credit, export taxation reduction and exemption and export subsidies. Discussion of this fund was superseded by the decision at COP-13 to develop a financial strategic program to scale up the level of investment climate-friendly technologies to help meet the needs of developing countries.

The Sao Paulo proposal developed under the BASIC project suggests the establishment of a Technology Funding Mechanism that aims to help developing countries participate in international efforts to develop climate change mitigation or adaptation technologies and to enhance diffusion through buying down the cost of relevant technologies. The mechanism could participate in international technology R&D efforts directly, and seek opportunities to make relevant technologies available at reduced cost within a limited public domain or geographic region. The mechanism would be supported with funds derived from a 2 per cent levy on international transfers of AAUs, ERUs and RMUs, as well as funding from Annex I/B Parties. The fund would be managed by an Executive Board that operates under the guidance of the COP. The board could establish panels to assist with screening of funding proposals and provide advice on specific issues. The mechanism would function in a bottom-up manner, inviting proposals for funding in regard to technology research and diffusion activities (BASIC Task 4 Team, 2007).

Many point to the Multilateral Fund for implementation of the Montreal Protocol as a successful example of technology cooperation. Developed countries contribute to the fund, which has disbursed over US\$2 billion. The fund looks after incremental costs for industrial transition or closure, funds the cost of technology transfer and domestic development of substitutes for ozone depleting substances in developing countries, and in some cases pays royalties and acquires patent rights on new technologies. While there are lessons from this fund, it is important to keep in mind that the climate change issue is orders of magnitude more difficult to solve because of the number of emission sources, technology options and the economic cost of control.

Other proposals, discussed briefly in Annex 1, suggest financing technology funds through a carbon tax or funding commitments for developed countries under a new regime. Most proposals are vague on details and modalities, but suggest that technology funds should leverage private sector investment, and could support such activities as R&D, demonstrations, sectoral agreements, progress toward technology targets and the implementation of performance standards for power generation and energy efficiency. The discussion could be advanced by exploring the modalities of a number of public and private research funds (in a variety of sectors) that disburse significant monies for technology RD&D at the national and international level to identify effective practices.

The UNFCCC Secretariat (2007b) indicates that a substantial part of the additional investment and financing needed for climate change could be covered

by available sources if the appropriate policies and measures were put in place. There is a need for coordinated and systemic thinking on how to address the need for large-scale financing for climate-friendly technologies. This is a critical issue in the effort to address climate change and is discussed in greater detail in Chapter 5.

4.2 Technology push and pull policy options

Governments have a key role to play in establishing the right environment for technology innovation and uptake, and have a variety of options in the policy mix to instigate the development and deployment of zero- and low-emission technologies. There are various viewpoints on what is needed to initiate real action on climate change, although there is increasing consensus that both technology “push” and “pull” measures are needed to stimulate required changes (Fisher *et al.*, 2006; Grubb, 2005; Leach *et al.*, 2005).

The technology push approach focuses on the development of low emissions technologies by governments or other public institutions playing a more direct role in funding technological change through such measures as R&D policies, support for demonstration projects, technology promotion programs, and research through effective public-private partnerships. Grubb (2005) noted that proponents of a technology push approach prefer investing in innovation in the short term and adopting emission reductions when technology improvements have lowered costs.

The technology pull approach focuses on technological change as a product that typically results from economic incentives, and that such change will primarily come from the private sector in response to market signals or economic incentives. Examples of technology pull measures include corporate tax breaks for R&D expenditure, carbon taxes and emission trading schemes. This perspective assumes that profit-seeking businesses will undertake innovation to reduce emissions at less cost.

A portfolio of policy approaches on both the pull and push side will be required to encourage the development and uptake of low emission technologies, and should include options to address the “technology valley of death”—where a number of technologies fail to cross from publicly funded demonstration to commercial viability (Murphy and Edwards, 2003). A number of governments have used strategic deployment technologies to build market scale and buy down the cost of technologies. Examples include the wind power industry in Denmark and India, feed-in tariff law in continental Europe, renewable portfolio standards in the United States, ethanol requirements in Brazil and vehicle emission standards in California. Other policy measures to encourage the adoption of clean energy technologies include investments in niche markets, learning by doing, removal of barriers (including barriers to market development because of the lack of internalization of externalities such as GHG emissions), market transformation techniques to address stakeholder

concerns, and market engagement programs to move technologies from public R&D funding to engagement with the private sector.

4.3 Carbon pricing⁵

There is general agreement that if a post-2012 agreement is to stimulate technology cooperation it will need to include emissions pricing as well as significant government spending on R&D to encourage the development of new low emissions technologies (Stern, 2006; Pezzey, 2006). A key consideration in encouraging large-scale technology transfer is the design of an international framework that can encourage appropriate price signals of similar magnitude in developed and developing countries. In market economies, relative prices must push in the correct direction, or nothing of significance happens. Zero-emission technologies can be developed with R&D and technology transfer can be fostered through mechanisms that affect a small percentage of the market—but the technologies will not be widely disseminated without appropriate price signals that account for the full social and environmental costs (negative externalities) associated with climate change.

New technologies often face major disadvantages when competing on a direct cost basis with conventional technologies. First, they generate fewer environmental externalities than conventional technologies, a benefit which is typically not (or not fully) reflected in market prices. Another disadvantage is that new technologies are competing against existing technologies that have already been implemented extensively—which has allowed these existing technologies to benefit from what is often termed “learning by doing.” Allowing free use of the atmosphere as a waste receptacle gives an enormous advantage to innovations that will use it in that way (e.g., all energy-using devices, from outdoor gas patio heaters to increasingly high-powered air conditioners), and does not encourage innovation to zero- or low-emission technologies.

Policy mechanisms (e.g., taxes, regulations, fiscal incentives) are required to provide the correct signal about the full social and environmental costs of technology choices. And price signals that reflect the negative environmental and social impacts related to energy use are needed to improve the uptake 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 (2002) note that market instruments (e.g., emission caps, market share requirement, regulations) that change energy prices to reflect negative externalities are becoming increasingly 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.” Policy discussions in regard to technology transfer should account for price signals even if the issue at hand is not to design the externality-correcting mechanism.

5 The authors acknowledge that the key themes and ideas in this section were provided by Mark Jaccard.

A post-2012 framework that includes a mechanism for pricing carbon (such as a cap and trade scheme) is an important and critical aspect of technology cooperation, as it is needed to stimulate innovation and direct investments toward climate-friendly technologies.

4.4 Major technologies to reduce GHG emissions

A number of stakeholders influence technology cooperation (the key stakeholders and their roles are outlined in Annex 4), and the international climate regime could be influential in directing the decisions of these stakeholders toward technologies that help reduce emissions in both the short and long term. Many researchers argue that commercially available technologies can meet the short-term goals of the Kyoto Protocol. Pacala and Socolow's (2004) research on "wedges" of technologies predicted that reductions of 7 GtC/year can be achieved within 50 years (the rate required to achieve stabilization at 500 ppm) based on utilization of technologies already deployed somewhere in the world at commercial scale.⁶ A report commissioned by the Government of the United Kingdom (Imperial College Centre for Energy Policy and Technology, 2003) noted that it is technologically and economically feasible to move to a low carbon emission path and achieve a virtually zero carbon energy system in the long term if energy is used more efficiently and low-carbon technologies are developed and utilized. NRTEE (2006) concluded that, from a technological standpoint, Canada could meet future energy needs and address climate change by 2050.

Pacala and Socolow (2004) note the critical role of energy efficiency, CCS, nuclear power, renewable energy, biomass fuel, and deforestation and afforestation. The IEA's (2006: 6) alternative policy scenario indicates that energy efficiency will contribute almost 80 per cent of avoided CO₂ emissions by 2030. Technologies will be needed to advance more efficient use of fuels, through efficient cars and trucks; more efficient energy production and efficient use of electricity in a wide range of applications (including lighting, air conditioning, appliances and industrial motors). NRTEE's report emphasized energy efficiency, CCS, clean coal technologies, co-generation and renewables. Research conducted by the Global Energy Technology Strategy Program (Batelle, 2006) identified advanced technologies that would need to be deployed globally to address the challenge of climate change: CCS, biotechnology and bio-energy, hydrogen energy and other advanced transportation technology systems, nuclear power, renewable energy technologies, and advanced energy efficiency technologies.

The research findings of all the above groups suggest that huge market penetration will be required, and dissemination will need to take place on a massive scale for these technologies to fulfil their promise for addressing climate

6 These and other scenarios are set against a "business as usual" projection—a world that pays no attention to global carbon.

change. Technological advances and substantial cost-reducing innovations will be needed, while recognizing that economic, social and environmental problems will arise that are not present at the current limited scale of deployment (e.g., NIMBY [not in my backyard] complaints in regard to wind farms; re-allocation of agricultural land from food supply to fuel supply).

While the research on wedges helps bring the technology issue down to understandable scale, it does not address policy requirements. The huge scale-up will only take place in the proper policy environment. As well, standards will be required to drive the required increased fuel economy for vehicles, which is critical for reducing emissions in the transportation sector. In the developing world, efforts to provide modern energy to two billion people will require advances in renewable energy; and CCS, clean coal and energy efficiency (especially in the transportation sector) will be important technologies for China and India. These countries, as well as the United States, have large reserves of coal that likely will be used for electricity generation for the next 25 years.

4.5 Timeframe for technology decisions

Evidence from energy outlooks and scenarios shows that the world, including Canada, will depend on fossil fuels for many decades to come.⁷ Clean technologies will take time to penetrate the market and economic characteristics will make fossil fuels attractive for a number of years. The existing quantity of capital stock for fossil fuel production has planned asset lives of 30 years or more, and is not easily diverted to other applications or shut down early without substantial cost. Demands for decarbonization will face pressure from a “locked-in” fossil fuel infrastructure until at least 2025. Even major technological breakthroughs will come up against the economic incentive to use capital stock until the end of its lifespan.

The phenomenon of lock-in is important for developing countries, which have a high proportion of emissions from non-CO₂ gases and land-use change and forestry. This is expected to change as countries develop and the growth in global energy demand shifts to developing nations. The IEA (2006: 1) predicts that over 70 per cent of the increase in global energy demand over the next 25 years will come from developing countries, with China alone accounting for 30 per cent. This reality means that technology policy and technology cooperation take on increased significance to put developing countries on a path of clean energy development—and prevent them from getting locked into dated and higher-polluting technologies that will result in high emissions for decades to come. The IEA (2006: 6) noted that without new policies, investment over the next decade will lock in technologies for over 60 years. Technology decisions in the next 10 years are critical, especially in large countries such as

7 See, for example, IEA (2006); National Energy Board (2003); Energy Information Administration (2006).

China, India and Brazil, where there is large scope for reducing energy consumption and CO₂ emissions.

In developed countries, there will likely be greater consideration of the evolution of technology development, whereby early phase-out or enforced technology change might not always be beneficial. The efficiency of technologies is likely to increase and the emissions associated with technologies are likely to decrease over time. Thus, technologies adopted five years down the road may lead to greater reductions over the capital lifecycle (30–40 years) of the technology. The possibility also exists that new technologies may not deliver as they promise and lead to premature lock-in. Careful consideration of the costs and benefits of early phase-out of capital equipment will need to guide industry decisions and government policy.

Understanding the capital stock cycle gives governments and companies a framework for integrating R&D and commercial deployment for climate-friendly technologies with periods of high-intensity plant or capital stock turnover. Work has been done in this area, with Canada's Clean Coal Technology Roadmap determining when coal-fired facilities would reach their 40-year life, helping firms and governments to plan replacement schedules and investment costs (Van Ham, 2005). Such knowledge can help policy-makers develop incentives for firms to reduce GHG emissions, and this also applies to decisions and major investments in new manufacturing, energy production and distribution infrastructure, and transportation. Governments might also provide a framework for considering significant innovation such as a shift to new kinds of infrastructure or delivery systems required for hydrogen, biogas, fuel cells, as well as anticipating planning, regulatory and systems issues arising from technological change (e.g., transmission and distribution matters that arise from higher levels of wind energy generation). Lempert, *et al.* (2005) note that, in the near term, patterns of capital consumption will be driven by factors largely unrelated to climate change and climate change will only be used as an investment decision factor when obligated to do so by regulations. Implementing effective policy frameworks and developing climate-friendly technology in a timely manner is of critical importance to ensure sustainable choices in capital stock replacement or addition.

4.6 Public-private partnerships

For successful technology cooperation it will be important to respond to the needs of business and private sector investors, given that the private sector is the main means for technology diffusion and private sector investments constitute the largest share of investment and financial flows (UNFCCC, 2007: 170). Exploration of options to facilitate the uptake of climate-friendly technologies and the provision of private capital investment in international frameworks is needed. This can include the strategic use of ODA programs to support public-private sector partnerships; the linking of ODA efforts with the export crediting agency loans (e.g., assisting with the incremental costs of cli-

mate-friendly technologies); encouraging climate-friendly loans and investments through the MDBs; and bilateral negotiations. The UNEP Sustainable Energy Finance Initiative (SEFI) is such an example, being set up as a platform to provide financiers with the tools and information to drive financial innovation in the clean energy sector, and to stimulate private-public partnerships to share costs and lower barriers.

Technology cooperation will need to encourage the transfer of best available and least polluting technologies, and companies will need to be compensated fairly for their efforts in this regard. This raises an important and contentious issue in regard to private sector participation and technologies in international frameworks—IPR. Many low-carbon technologies are unaffordable to developing countries, and the question of who will buy down the costs of low-carbon technology will arise in post-2012 negotiations. Encouraging technology cooperation at the early stages of R&D or for technologies that are not expected to be commercially viable in the foreseeable future can avoid the IPR issue, but it does little to drive the massive changes needed in energy systems. There is scope for the innovative use of ODA to assist in overcoming IPR barriers, and the issue of a fund to buy out patents and leverage private investment—originally put forward by the 2006 South African Ministerial Indaba on Climate Action and taken up by the G77-China—will remain a key consideration for UNFCCC technology discussions.

4.7 A variety of technology cooperation agreements

Technology cooperation can take on many forms, including collaboration between investors and local communities, and private companies and governments. Such partnerships can take place between developed and developing nations, between countries in a region, between developed countries and between developing countries. Technology cooperation agreements could be part of the overall climate regime, or negotiated separately with such agreements being possible at bilateral, regional and multilateral levels. They could emerge within or outside of the formal parameters of the UNFCCC.

Technology cooperation with large developing countries could be a means of stimulating action in these countries, as well as help to build up goodwill and increased understanding of each other's often divergent viewpoints. Such cooperation will need to include large commercial, private sector agreements to create the technology change on the scale that is needed. Technology cooperation might also be considered among the top 20 emitters that are responsible for approximately 80 per cent of global emissions. While issues of global equity might suggest that a narrow technology cooperation approach is not politically feasible; issues of global security and the global environment could override this concern. Diffusion of climate-friendly technologies in these 20 countries could yield a huge impact—a critical mass of technology consumption that not only lowers emission, but also reduces technology costs and makes leading-edge technologies more widely available around the world.

Support for lesser developing nations and LDCs is also important, as they require assistance in capacity building, policy development, technology diffusion and costs. Traditional patterns of support—ODA and through multilateral institutions—will remain important and be a key means for technology change in LDCs. Support for south-south cooperation could be a cost-effective means to assist developing nations. For example, considerable expertise in the area of bioenergy exists in developing countries and would be more easily transferable than northern solutions. As well, adaptation technologies may be in greater demand in many of these countries, which are likely to suffer greater environmental and economic stress as a result of climate change. Funding to support this cooperation will be required from developed nations.

A number of multilateral technology agreements have been initiated in the past few years, and are briefly discussed in Annex 2. Most of these agreements are in their early stages, making evaluations of their effectiveness less than certain. Fujiwara's (2007) review of the APP indicates that the governments of the United States and Australia have provided only modest seed money, approximately US\$45 million and \$75 million respectively, which is meant to mobilize investment from the private sector. The eight public-private sector task forces addressing clean development issues have each developed projects in the initial six partner countries (not including Canada, which joined in October 2007), despite considerable differences in national circumstances. The APP has begun to reach out to other organizations, such as the IEA and IFIs, suggesting that there is possibility of coordination with other efforts. Activities to date have focused on data collection and information sharing; projects were launched in 2006, but these are still in progress and have yet to deliver tangible benefits.

Grubb (2005) has noted that many current technology agreements focus on information sharing, but do not provide clear details on the instruments to be employed, what kinds of technologies will benefit, which types of technologies will work best between developed and developing nations, and their political viability and impact. He concludes that future technology agreements need to be better defined and designed than present agreements to ensure success, and that successful technology cooperation would need greater output orientation. Given the importance of ramping up deployment of technologies in the short term to prevent technology lock-in, further research is needed to assess the effectiveness of the numerous technology cooperation arrangements to contribute to the development of an effective international technology framework for post-2012.

4.8 Building on existing institutions and programs

Technology cooperation in a post-2012 climate regime should make use of and build on existing programs and institutions. The work of the EGTT on enabling environments is an important precursor to cooperation agreements, and activities to identify technology needs offer insights about key technologies to promote under bilateral and regional technology cooperation agreements.

The GEF and its implementing agencies are established and functioning, indicating that such institutions could be used to support technology cooperation programs, and could house any technology funds that might be established (if indeed any are established). This is not to say that these organizations do not require improvements, but “fixing” these entities likely would be more cost effective than developing new institutions; although there could be considerable resistance from lesser developed countries. The Resource Allocation Framework for the GEF Trust Fund channels climate money primarily to large emitting and rapidly growing countries, and the requirement of generating global environmental benefits can be very difficult to meet when applied to adaptation funding.

International technology efforts should build on the work of the G8, IEA and specific technology partnerships, such as the APP, CSLF, IPHE and M2M. While the outputs of these entities have not yet generated significant GHG emission reductions, the institutions are established and have taken important first steps in collaboration, including information exchange.

Efforts to build on the CDM could work to overcome perceived weaknesses with the mechanism while widening the scope of eligible activities. The CDM could encourage greater technology cooperation and contribute to sector-wide technological transformation by expanding to include policy and sectoral CDM. The former would allow activities under public policies aimed at reducing GHG emissions to be eligible for the CDM; while sectoral CDM would allow GHG emission reductions activities along the lines of a sector or sub-sector (e.g., cement) by setting no-lose sectoral targets while allowing for sales of CERs.

Current private sector efforts, such as the work of the Cement Sustainability Initiative, should inform the design of sectoral agreements. It is widely recognized that agreements based on technology standards could encourage emission reductions, and work such as this is needed and should be encouraged to ensure the proper design and implementation of agreements.

4.9 New technology development models

In order to succeed, technology cooperation efforts will need to build on new technology innovation strategies and approaches that are emerging around the world. Many of these go beyond the conventional approaches of information networks, research or demonstration projects that have been the standard *modus operandi* of climate technology cooperation. Alternative strategies and approaches include: short- and long-term no-carbon emitting technology goals and targets; specific technology commercialization agreements; sectoral no-emissions goals; CO₂ and energy efficiency performance standards; niche market strategies; technology prizes; advanced purchase commitments; government procurement; new strategies to address IPR; transition management policies; policies that bolster public and private research and development; and many other new and aggressive climate and energy strategies that require collective commitment.

Milford (2007) proposes a new global climate technology innovation initiative—a “distributed” model of climate innovation and commercialization—that goes beyond the current climate technology approaches. The distributed innovation approach is found in the information technology, industrial, agriculture and health sectors, but has never been applied to climate technology. The approach brings together parties along a value chain for select technologies to collaboratively identify problems and solutions. Participants in distributed innovation projects include the upstream research community (e.g., university and governments) with the downstream finance and deployment community (e.g., companies, investors, foundations, financial institutions). This innovative technology initiative enables people to attack the problem from multiple intervention points including, but not necessarily limited to, technical, market and financial, policy, regulatory, legal, institutional and intellectual property issues. Team members would come from across the globe, with teams of experts assembled around specific climate technologies and supported by a global innovation community.

The point is that the international climate community needs to consider strategies that incorporate innovative thinking and go beyond established patterns of cooperation.

5.0 Reflections on a way forward

The Bali Action Plan clearly indicates that a post-2012 regime will be expected to encourage and support technology cooperation efforts that will stimulate the massive scale-up of technologies needed across the world. The design of a post-2012 regime should build on the ideas put forward in Section 4, including: adequate financing, use of both technology push and pull policy measures; an appropriate price signal to stimulate and steer technology investments; capital investments directed in the short term toward clean technology; private sector involvement; building on existing cooperation and use of new technology approaches.

A post-2012 approach to technology will also need to encourage action in all countries, as a global effort will be needed to halve emission reductions by 2050. Cost-effective technologies will need to be available to end users in developing countries on preferential terms, and technology development and innovation will need to be encouraged in developing countries to build on strengths and encourage accessibility in all countries. For example, Brazil is a leader in biofuels, India is a significant player in wind industry, and China is a dominant manufacturer of solar power components. A global framework will need to recognize the various strengths of different partners, and, as described by the South Centre (2007: 17):

“ensure that the best appropriate technologies for climate change monitoring, mitigation and adaptation be made available to developing countries under conditions that are cost-effective or commercially preferential, and

with the corresponding policy, technical assistance and financial support package needed to make it easy to developing countries to innovate and adapt transferred technologies to make them more appropriate to their development and climate change needs and priorities.”

5.1 Considerations for a post-2012 technology regime

A post-2012 regime with a *longer time horizon for commitments* to mitigation is necessary to promote the development of reasonably-priced climate-friendly technology. Some, but not all, emission reductions can be made in the short to medium term; and a new climate regime will need to prepare for emission reductions over the longer term. Such a focus will help to encourage national policies and private sector investments that drive clean investments over the longer term. But a longer time frame needs to be accompanied by shorter term “flag posts” in appropriate forms (e.g., amount spent on technology, capital stock turnover rates) to ensure the world and countries are on track to meet the longer term target.

Technology development can be stimulated by *appropriate carbon pricing*, which can be brought about through tax, trading or regulation. Many low-carbon technologies are more expensive than fossil fuel alternatives, and carbon pricing provides incentive to develop and deploy technologies that reduce carbon. Countries are unlikely to endorse a carbon tax in an international post-2012 regime; thus, carbon pricing will likely continue to be created through cap and trade schemes, such as the European Union Emissions Trading Scheme and those being developed in Canada and other countries.

A post-2012 technology regime should *facilitate action through multiple venues*, building on the numerous multilateral technology initiatives underway. A number of technology approaches can occur simultaneously, with countries being able to work with like-minded nations on a multilateral, regional or bilateral basis. Many countries have expressed interest in technology initiatives that take place in less formal settings with varying combinations of nations who are interested and willing to act on specific technologies or sectors. These groups can include wider participation, including the private sector, NGOs, provincial governments and municipalities. These groups may be able to move forward in a more efficient manner, and may be better positioned to act on new and innovative approaches in a more expedient manner, not being constrained by UN consensus rules.

International technology agreements are needed, whether negotiated within or outside the official auspices of the UNFCCC. International R&D agreements could encourage countries to step up contributions to R&D on clean energy breakthrough technologies. While the private sector is expected to make up a large portion of the gap between current funding levels for technology cooperation and anticipated needs, it is important to recognize the role of the public sector funding in basic R&D. Direct subsidies to R&D are required and are a neces-

sary supplement to a cap and trade regime. Alfsen and Eskeland (2007) envision that each party to an agreement would be assured of receiving a proportional share of the resources; but the teams carrying out the research would be international in scope, encouraging access to knowledge and technology transfer.

International agreements could include cooperation in climate-related science and monitoring, as the linkage between climate science and policy will be a factor of success in the post-2012 regime. Science needs to form the basis of any post-2012 agreement, and there needs to be increased support for institutional building in developing countries, as well as increased technical cooperation efforts between countries.

International sectoral agreements will also be an important component of technology cooperation. Efforts would need to go beyond current actions in such sectors as cement, steel and aluminum, expanding to include the critical economic sectors of: energy, transportation, buildings, agriculture, forestry and other industrial sectors. This would broaden the actors in climate change actions to sectoral ministries and departments in governments beyond environment; and help to shift the focus to one of national and economic development, rather than a narrowly defined environmental issue. Sectoral agreements could support specific programs that have real targets and timelines (e.g., benchmarks such as technology market penetration rates to achieve by a set date); encourage private sector involvement in sector-specific solutions to help address competitiveness concerns; and help to harmonize adaptation and mitigation efforts (e.g., renewable energy projects that lessen reliance on forests for bio-fuels; building standards and regulations that meet energy efficiency and adaptation concerns).

The CDM could be expanded to include *policy and sectoral CDM*. But before considerable efforts are made to develop modalities for new forms of CDM, support should be provided for programmatic CDM to enable the design and implementation of wide programs in the renewable energy, energy efficiency and transportation sectors.

Adequate *financial support* will be needed to support technology development in and transfer to developing nations. Traditional patterns of financial support—ODA through bilateral and multilateral institutions—will remain important and be a key means for technology change in LDCs. Developed countries will be encouraged to increase levels of ODA and to ensure that climate change and clean energy considerations are mainstreamed in programs and projects. The outcomes of the World Bank's clean investment framework could provide valuable lessons on effective aid programming. But efforts will need to go beyond ODA, and be at levels that are greater than current ODA programming for climate change efforts. Increased funding commitments for technology from developed countries are likely to be part of a post-2012 agreement, and this could include a technology fund. This could have any number of objectives—including helping to pay down the costs of IPRs, and encouraging inno-

vation in transferring and adapting new technologies in developing countries—and will be informed by the work of the GEF and other MDBs in setting up a strategic framework for increasing technology financing and investment.

A post-2012 regime could include *technology commitments* on the part of developed countries to encourage both domestic and international action. Developed nations could agree to technology cooperation commitments under the UNFCCC, including financing commitments for actions in developing countries, as well as agreeing to undertake action at home and with like-minded countries on a bilateral, regional or multilateral basis. After a certain period, the actions could receive international review.

Consistent with the Bali Action Plan, a post-2012 framework would also need to encourage technology actions in developing countries that are measurable, reportable and verifiable. This could include commitments on the part of developed nations to work with developing nations to develop and use low carbon technologies. Such actions could be measured through technology targets and benchmarks (e.g., low carbon fuel standards by a specified date), technology penetration rates (measured in terms of market share or market saturation in an identified market, such as percentage of hybrid vehicles in the passenger car market or percentage of wind turbines in a country's electric sector), and technology financing targets (e.g., support for demonstration projects that aggregate to an identified amount, such as 1–2 GW per year).

5.2 Possible role of the UNFCCC

The UNFCCC has played a role in technology cooperation, primarily through the SBSTA and the EGTT, by assisting developing countries in preparing technology needs assessments, assessing barriers to technology transfer, developing information tools and technical reports. Overall, the UNFCCC has played an awareness and information sharing role, which has been complemented by a facilitative role of helping developing countries create the right enabling environment to encourage technology investment and development. The UNFCCC also oversees the funding allocated to the GEF's focal area of climate change and under the special climate change funds. The UNFCCC Secretariat also plays an important role in communicating with other conventions to seek synergies in technology actions, as well as with the private sector, NGOs and international organizations such as the World Trade Organization.

When exploring technology cooperation in a post-2012 regime, there is some expectation that the UNFCCC will be more involved in the implementation of technology activities. But technology efforts will need to be incorporated into the decision-making efforts of various stakeholders (described in greater detail in Annex 4) that have key roles to play in ensuring technology cooperation occurs at the scale required. Governments create the appropriate investment climate and support RD&D through a variety of policy tools, the private sector will be the source of the majority of investment, and development assis-

tance providers will distribute funds for technology cooperation through a variety of channels and will be of particular importance in stimulating technology development in poorer countries.

It is perhaps most appropriate that the UNFCCC play a facilitative role in regard to technology cooperation in a post-2012 regime. This could include continued work under the EGTT, with a particular focus on issues of interest to poor developing nations, many of which are not yet at an appropriate stage of development to participate in many technology cooperation initiatives. Thus, there will likely be a continued role for the UNFCCC funds to assist in directing technologies to poorer nations (and of course, bilateral and multilateral assistance will also be expected to play a role in this regard). The UNFCCC Secretariat could establish reporting and monitoring mechanisms to ensure that the contributions of technology programs to global emission reductions are recognized and accounted for. The secretariat could also help coordinate technology cooperation activities to prevent duplication of effort and encourage synergies.

5.3 Implications for Canada

Many of Canada's strengths can be accommodated in the framework set out in Section 5.2., and Canadian interests can be advanced through a number of the suggested ways forward.

A longer timeframe for commitments to mitigation is consistent with the Canadian Government's stated goal of reducing GHG emissions by 60–70 per cent by 2050. It also helps to address concerns from industry about the timing of the replacement of the existing quantity of capital stock. A longer timeframe will likely find favour in Canada because of the resource-intensive nature of the economy, where continued economic growth with deep CO₂ reductions will require the uptake of a number of new technologies, including CCS which likely will not be viable until 2015 at the earliest.

Appropriate carbon pricing is also consistent with the new regulatory framework which will establish a cap and trade scheme for large emitters. A number of provinces have been investigating emissions trading schemes, and British Columbia, Quebec and Manitoba have signed on to the Western Climate Initiative with six western States that plans to develop a cap and trade scheme for 2009. Emissions trading and technology should coexist independently on the international stage, although at the domestic level a "safety valve" is possible, whereby price caps raise revenue from emissions permit sales, with the revenues directed to technology subsidies. This is consistent with Canada's plan to include a technology fund as a compliance mechanism.

Canada could be particularly interested in *facilitating action through multiple venues*. Regardless if it is a world with or without targets, encouraging technology cooperation agreements at a variety of levels would best serve Canada's interests. Bilateral agreements could promote action with the United States

and other large emitters, focused technology agreements could promote Canadian technologies in identified developed and developing country markets, and action with the top 20 emitters might be a means of kick-starting deep emission reductions in these countries. Public-private sector partnerships should be encouraged within technology agreements, and the views of provinces, leading Canadian firms, NGOs and other stakeholders could be sought on the structure and framework of such partnerships and agreements.

Canada's efforts should build on the work of the G8, IEA and specific technology partnerships, such as CSLE, IPHE and Methane to Markets. Canada could pursue an innovative technology path under an established technology agreement, or opt to establish and lead a distributed model of climate innovation and commercialization for a select technology. The technology to pursue could be based on needs at home (e.g., CCS), or on possibilities to increase access to export markets (e.g., fuel cells). Supporting a case study for the distributed innovation approach could help to position Canada as a leader in technology innovation.

While climate change is a global approach requiring global action; if the international approach should falter or face large problems, technology cooperation on a bilateral or regional basis could be beneficial for Canada. First and foremost is technology cooperation with the United States. Domestic action to reduce emissions is inextricably linked to that of the United States, which is the recipient of a large proportion of Canada's oil and gas exports, the equivalent of 2.3 million barrels of oil a day (NRCan, 2007). Economic and trade ties, cultural similarities and the fact that the United States is a global innovation centre mean that technology cooperation with the United States—especially in the areas of oil sands, electricity generation, transmission, refining, energy efficiency, automobiles and appliances—could be a key component of Canada's climate change policy, regardless of the shape of the international framework. The influence and economic strength of the United States means that Canada would need to carefully consider where it would exert influence to be a leader in bilateral or North American technology cooperation programs.

An *expanded CDM* could offer greater opportunity for Canadian firms to offset emissions. The successful implementation of programmatic CDM and sectoral CDM would likely increase available credits from projects and programs of activities in the sectors of energy efficiency, renewable energy and afforestation/reforestation, all of which have potential high development dividends.

Canadians would likely be interested in *international technology agreements*, especially if Canada has the ability to select which agreements it participates in, allowing it to assist developing nations, develop technologies that demonstrate domestic strategic importance, or gain access to markets. Canada will need to provide strong support for S&T in the three identified priority areas in Canada—clean electricity, clean carbon-based fuels, and energy efficiency. Technology efforts at the domestic level should be broad to allow provinces to focus on those technologies that best apply to their natural resource base, and

Canada will need to participate in international sectoral agreements, especially in sectors of strategic interest, such as CCS, biofuels, and oil and gas.

Canada will also need a strategic assessment of where technology leadership could contribute the most in regard to international negotiations. In short, what areas of technology leadership could impact on Canada's ability to influence other countries' participation and action under the UNFCCC? For example, China and India have expressed strong interest in clean coal technology solutions to stimulate emission reductions in their fast-growing economies, and technology agreements in the areas of Canadian expertise could be pursued with these countries. Support to agreements to enhance climate change monitoring capabilities could draw on Canada's significant expertise in this area. A previous Canadian government proposal suggested that five per cent of R&D programs be done in partnership with developing nations (Anderson, 2004); this could be a consideration to stimulate developing country participation in R&D agreements.

Canada will need to provide *financial support* for technology cooperation efforts in developing countries. In regard to ODA, Canada could ensure that climate change and clean energy considerations are mainstreamed in all aid programs. Canada could also explore options for the innovative use of aid to facilitate the uptake of commercial technologies, leverage private capital investment and assist in overcoming IPR barriers. Options to explore include linking ODA efforts with the export crediting agency loans (e.g., assisting with the incremental costs of climate-friendly technologies); encouraging climate-friendly loans and investments through the MDBs; and using bilateral negotiations to encourage countries to pursue climate-friendly technology pathways. The promotion of Canadian private-public sector partnerships in international technology cooperation efforts could include the use of ODA to promote leading Canadian private sector technologies. Canada could formalize its commitment to developing countries by launching a re-invigorated Canada Climate Change Development Fund (CCCDF) or similar type program. The first CCCDF generated substantial goodwill with high emitters and LDCs. A new program could be structured to support technology cooperation efforts, including mitigation efforts in high-emitting countries and adaptation efforts in least-developed nations.

Canada's support will need to go beyond ODA, and Canada will need to consider increased contributions at home and abroad to meet *technology commitments* in a post-2012 agreement. This could include increased funding for RD&D at home, efforts to establish and achieve technology penetration rates,⁸

8 For example, an NRCan study established market penetration rates for renewable energy in Canada. Such targets included installed wind capacity of 10,000 MWe by 2015 and 25,000 MWe by 2050; and installed photovoltaic capacity of 437 MWe by 2015 and 10,000 MWe by 2050 (Brandon, 2004).

contributions to an international technology fund and assistance to developing countries. Given the relative wealth of Canada, contributions to support technology cooperation in developing countries will be expected and should be encouraged. To keep administration to a minimum, it could be suggested that such efforts build on existing programs and mechanisms (e.g., a vastly expanded technology component in the SCCF).

Canada will be expected to make real commitments under a technology pillar in a post-2012 agreement. This could include entering into and financing technology agreements to share information, undertake R&D, implement technology demonstrations and transfer technology. For example, sectoral cooperation with other countries on technology standards could pave the way for more effective agreements that include output-oriented goals; and options could be explored for linking developing country domestic measures and targets with international technology efforts. Also important will be reporting to Canadians on action undertaken domestically and internationally.

If Canada is serious about climate change, then support for technology initiatives at home and abroad will need to be ramped up. New policies and programs to promote technology have been introduced at the federal and provincial level, but more are needed to demonstrate real commitment on the climate change issue. These could include establishing national renewable portfolio standards, levelling the playing field between renewable and fossil fuels by phasing out fossil fuel subsidies, adopting cap and trade systems, encouraging ecological tax reform and adopting energy efficiency incentives.

6.0 Conclusion

Technology is identified in the Bali Action Plan as a key component of any post-2012 framework. A number of considerations have been put forward in this chapter, looking at options that can help to ensure that the best technologies for climate change monitoring, mitigation and adaptation are available to developed and developing countries under conditions that are appropriate to their development and climate change needs and priorities.

A massive scale-up of climate-friendly technologies is required internationally to meet the goal of the UNFCCC, and Canada should perceive this as a significant opportunity. Canada will need to establish and support processes and programs that can both contribute to and benefit from international technology cooperation. Technology cooperation offers opportunities to demonstrate leadership on important technology options, as well as build goodwill with large emitters that require the best available technologies to reduce emissions.

To be perceived as a serious player on the technology cooperation front and demonstrate commitment to furthering the goal of the UNFCCC, Canada will need to undertake real action at the domestic and international levels, enter into a range of technology cooperation agreements (e.g., bilateral or regional on a specific technology basis; R&D agreements with developing nations; sec-

toral agreements with like-minded nations; technology support for LDCs) and allocate significant funding to technology efforts at home and abroad.

Annex 1: Examples of proposals/approaches that support technology cooperation

Proposal	Approach
Agreement on Energy Efficiency Levels (Ninomiya, 2003)	<ul style="list-style-type: none"> International agreement on energy efficiency levels in major emitting industries and energy efficiency standards for major appliances in the residential and transportation sectors. Participation is encouraged by developed and major developing countries. An R&D fund would support the development of appropriate technologies.
Best Available Technologies (BAT) Protocol (Tol, 2002)	<ul style="list-style-type: none"> Adoption of a protocol that specifies the speed at which BAT standards would progress. Standards only apply to developed nations.
Carbon Credit Banking, Dual Track Approach and Technology + Compensation Fund (Kameyama, 2006)	<ul style="list-style-type: none"> Numerous technology agreements are signed on a bilateral or regional level, and each establishes a technology compensation fund. A group of scientists, such as the IPCC, monitor global emission trends; if the group finds emissions are likely to go above a climatic limit, all technology agreements around the world are required to pay money into their respective compensation funds to spread technology and speed up emissions reductions.
Common Technology Standards (Barrett, 2001)	<ul style="list-style-type: none"> Establishment of technology protocols for developed nations in the use of hybrid engines, fuel cells or fossil fuel power plants to capture and store carbon. Developing countries bound by technology standards in separate protocols, with diffusion of technologies financed by developed countries.
Energy Efficiency Protocol (European Commission, 2006)	<ul style="list-style-type: none"> The European Commission has proposed the development of an international framework agreement on energy efficiency with key external trading partner countries (including Brazil, China, India, Japan, Russia and the United States) and international organizations (United Nations, the International Energy Agency, G8 (Gleneagles Dialogue on Climate Change), the World Trade Organization, the World Bank, the EBRD, EIB and other institutions). The agreement will focus on improving energy efficiency in end-use sectors and in energy transformation and will use a large number of policies and measures. The aim is to develop closer co-operation on energy efficiency measurement and evaluation, minimum performance requirements for goods and services, labelling and certification, energy audits, stand-by losses, and codes of conduct.
Gradual Process of Accommodation (Wara, 2006)	<ul style="list-style-type: none"> The CDM is restricted to CO₂; multilateral funds for technologies are established to encourage action to reduce other GHGs in key developing countries.
Hundred-flowers-bloom strategy (Sanden and Azar, 2005)	<ul style="list-style-type: none"> A portfolio of technology specific policies are needed to meet longer-term targets (in addition to economy wide price incentives for the short term), including RD&D funding, support for industry network formation, niche market creation and institutional adaptation. A carbon levy of US\$1 per tonne could be redirected into RD&D.
International Sectoral Agreements (Bodansky, 2007)	<ul style="list-style-type: none"> Sectoral approaches take on the form of inter-governmental agreements in which governments commit to actions intended to reduce GHG emissions from a given sector.
Portfolio Approach (Benedick, 2001)	<ul style="list-style-type: none"> Adoption of a portfolio of policies coordinated with like-minded nations, including technology targets for power generation and fuel efficiency for vehicles. A carbon tax will fund new technology research and developed countries will fund technology transfer programs.

Proposal	Approach
Sao Paulo Proposal: The BASIC Project (BASIC Task 4 Team, 2007)	<ul style="list-style-type: none"> • Transfer of existing technology is facilitated by enhancing the provision of information on available technologies and the resolution of specific disputes over restriction on technology transfer. • A new Technology Funding Mechanism governs an Executive Board that takes over from the EGTT will promote research and development of new technologies.
Sector-based Approach (Schmidt, Helm, Lee and Houdaschelt, 2006)	<ul style="list-style-type: none"> • To encourage developing countries to pledge to meet a voluntary sector “no lose” intensity target, developed nations and international financial institutions would provide a <i>Technology Finance and Assistance Package</i>. • The package would support specific commitments for the deployment of advanced technologies, development of SMEs to assist in technology implementation, capacity building, and support for pilot and demonstration projects. It would be designed to leverage increased private sector investment.
Technology Backstop Proposal (Edmonds and Wise, 1998)	<ul style="list-style-type: none"> • Establishment of medium-to long-term international technology targets and/or standards for new fossil fuel power plants and synthetic fuel plants installed in developed countries after 2020. • Developing countries would be subject to targets upon reaching identified levels of development.
Technology Cooperation: Pocantico Dialogue (Pew Center, 2005)	<ul style="list-style-type: none"> • Targeted efforts could include agreements or commitments among groups of countries to better coordinate and increase government support for technology initiatives. • Examples include demonstration projects, partnerships with industry, technology-sharing terms; sectoral agreements; tax incentives and loan guarantees form ECAs to promote private sector investment; long-term concessionary loans through IFIs; capacity building; and agreements among governments to ease access to commercial technologies while protecting property rights and other legal interests.
Technology Innovation (Grubb, 2005)	<ul style="list-style-type: none"> • Emphasizes combination of technology cooperation and carbon pricing. Innovation to be promoted through a number of options including Clean Energy Funds (for R&D, demonstrations, venture capital), technology transfer agreements, strategic deployment agreements.
Zero Emissions Technology Treaty – ZETT (Sugiyama, <i>et al.</i> , 2003)	<ul style="list-style-type: none"> • An orchestra of treaties, including the ZETT that sets zero CO₂ emissions from the energy sector as the long-term goal to encourage technology change. The treaty begins as a non-binding pledge and review system. • Funding commitments for R&D are included.

Annex 2: Agreements between like-minded countries

Agreement	Description
Asia Pacific Partnership on Clean Development and Climate http://www.asiapacificpartnership.org	In 2005, Australia, China, India, Japan, the Republic of Korea and the United States announced the Asia Pacific Partnership on Clean Development and Climate (APP). In 2007, Canada joined the partnership, which is described as a model for public-private collaboration, and aims to develop and deploy low-emissions technologies. Public-private Task Forces developed action plans in eight sectors: cleaner fossil energy, renewable energy and distributed generation, power generation and transmission, steel, aluminium, cement, coal mining, and buildings and appliances.
Carbon Sequestration Leadership Forum (CSLF) http://www.csforum.org	The CSLF is an international climate change initiative that is focused on development of improved cost-effective technologies for the separation and capture of carbon dioxide for its transport and long-term safe storage. The purpose of the CSLF is to make these technologies broadly available internationally; and to identify and address wider issues relating to carbon capture and storage. This could include promoting the appropriate technical, political, and regulatory environments for the development of such technology. Canada is a member of the CSLF, which is comprised of 22 members, including 21 countries and Canada.
Generation IV International Forum (GIF) http://gif.inel.gov/	Generation IV International Forum (GIF) was chartered July 2001 to collaborate efforts of leading nuclear technology nations in developing next generation nuclear energy systems. In 2005 five of the forum's 13 member countries signed a milestone agreement for the development of advanced nuclear energy systems. The 13 members include Canada.
Global Nuclear Energy Partnership http://www.gnep.energy.gov/	The Global Nuclear Energy Partnership focuses on the development and deployment of advanced nuclear recycling and reactor technologies. This initiative aims to develop worldwide expanded use of economical, environmentally clean nuclear energy to meet growing electricity demand, while virtually eliminating the risk of nuclear proliferation. It would achieve its goal by having nations with secure, advanced nuclear capabilities provide fuel services—fresh fuel and recovery of used fuel—to other nations who agree to employ nuclear energy for power generation purposes only. Sixteen nations signed on to this international cooperation agreement in September 2007; Canada attended the meeting as a candidate partner/observer country.
IEA Technology Agreements (Implementing Agreements) http://www.iea.org/Textbase/techno/index.asp	The IEA provides support for over 40 international cooperation and collaborative agreements in energy technology R&D, deployment and information dissemination, called "Implementing Agreements." The agreements are in the areas of fossil fuels, renewables, energy end-use (transportation, industry, buildings, and information centres/systems analysis), transfer of technology and fusion power. For example, the Global Market Initiative for Concentrating Solar Power (GMI-CSP) aims to achieve an installed solar thermal capacity of approximately 5,000 MW by the year 2015. Another example is the Climate Technology Initiative (CTI) aims to accelerate the development, application and diffusion of climate-friendly technologies and practices, with an emphasis on technology transfer. Its work is closely linked with the UNFCCC process. Canada and eight other countries are members of the CTI.

Agreement	Description
<p>International Partnership for the Hydrogen Economy (IPHE) http://www.iphe.net</p>	<p>The IPHE, established in 2003, aims to accelerate the development of hydrogen and fuel cell technologies. The Partnership provides a mechanism for research, development, demonstration and commercial utilization activities related to hydrogen and fuel cell technologies. It acts as a forum for advancing policies and standards that could contribute to an effective transition to a hydrogen economy. Sixteen countries, including Canada, are members of the IPHE.</p>
<p>ITER http://www.iter.org/ (ITER means "the way" in Latin. Formerly interpreted to stand for International Thermonuclear Experimental Reactor, this usage has been discontinued.)</p>	<p>ITER is a joint international research and development project that aims to demonstrate the scientific and technical feasibility of fusion power. The aim of ITER is to show fusion could be used to generate electrical power, and to gain the necessary data to design and operate the first electricity-producing plant. ITER will be constructed in France. The partners in the project are the EU, Japan, China, India, the Republic of Korea, the Russian Federation and the United States.</p>
<p>Methane to Markets http://www.methanetomarkets.org</p>	<p>The international initiative advances cost-effective, near-term methane recovery and use as a clean energy source. The partnership currently focuses on four sources of methane emissions: agriculture (animal waste management); coal mines; landfills; and oil and gas systems. Twenty national governments, including Canada, accounting for approximately 60 per cent of global methane emissions from the targeted sources, are partners. Project network members include private sector entities, development banks, non-governmental organizations, financial and technical experts with experience or interest in methane recovery.</p>
<p>Renewable Energy and Energy Efficiency Partnership (REEEP) http://www.reeep.org/</p>	<p>REEEP is a global public-private partnership that structures policy initiatives for clean energy markets and facilitates financing for sustainable energy projects. It is backed by more than 200 national governments, businesses, development banks and NGOs; and funded by a number of governments including Canada. The aim of the REEEP is to reduce GHG emissions, improve access to reliable and affordable clean energy services, and promote energy efficiency and the share of indigenous renewable resources in the energy mix of nations.</p>

Annex 3: Major stakeholders in technology cooperation

Advancing technology cooperation in a post-2012 climate change regime will require concerted support and input from a variety of stakeholders. The different roles of the stakeholders are described below.

1. UNFCCC

Technology transfer has been on the agenda of the UNFCCC's Subsidiary Body for Scientific and Technical Advice (SBSTA). Early work focused on the gathering of information related to technology and technology transfer, including technical reports and workshops on inventory, needs assessments, barriers, capacity building, financial flows and enabling environments. Much work related to technology transfer has been taken up by the EGTT, which reports to and supports the work of the SBSTA. At COP-7, Parties agreed on a framework for technology transfer, in the areas of technology needs and needs assessment, technology information, enabling environments, capacity building and mechanisms for technology transfer. The EGTT had its mandate extended for five years at COP-13, and has been asked to pay particular attention to financial support for technology initiatives, and to work on performance indicators for monitoring and evaluating progress on the development, deployment and transfer of environmentally sound technologies.

At COP-13, governments agreed to develop a strategic program to scale up the level of investment for the transfer of both the mitigation and adaptation technologies to help meet developing country needs. The program aims to encourage concrete demonstration projects, create more attractive environments for investment, and provide incentives for private sector involvement in technology transfer. The GEF will work with MDBs and representatives of the private financial sector to elaborate the program. This work will inform the technology development and transfer pillar of the Bali Action Plan, agreed to at COP-13 in 2007.

2. National governments

National governments have a key role to play by creating the appropriate investment climate and helping to manage risk in the deployment of technologies. Policies and programs at the national level can enhance technology development across the innovation chain, and governments can use a variety of policy tools (e.g., fiscal measures; regulatory policy; and information, labelling, voluntary and other assistance programs) to enhance technology RD&D. Government policies can assist in reducing firm's uncertainty about investments in new technologies, and policies designed to enhance "learning by doing" can help to increase the likelihood that new technologies will be deployed during times of capital turnover. Governments can also induce firms to retire old technologies through regulatory reform, standards, infrastructure

policies, and information dissemination programs. Governments can also promote a strong degree of public-private technology cooperation. A clear policy signal on climate change action can provide consistency and assurance to energy innovators and technology developers, and indicate which technology pathways to pursue. Technology uptake in developing countries is impacted by actions in developed nations: the greater the number of clean technologies up and running in OECD countries, and the shorter the timeframe for their deployment, the quicker there will be uptake internationally, particularly in large emitting developing countries.

The UNFCCC report on adaptation technologies (2006) noted that there might be instances where climate change impacts will impinge on collective public goods and systems, such as food and water security, biodiversity and human health and safety. These impacts could affect commercial interests indirectly, but often the strongest and most direct incentives to adapt are with the public sector. For example, coastal management is usually a public sector responsibility, and the planning and design of coastal adaptation to climate change needs may rely heavily on government resources.

Governments in developing countries can establish enabling environments (including rule of law, protection of intellectual property, safe and secure environment for workers and communities) to encourage the private sector to bear the risks and capture the rewards of deploying technologies. Developed countries have a role to play in assisting developing nations in both establishing enabling environments and leapfrogging to the most advanced technologies. This will require programs to build capacity, promote technology transfer and collaborate on research and development—many of which could be financed through ODA (discussed below).

3. Private sector

The effectiveness of governments in engaging capital markets in technology deployment and uptake may be the single greatest determining factor of success in implementing new and clean energy infrastructure and systems. If capital markets are driven to invest in clean energy technology then clean energy will result. If there is no financial advantage to investing in clean energy, the investment dollars will continue to flow to the most lucrative options.

While past work under the UNFCCC has emphasized action by governments and large donors, recent efforts by the EGTT have focused more on engaging private sector actors who play a crucial part along the entire technology cooperation pathway. The role of the private sector has increased in the coal, gas, oil and electricity sectors over the past two decades and will continue to rise as public involvement in the energy sector declines. Private sector investment should be viewed as one of the main vehicles for ensuring technology cooperation contributes to short- and long-term climate change mitigation. Many technologies for GHG mitigation or adaptation are owned by private compa-

nies that require the correct environment or incentives to participate in technology cooperation efforts. The commercial needs that drive the private sector must be acknowledged, and successful technology cooperation will require both appropriate enabling environments for private sector investors (e.g., protection of IPR) as well as cost recovery for investors.

Most energy-related investment will come from the private sector, although as noted above, governments have a key role to play in stimulating investment in climate-friendly technologies. The IEA's World Energy Outlook 2006 predicts that up to US\$20 trillion will be invested in the energy sector by 2030. FDI is expected to be a major factor in financing energy and transportation infrastructure in both developed and developing countries, accounting for 60–80 per cent of global financial flows in recent years (Violetti, 2004). In 2004, FDI accounted for more than half of all resource flows to developing countries and was considerably larger than ODA (UNCTAD, 2005: 8). FDI is concentrated in a handful of developing countries (China, Brazil, Hong Kong [China], Mexico and Singapore), suggesting that different technology cooperation strategies are required for different countries to account for differences in wealth, development and absorptive capacity.

The UNFCCC workshop on innovation options for financing the transfer of technologies (van Aalst, 2005) noted that the added value of mitigation or adaptation to climate change should be a factor in qualifying for financing. Climate change-related returns may not be obvious at first glance, but if properly substantiated could improve the chances of success (or lower the risk of failure) and may assist in gaining access to financing.

Private-public partnerships are increasingly being used to promote private sector investment in environmental technologies. The UN Foundation (UNF, 2006) promotes public-private partnerships with UN agencies to advance innovative sustainable energy programs in developing countries; and the APP is described as a model for public-private collaboration for technology development and deployment in key industry sectors—yet its early stage of development makes it difficult to assess achievements or failures. Some financiers are blending public and private money (e.g., combining low cost public money with commercial investments) to create funds that have the capacity to meet different investor expectations.

The Equator Principles are attracting attention from companies that want to go to global capital markets for investment dollars. Financial institutions that have adopted these principles ensure that financed projects are developed in a manner that is socially responsible and reflect sound environmental management practices. While not specifically addressing climate change, the more than 40 financial institutions that have signed on to these principles will likely pay greater heed to climate change considerations.

4. Development assistance providers

ODA is distributed through a variety of channels that offer opportunity to impact technology cooperation. The GEF, which is the financial mechanism for the UNFCCC, manages two Convention funds—the LDCF and SCCF—mainly funded by donor countries through ODA budgets. Other development assistance providers include bilateral agencies such as the Canadian International Development Agency (CIDA), multilateral agencies such as the UN institutions, and MDBs such as the World Bank and regional development banks.

ODA directly supports projects and programs in sectors related to climate change, including energy, transportation, agriculture and forestry. Efforts to introduce climate screening to ensure that climate change is mainstreamed in these programs and projects could influence development paths. In particular, MDBs—through their technical assistance, policy advice and support for projects—exert considerable influence over development choices and decisions, as well as leveraging private sector financing and building investor confidence in countries.

Developing countries have not, for the most part, identified climate change as an issue of concern to development assistance providers. This is not because climate change does not represent a growing concern amongst those in the know; it's often the case that those who hold the major levers of policy are still not up to speed on effectively addressing climate change. While there are a number of successful initiatives related to climate change, the linkages between climate change, poverty alleviation and development are not fully appreciated. But this is changing. The World Bank's *Investment Framework for Clean Energy and Development* (2007), developed within the context of the Gleneagles Communiqué on Climate Change, Clean Energy and Sustainable Development (G8 2005), is intended to be a vehicle to accelerate investments to address developing country energy needs for growth and access for the poor; mitigate greenhouse gas emissions by moving to a low-carbon economy; and support developing countries in adapting to climate variability and risk. There is considerable latitude for this framework to influence operations and funding allocations; Sohn, *et al.* (2005) note that between 2000 and 2005, more than 80 per cent of all World Bank lending in the energy sector did not even consider climate change in project loans.

ODA may be best positioned to assist developing countries in areas where the private sector is not active, such as adaptation, or where there are gaps in financing that create blockages to the development of enterprises or commercial operations. ODA could be crucial for small island states and LDCs that have difficulty attracting private sector investment, and support for climate-friendly technologies in the transport and energy sectors could be instrumental in putting countries on a clean energy path. The leverage of ODA is marginal in high emitting developing countries. For example, in 2005, China was

the third largest recipient of FDI, after the United States and United Kingdom, and does not depend on ODA.

5. Communities

Social and behavioural preferences for existing technologies and lifestyles at the household level influence technology uptake in developed nations, and are often reinforced by media and advertising. Key developing nations, such as China and India, have large and growing middle classes that aspire to the levels of prosperity that developed countries have enjoyed for years. Increased consumption by such large swaths of the global population, coupled with (albeit slow) population growth in high-consuming countries will increase energy demand—highlighting the need for effective emission reduction technologies.

Technology diffusion and uptake (and the success of technology cooperation programs) depends on the decisions of millions of firms and households around the world. If individuals in developed and developing nations continue to make unconstrained decisions to acquire technologies that emit relatively high levels of GHGs and industry decides to provide secondary energy and products to these people without worrying about paying for GHG emissions, technology cooperation efforts will have little success in reducing overall emission levels. Consumer information and outreach/education campaigns can help to engage a broad constituency at the local level, and financial incentives (subsidies and tax credits) at the household and business level can help to drive behavioural change.

References

Alfsen, Knut H. and G.S. Eskeland, 2007. *A Broader Palette: The Role of Technology in Climate Policy*. Report to the Expert Group for Environmental Studies. Stockholm: Swedish Ministry of Finance.

Anderson, G., 2004. *Markets, Geopolitics, Energy Security and Sustainability*. Presentation at the 19th World Energy Council Congress, Sydney, Australia, September 5–9. <<http://www.worldenergy.org/wec-geis/congress/bycountry.asp?year=2004>>.

APEC, 2007. *Sydney APEC Leaders' Declaration on Climate Change, Energy Security and Clean Development*. Sydney, Australia, September 9. <http://www.apecsec.org.sg/apec/leaders__declarations/2007/aelm_climatechange.html>.

Barrett, S., 2001. "Towards a Better Climate Treaty." *World Economics* 3(2): 35–45.

BASIC Task 4 Team, 2007. *The Sao Paulo Proposal for an Agreement on Future Climate Policy – Paper 17*. <<http://www.basic-project.net/>>.

Battelle, 2006. *Battelle Global Energy Technology Strategy Program Releases Comprehensive Analysis: Carbon dioxide capture and storage technologies will play critical role in addressing climate change*. NSD Press Release, October 5.

Baumert, K.A., T. Herzog and J. Pershing, 2005. *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy*. Washington, D.C.: World Resources Institute.

Bell, W., J. Van Ham, J. Parry, J. Drexhage and P. Dickey, 2005. *Canada in a Post-2012 World: A Qualitative Assessment of Domestic and International Perspectives*. Winnipeg: International Institute for Sustainable Development.

Benedick, R., 2007. *An Architecture of Parallel Regimes: Disaggregating the Climate Negotiations*. Paper prepared for the Heinrich Böll Foundation Montreal Follow-up Meeting, Berlin, Germany, September 27.

Benedick, R., 2001. "Striking a New Deal on Climate Change." *Issues in Science and Technology*, Fall, pp. 71–76.

Bodansky, D., 2007. *International Sectoral Agreements in a Post-2012 Climate Framework: A Working Paper*. Washington, D.C.: Pew Center on Global Climate Change.

Brandon, R., 2004. *T&I Distributed Energy Production Strategic Plan*. Presented to the Distributed Energy Production Steering Committee, April 2, 2004. Ottawa: Natural Resources Canada.

Canadian Council of Chief Executives (CCCE), 2007. *Clean Growth: Building a Canadian Environmental Superpower*. Ottawa: CCCE.

Capoor, K. and P. Ambrosi, 2007. *State and Trends of the Carbon Market 2007*. Washington, D.C.: World Bank.

Coninck, H.C., de, F. Haake and N.H. van der Linden, 2007. *Technology Transfer in the Clean Development Mechanism*. Petten: Energy Research Centre of the Netherlands.

Edmonds, J. A. and M. Wise, 1998. "Building Backstop Technologies and Policies to Implement the Framework Convention on Climate Change." *Energy & Environment* 9(4): 383–398.

Energy Information Administration, 2006. *Annual Energy Outlook 2007 (Early Release)*. Report #:DOE/EIA-0383(2007).

Environment Canada, 2007. *Inventory Report 1990–2005: Greenhouse Gas Sources and Sinks in Canada*. Gatineau: Environment Canada.

Environment Canada, 2006. *Canada's Fourth National Report on Climate Change: Actions to Meet Commitments under the United Nations Framework Convention on Climate Change*. Ottawa: Government of Canada.

European Commission, 2006. *Action Plan for Energy Efficiency: Realising the Potential*. COM(2006)545 final. Brussels, October 19. <http://ec.europa.eu/energy/action_plan_energy_efficiency/doc/com_2006_0545_en.pdf>

Executive Forum on Climate Change, 2005. *Call to Action on Climate Change and Energy*.

Fisher, B.S., M. Ford, G. Jakeman, A. Gurney, J. Penm, A. Matysek and D. Gunasekera, 2006. *Technological Development and Economic Growth*, ABARE Research Report 06.1, prepared for the Inaugural Ministerial Meeting of the Asia Pacific Partnership on Clean Development and Climate, Sydney, January 11–13, ABARE, Canberra.

Fujiwara, N., 2007. *The Asia-Pacific Partnership on Clean Development and Climate: What it is and what it is not*. CEPS Policy Brief No. 144.

G8, 2007. *Joint Statement by the German G8 Presidency and the Heads of State and/or Government of Brazil, China, India, Mexico and South Africa on the occasion of the G8 Summit in Heiligendamm, Germany, 8 June 2007*. <http://www.g-8.de/Content/EN/Artikel/_g8-summit/anlagen/o5-erklaerung-en,templateId=raw,property=publicationFile.pdf/o5-erklaerung-en>.

G8, 2005. *The Gleneagles Communiqué*. <http://www.fco.gov.uk/Files/kfile/PostG8_Gleneagles_Communique,0.pdf>.

Global Environment Facility (GEF), 2006. *Status Report on the Climate Change Funds*. GEF/C.28/4/rev.1.

Government of Canada, 2007. *Regulatory Framework for Air Emissions*. Ottawa: Environment Canada.

Grubb, M., 2005. "Technology Innovation and Climate Change Policy: An Overview of Issues and Options." *Keio Economic Studies* 41(2): 103–132.

Imperial College Centre for Energy Policy and Technology, 2003, *Assessment of Technological Options to Address Climate Change*. London: Department for Environment, Food and Rural Affairs.

International Energy Agency (IEA), 2007. *Tracking Industrial Energy Efficiency and CO₂ Emissions*. Paris: IEA.

IEA, 2003. *World Energy Outlook 2003: Summary and Conclusions*. Paris: IEA.

IEA, 2006. *World Energy Outlook 2006: Summary and Conclusions*. Paris: IEA.

International Iron and Steel Institute (IISI), 2007. *A Policy to reduce steel-related greenhouse gas emissions*. <<http://www.worldsteel.org/index.php?action=storypages&id=226&subId=179>>.

Intergovernmental Panel on Climate Change (IPCC), 2007. *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds.). Cambridge and New York: Cambridge University Press.

IPCC, 2000. *Methodological and Technological issues in Technology Transfer*. Cambridge: Cambridge University Press.

Jaccard, M. and Y. Mao, 2002. "Making Markets Work Better." in Johansson and Goldenberg, *Energy for Sustainable Development: A Policy Agenda*. New York: United Nations Development Programme.

Kameyama, Y., 2005. *The Future Climate Regime: Using the Scenario Planning Approach to Develop Options*. Tsukuba: National Institute for Environmental Studies and Kanagawa: Institute for Global Environmental Studies.

Kline, D. M., L. Vimmerstedt and R. Benioff, 2004. "Clean Energy Technology Transfer: A Review of Programs under the UNFCCC." *Mitigation and Adaptation Strategies for Global Change* 9: 1–35.

Leach, M., D. Anderson, P. Taylor and G. Marsh, 2005. *Options for a low Carbon Future: Review of Modelling Activities and an Update*. Report for the DTI, Imperial College Centre for Energy Policy, and Technology and Future Energy Solutions.

Lempert, R.J., S.W. Popper, S.A. Resetar and S.L. Hart, 2002. *Capital Cycles and the Timing of Climate Change Policy*. Washington, D.C.: Pew Center on Global Climate Change.

Maurer, C., 2003. "Financing Carbon: Export Credit Agencies and Climate Change." in Smita Nakhoda (ed.), *Transition from Fossil to Renewable Energy Systems: What Role for Export Credit Agencies?* Washington, D.C.: World Resources Institute (WRI).

Milford, L., 2007. *Massive Climate Technology Innovation: A New Geometry of Complementary Strategies Post-2012*. A Statement Paper Presented at the Ministerial Meeting of the Gleneagles Dialogue on Climate Change, Clean Energy and Sustainable Development, September 9–11. Montpelier, VT: Clean Energy Group.

Murphy, D., J. van Ham and J. Drexhage, 2005. "Climate Change and Technology" in Cosbey, A., et al., *Which Way Forward: Issues in developing an effective climate regime after 2012*. Winnipeg: International Institute for Sustainable Development.

Murphy, L. and P. Edwards, 2003. *Bridging the Valley of Death: Transitioning from Public to Private Sector Financing*. Golden, Colorado: National Renewable Energy Laboratory.

National Advisory Panel on Sustainable Energy Science and Technology (SEST), 2006. *Powerful Connections: Priorities and Directions in Energy Science and Technology in Canada*. Ottawa: NRCan.

National Energy Board, 2003. *Canada's Energy Future: Scenarios for supply and demand to 2025*. Calgary: NEB.

National Round Table on the Environment and the Economy (NRTEE), 2006. *Advice on a Long-term Strategy on Energy and Climate Change*. Ottawa: NRTEE.

Natural Resources Canada (NRCan), 2007. *Canada top US supplier as scientific research and technological innovation fuels energy sector*. Press release. <http://www.eurekalert.org/pub_releases/2007-04/nrc-cu041807.php>.

Ninomiya, Y., 2003. "Prospects for Energy Efficiency Improvement through an International Agreement." *Climate Regime beyond 2012: Incentives for Global Participation*. National Institute for Environmental Studies and the Institute for Global Environmental Strategies.

OECD, 2007. *Arrangement on Officially Supported Export Credits – 2007 revision*. TAD/PG(2007)18. Paris: OECD.

OECD, 2005. *Aid rising sharply, according to latest OECD figures*. Paris: OECD.

- Ott, H.E., 2007. *Climate Policy Post-2012 – A Roadmap: The Global Governance of Climate Change*. A discussion paper for the 2007 Tällberg Forum.
- Pacala, S. and R. Socolow, 2004. “Stabilization Wedges: Solving the Climate Problem for the Next Fifty Years with Current Technology.” *Science*, 305: 968–972.
- Paulson, H., A. Darling and F. Nukaga, 2008. “Financial bridge from dirty to clean energy.” *Financial Times*. February 7.
- Petroleum Technology Alliance of Canada (PTAC), 2006. *Filling the Gap: Unconventional Gas Technology Roadmap*. Calgary: PTAC.
- Pew Center on Global Climate Change, 2005. *International Climate Efforts Beyond 2012: Report of the Climate Dialogue at Pocantico*. Arlington: Pew Centre on Global Climate Change.
- Pezzey, J.V.C., F. Jotzo and J. Quiggin, 2006. *Fiddling while Carbon Burns: Why carbon policy needs pervasive emission pricing as well as technology promotion*. Australian National University, Economics and Environment Network Working Paper.
- Republic of South Africa, Department of Environmental Affairs and Tourism, 2006. *Policy Discussion Paper for the Ministerial Indaba on Climate Action*. South Africa, June 18–21.
- Reuters, 2007. “OPEC willing to help fund climate change battle.” *Globe & Mail Report on Business*, November 15.
- Sanden, B. and C. Azar, 2005. “Near-term technology policies for long-term climate targets – economy wide versus technology specific approaches.” *Energy Policy*, 33: 1557–1576.
- Schmidt, J., N. Helme, J. Lee and M. Houdaschelt, 2006. *Sector-based Approach to the Post-2012 Climate Change Policy Architecture*. Washington, D.C.: Center for Clean Air Policy.
- Sohn, J., S. Nakhooda and K.A. Baumert, 2005. *Mainstreaming Climate Change Considerations at the Multilateral Development Banks*. World Resources Institute Issues Brief. July.
- South Centre, 2007. *Integrating Development in Climate Change: A Framework Policy Discussion Paper on Key Elements for the Development of the Post-2012 Global Climate Policy Regime*. Special Policy Discussion Paper.
- Statistics Canada, 2006. “Total spending on research and development in Canada, 1990 to 2006, and provinces, 1990 to 2004.” *Science Statistics* 30(7): 3.

- Statistics Canada, 2005. *Greenhouse Gas Technologies: Industry Expenditures and Business Opportunities*. Environment Accounts and Statistics Technical Paper Series 16-001-MIE.
- Stern, N., 2006. *Stern Review on the Economics of Climate Change*. Report presented to the Prime Minister and the Chancellor of the Exchequer on the Economics of Climate Change.
- Sugiyama, T. and J. Sinton, 2003. *Orchestra of Treaties*. CRIEPI paper published under the FNI/CRIEPE/HWWA/CASS Post-2012 Policy Scenarios Project.
- Sustainable Development Technology Canada (SDTC), 2005. *Canadian Private Investment Trends: Investment Opportunities with SDTC*. <<http://www.sdtc.ca/en/about/innovation.htm>>.
- Sustainable Energy Finance Initiative and New Energy Finance (SEFI and NEF), 2007. *Global Trends in Sustainable Energy Investment 2007: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency in OECD and Developing Countries*. Paris: UNEP Energy Branch.
- Tamura, K., 2006. "Technology Development and Transfer" in Srinivasan Ancha (ed.) *Asian Aspirations for Climate Regime Beyond 2012*. Hayama, Japan: Institute for Global Environmental Strategies.
- Tirpak, D. and H. Adams, 2007. "Trends in Official Bilateral and Multilateral Development Assistance in the Energy Sector: Has the DA Community Responded to the United Nations Climate Change Convention?" submitted to *Climate Policy*.
- Tol, R.S.J., 2002. Technology Protocols for Climate Change: An Application of FUND. *Climate Policy* 4: 269–287.
- Ueno, T., 2006. *Reengineering the Climate Regime: Design and Process Principles of International Technology Cooperation for Climate Change Mitigation*. Washington, D.C.: Resources for the Future.
- United Nations (UN), 1997. *Kyoto Protocol to the United Nations Framework Convention on Climate Change*. New York: United Nations.
- UN, 1992. *United Nations Framework Convention on Climate Change*. New York: United Nations.
- UNCTAD, 2005. *World Investment Report 2005: Transnational Corporations and the Internationalization of R&D*. New York & Geneva: United Nations.
- United Nations Foundation. 2005. *What the UN Foundation is Doing*. <http://www.unfoundation.org/programs/environment/what_unf_is_doing.asp>.

United Nations Framework Convention on Climate Change (UNFCCC), 2007a. *Bali Action Plan*. Decision adopted by COP-13 and CMP 3. December 2007. <http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf>.

UNFCCC, 2007b. *Investment and Financial Flows to address Climate Change*. Bonn: UNFCCC.

UNFCCC, 2006. *Application of environmentally sound technologies for adaptation to climate change*. (FC/TP/2006/2), May 10.

UNFCCC. 2004. *Report on the UNFCCC workshop on innovative options for financing the development and transfer of technologies, note by the secretariat*. FCCC/SBSTA/2004/1.

van Aalst, P., 2005. *Innovative Options for Financing the Development and Transfer of Technologies in the Context of the United Nations Framework Convention on Climate Change (UNFCCC): Background Information Paper*. Prepared for the UNFCCC Secretariat.

Van Ham, J., 2005. *Canada's Clean Coal Technology Roadmap*. Ottawa: NRCan.

Violette, D., 2004. "Trends in Financial Flows and Technology Transfer." Presentation at the UNFCCC workshop on *Innovative Options for Financing the Development and Transfer of Technologies*. Intercontinental Hotel, Montreal, Canada, September 27–29.

Wara, M., 2006. *Measuring the Clean Development Mechanism's Performance and Potential*. Workshop Paper #56, Stanford University.

World Bank, 2007. *Clean Energy for Development Investment Framework: The World Bank Group Action Plan*. DC2007-0002, March 28. Washington, D.C.: World Bank.

World Bank, 2006. *An Investment Framework for Clean Energy and Development: A progress report*. DC2006-0012, September. Washington D.C.: World Bank.

Chapter 5: Investment and Finance in the Emerging Post-2012 Climate Regime

Dennis Tirpak, John Drexhage, Deborah Murphy,
Jean Nolet and Jo-Ellen Parry

1.0 Introduction

Financial resources and investment is the fourth pillar of the Bali Action Plan. This pillar will consider, *inter alia*, improved access to adequate and sustainable financial resources, including official and concessional funding for developing countries, positive incentives for developing countries for enhanced implementation of mitigation strategies, and mobilization of public and private funds to facilitate carbon-friendly choices.¹

Each of the four pillars in the Action Plan represents a special challenge for negotiators over the next several years. Finding a means to improve the cost-effectiveness of, and generating sufficient, predictable and sustainable financial resources for mitigation and adaptation will be a particularly crucial task. This chapter provides an introduction to the various parameters that will affect negotiation of this critical issue. It provides an overview of the size of the anticipated needed financial resources; the degree to which these resources are currently being provided; and mechanisms by which the gap between current resources and future demand could be met. It concludes by providing some initial ideas regarding Canadian perspectives on financing and investment in a post-2012 climate regime.

2.0 Setting the context: investment and finance

An analysis of the financial resources and investment that would be required for mitigation and adaptation has been undertaken by the UNFCCC Secretariat, and is summarized below. This analysis indicates that significant changes in the existing patterns of public and private investment and financial flows will be required (UNFCCC, 2007d).

- Additional investment and financial flows in 2030 to address climate change amounts to 0.3 to 0.5 per cent of global domestic product and 1.1 to 1.7 per cent of global investment. This is a small amount in overall global GDP, but large compared to the currently available public and private financial

1 See decision 1/CP.13 for full text (UNFCCC 2007a).

resources for climate change (including the ones available under the UNFCCC and its Kyoto Protocol, as discussed in section 4.0 below). Existing resources and instruments on their own cannot lead to a meaningful transition to a low-emission economy, nor can they address much-needed large-scale adaptation measures.

- Mitigation measures needed to return global greenhouse gas (GHG) emissions to current levels by 2030 require additional global investments and financial flows of between US\$200 to 210 billion per annum in 2030 (UNFCCC, 2007d). In many sectors, such as the power generation sector or industry, the lifetime of capital stock can be thirty years or more. Total investment in new physical assets is projected to triple between 2000 and 2030. Due to rapid economic growth, a large share of these investments will occur in developing countries.
 - *Energy supply*: it is projected that US\$432 billion will be invested annually into the power sector. Of this amount, US\$148 billion needs to be shifted to renewables, carbon capture and storage (CCS), nuclear and hydro. Investment and financial flows would be reduced by US\$67 billion owing to energy efficiency and biofuel investments of US\$148 billion.
 - *Industry*: additional investment and financial flows are estimated at about US\$36 billion. More than half of this additional investment is for energy efficiency.
 - *Buildings*: additional investment and financial flows amount to about US\$51 billion. Currently, commercial and residential energy efficiency investment comes from building owners and is financed domestically.
 - *Transportation*: additional investment and financial flows amount to about US\$88 billion. Efficiency improvements for vehicles and increased use of biofuels are likely to require government policies, but investments will come mostly from the private sector.
 - *Waste*: additional investment and financial flows are estimated at about US\$1 billion. Capture and use of methane from landfills and wastewater treatment could reduce emissions by about 50 per cent in 2030 mainly in Parties not included in Annex I to the Convention (Non-Annex I Parties), which are generally developing countries.
 - *Agriculture*: additional investment and financial flows are estimated at about US\$35 billion. Non-CO₂ emissions from agriculture production could be reduced by about 10 per cent at cost of US\$20 billion in 2030. With a concerted international effort and an annual investment of about US\$15 billion, agroforestry could be expanded at a rate of about 19 million ha per year by 2030, with corresponding environmental and adaptation benefits.

- *Forestry*: additional investment and financial flows are estimated at about US\$21 billion. An indicative estimate of eliminating deforestation and forest degradation in non-Annex I Parties in 2030 is US\$12 billion. The estimated investment and financial flows in 2030 to increase GHG removals by sinks through sustainable forest management is US\$8 billion and the estimated investment and financial flows needed for afforestation and reforestation is US\$0.1 to 0.5 billion.
- *Technology research and development (R&D) and deployment*: additional investment and financial flows are estimated at about US\$35 to 45 billion. Government spending on energy R&D and technology deployment need to double by 2030.
- Adaptation requires additional investment and financial flows which by 2030 will amount to several billions of dollars. The UNFCCC has estimated that in 2030, between US\$49 and 171 billion dollars in additional investment and financial flows will be needed globally for adaptation. Of this amount, US\$28 to 67 billion will be needed by non-Annex I Parties. However, the difficulties associated with estimating the cost of adaptation are widely acknowledged, making precise predictions impossible. Current estimates by the UNFCCC and others, suggest that needs are tens to hundreds times greater than the current sources of funding available for adaptation under the Convention and Kyoto Protocol.

3.0 Financial obligations of developed countries under the Convention and the Kyoto Protocol

Articles 4.3 and 4.5 of the Convention both call for developed countries to provide new and additional financial resources to meet the agreed costs of developing countries in complying with their obligations under the UNFCCC. This includes implementing measures to mitigate climate change by addressing anthropogenic emissions by sources, such as fossil fuel combustion and removals by sinks (UN, 1992). In addition, Article 11.5 stipulates that developing countries may avail themselves of financial resources related to the implementation of the Convention through bilateral, regional and other multilateral channels. More specifically, the Convention established a new financial mechanism, the Global Environment Facility (GEF), for the provision of financial resources on a grant or concessional basis. Also, under Article 4 of the Convention, developed countries are required to assist developing countries that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation. No specific provisions are included in the Convention for financing mitigation and adaptation actions of developed countries; rather it is assumed that these countries have mechanisms to finance their own activities.

Articles 10 (c) and 11 (a) of the Kyoto Protocol reiterate and further enforce the requirements of the Convention. The Kyoto Protocol also set up a new mechanism, the Clean Development Mechanism (CDM), under Article 12 that is to help developing country Parties achieve their sustainable development objectives and developed country (Annex B) Parties comply with their quantified emission limitations and reduction commitments under the Protocol (UN, 1998).

4.0 How have developed countries responded?

Financing for climate change has generally flowed from four sources: 1) bilateral and multilateral development assistance, including the GEF; 2) the carbon market, including the CDM; 3) foreign direct investment (FDI); and 4) internally generated sources of funds, including government and private sector financing. Each of these sources is expected to continue to play a critical role in the future climate regime.

4.1 Bilateral and multilateral assistance

Over the period 1997 to 2005, official development assistance (ODA) provided by donor countries for all purposes totalled approximately US\$490 billion. This period in time saw a significant increase in financing, rising from the low level of US\$60 billion in 1997 to US\$106.8 billion in 2005, the highest level ever in real and nominal terms. The level of funding provided in 2005 was high due in part to exceptional circumstances; the Paris Club's debt relief effort for Nigeria and Iraq that accounted for nearly 20 per cent of the total, and tsunami relief and other humanitarian needs (Manning, 2006).

It is difficult to determine the portion of this funding that was directly relevant to climate change mitigation and adaptation. While the OECD maintains a database of development assistance for disaster relief, education, health, energy, agriculture and other areas, most projects are initiated for non-climate reasons and often have multiple purposes.

Bilateral and multilateral support for energy projects totalled over US\$64 billion from 1997 to 2005, with multilateral institutions accounting for nearly 70 per cent of the support. As seen in Table 1, support for energy projects has ranged from six to 10 per cent of all development assistance during this period, but was virtually stagnant at approximately US\$6–7 billion per year during this period. The World Bank Group was the largest source of multilateral funds, contributing nearly 39 per cent of all funding, including bilateral funds.² Support for the power sector, while down from earlier years has dominated energy funding. Funds for the oil and gas category have been relatively constant, while support for energy efficiency measures and renewables has been variable, despite efforts since the early 1990s to expand both portfolios.

2 See Annex 1 for a listing of World Bank funds and initiatives, including those focused on carbon financing.

Collectively, the power, coal, oil and gas categories account for 75 per cent of all funding. The GEF represented only two per cent of all development assistance for energy. However, this may mask its importance to many small developing countries (Tirpak and Adams, 2008).

Table 1. Multilateral and bilateral funding for energy during the period 1997–2005 (US\$ millions)

Multilateral and Bilateral Energy Support for Energy Projects										
Source	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
Bilateral ODA	3,992	2,522	1,820	1,294	1,950	1,950	2,726	2,296	2,132	20,104
World Bank Group	3,633	3,833	2,258	2,643	2,817	2,817	2,450	1,828	2,794	24,898
EBRD	357	357	357	587	620	680	667	768	765	5,158
GEF	136	113	83	113	97	97	120	134	124	1,054
ADB	824	400	699	1,042	663	927	654	707	677	6,593
IADB	1,131	1,261	464	1,172	1,188	184	379	152	1,056	6,987
Total	10,073	8,486	5,681	6,851	6,619	6,655	6,996	5,885	7,548	64,794

Source: Tirpak and Adams, 2007.

Bilateral development assistance for energy was at its highest in 1997, reaching nearly US\$4 billion and at its lowest in 2000 (approximately US\$1.3 billion). It has recovered in recent years, during which funding has averaged slightly more than US\$2 billion annually. Japan provided over two-thirds of all bilateral aid for energy during the period 1997 to 2005, out-distancing by far the next most important donors (as seen in Table 2), namely Germany (12.0 per cent) and France (3.4 per cent).

Table 2: Bilateral assistance to all energy sectors from 1997 to 2005 from major donors (US\$ millions)

	1997	1998	1999	2000	2001	2002	2003	2004	2005	Country total 1997-2005 (million USD)	% of total 1997-2005 (million USD)
Japan	3,088.3	1,746.2	1,204.7	803.9	888.5	1,332.9	2,151.8	1,666.5	1,035.6	13,918.4	69.2
Germany	387.2	316.7	298.6	81.9	229.5	100.9	188.0	319.8	496.5	2,419.1	12.0
France	94.1	187.2	66.9	27.0	25.8	38.9	77.1	80.5	82.3	679.7	3.4
Spain	166.0	54.5	62.4	112.6	14.2	75.4	36.3	0.5		521.9	2.6
Italy	24.1	4.2	9.1	13.1	13.2	29.5	53.3	22.6	273.4	442.7	2.2
United Kingdom	18.4	58.1	45.8	69.3	48.7	43.8	48.7	73.2	1.8	407.9	2.0
United States	6.6	10.1	17.6	59.6	46.9	148.5	15.0	8.1	69.0	381.4	1.9
Norway	55.7	45.2	20.9	34.0	60.4	23.7	30.1	19.1	23.3	312.5	1.6

	1997	1998	1999	2000	2001	2002	2003	2004	2005	Country total 1997-2005 (million USD)	% of grand total 1997-2005 (million USD)
Denmark	31.4	30.3	15.4	18.6	5.1	55.0	24.6	40.4	64.3	285.3	1.4
Netherlands	23.7	23.7	12.2	29.2	24.6	44.6	14.8	3.5	9.4	185.8	0.9
Canada	66.6	19.3	33.1	11.3	0.2	11.1	9.4	3.1	6.6	160.5	0.8
Sweden	9.1	13.2	14.4	20.3	8.0	13.3	29.5	19.1	23.4	150.2	0.7
Finland	2.1	2.7	5.6	0.5	0.4	4.7	15.0	12.0	33.3	76.1	0.4
Belgium	1.8	1.0	6.5	3.9	1.1	6.4	3.2	14.3	6.0	44.3	0.2
Switzerland	0.7			1.3		0.4	26.7	10.9		40.1	0.2
Australia	16.1	8.2	3.5	5.0	2.2	2.1	0.0	0.3		37.4	0.2
Austria	0.9	1.9	4.1	3.1	2.5	16.6	0.7	1.0	4.2	35.0	0.2
New Zealand						1.0	0.8	0.4	1.8	4.0	0.0
Portugal				0.0	0.4	0.9	1.0	0.5	0.2	3.1	0.0
Luxembourg					0.4				0.4	0.8	0.0
Greece						0.1		0.1	0.2	0.4	0.0
Ireland				0.1	0.1	0.1		0.0		0.3	0.0
Total	3,992.8	2,522.6	1,820.8	1,294.6	1,372.4	1,950.1	2,725.8	2,295.9	2,131.8	20,106.88	100.0

Source: Tirpak and Adams, 2008.

4.2 The Global Environment Facility

The GEF Trust Fund has allocated (since its inception) a total of approximately US\$3.3 billion to climate change projects. The GEF estimates that co-financing in excess of US\$14 billion has been leveraged for these GEF projects, or US\$4.2 per dollar of GEF grant. However, in the last reporting period (from September 2005 to August 2006), this ratio was higher—US\$6.4 per GEF dollar (UNFCCC, 2007d).³ GEF funding represented 1.6 per cent of funds from bilateral and multilateral sources for energy projects during the period 1997 to 2005.

Under the GEF's Fourth Replenishment for the period of 2006 to 2010, its new climate change strategy and climate change programming framework provides for a set of links between the GEF's mission, its strategic approach, priorities, operational programs and project areas. Climate change programming for 2006 to 2010) is to amount to US\$990 million (UNFCCC 2007c). These funds

3 It is difficult to verify estimates of co-financing. Such financing may be subject to double counting as it often comes from the World Bank Group and other MDBs.

are to be directed primarily towards mitigation activities, with the balance allocated to the Small Grants Programme, cross-cutting capacity-building activities and support to LDCs and SIDS. Funding for adaptation will continue a previous allocation of US\$50 million to the strategic priority on adaptation, Piloting an Operational Approach to Adaptation. No new funding for adaptation within the period of GEF's Fourth Replenishment is planned at present.

In addition, Parties have established two special funds under the Convention: the Special Climate Change Fund (SCCF) with contributions of US\$70 million and the Least Developed Countries Fund (LDCF) with contributions of US\$163.3 million.⁴ These two funds are managed by the GEF. An Adaptation Fund, under the Kyoto Protocol, to finance adaptation projects and programs in developing countries that are Parties to the Kyoto Protocol, will be managed by an Adaptation Fund Board with the GEF providing it with secretariat services.

4.3 The carbon market

The World Bank estimated that the value of the carbon market in 2006 was US\$30 billion, with US\$5 billion from CDM. The European Union Emissions Trading System (EU ETS) dominated the market. The average price for Certified Emission Reduction credits (CERs) generated through the CDM was US\$10.91. As of February 1, 2008, the CDM pipeline included 2,974 projects (909 registered and 2065 in the registration process) involving over 2.46 billion CERs.⁵ China dominated the CDM market, with over 1,000 projects accounting for nearly 53 per cent of all CERs (see Table 3). European countries are the main buyers, with an 86 per cent share (versus 50 per cent in 2005). Private sector buyers, especially banks and carbon funds, continued to buy large volumes of CDM assets (while public sector buyers dominated Joint Implementation (JI) purchases) (Capoor and Ambrosi, 2007). Renewable projects account for approximately 61 per cent of all projects, but projects that aim to reduce emissions from hydrofluorocarbons, perfluorocarbons and nitrous oxide sources will account for 31 per cent of CERs by 2012. Renewable projects represent only about a fifth of the likely demand for first commitment period credits, as illustrated in Table 4.

The past two years have seen a shift in investment strategies and approaches, with a substantial increase in the number of funds seeking to provide cash returns to investors rather than credits to meet compliance needs. Carbon procurement vehicles play an important role in international carbon markets currently financing an estimated 25 per cent of all CERs and 31 per cent of ERUs (Cochran and Leguet, 2007: 1). While the future of the carbon market is uncertain as a successor to the Kyoto Protocol is not yet negotiated, there is confidence in the future of the carbon asset market. In October 2007, the European Investment Bank launched the first dedicated post-2012 carbon fund.

4 Figures as of September 30, 2007 (GEF, 2007).

5 The statistics are taken from the UNEP-Risø Pipeline of February 1, 2008.

Table 3: Distribution of CDM projects and CERs by country

	Total CDM Projects		2012 k CERs	
China	1,003	33.7%	1,301,749	52.9%
India	840	28.2%	370,313	15%
Brazil	255	8.6%	169,794	6.9%
Mexico	182	6.1%	68,566	2.8%
Malaysia	96	3.2%	58,357	2.4%
Sub-total	2,376	79.8%	1,968,779	80%
Other developing countries	598	20.2%	494,066	20%
Total	2,974	100%	2,462,845	100%

Source: UNEP-Risø Pipeline of February 1, 2008

Table 4: The distribution of CDM CERs by project type

	Number (%) of CDM projects	CERs until 2012 (%)
Renewables	61%	30%
CH ₄ reduction and cement and coal mine/bed	17%	20%
Supply side EE	10%	11%
Demand side EE	5%	1%
Fuel switch	3%	7%
HFCs, PFCs and N ₂ O reduction	3%	31%
Afforestation and reforestation	0.5%	0.3%
Transport	0.2%	0.1%

Source: UNEP-Risø Pipeline of February 1, 2008

The CDM can play a role in encouraging FDI in climate-friendly investments in developing nations. Capoor and Ambrosi (2007: 30) estimate that since 2002, clean energy investment credits under the CDM (renewable energy and methane recovery, fuel switching and energy efficiency) worth US\$2.7 billion have leveraged an estimated additional US\$16 billion in associated investments in those sectors in developing countries. The CDM could be expanded in a number of ways that could allow the mechanism to have greater influence on major capital investments in the energy sector, or in sectors that have seen little CDM activity such as transportation. An expanded CDM might also create more effective linkages with national development priorities. There is also considerable potential under a “programmatic approach” to incorporate standards and policies which could lead to more energy efficiency projects. In December 2006, the Executive Board approved Guidance on the Registration of Project Activities under a Programme of Activities as a Single CDM Project Activity—guidance that effectively clears the way for explicit approval of programmatic CDM (UNFCCC, 2006). Further guidance has been issued by the

Executive Board in 2007, but no large-scale CDM program of activities has yet been registered (UNFCCC, 2007c).

4.4 Private sector investments

During the period from 1997 to 2005, inflows of all FDI to developing countries totaled over US\$2 trillion. Inflows of FDI to developing countries were US\$267, 164 and 334 billion in 2000, 2002 and 2005 respectively, with FDI nearly three times higher than ODA in 2005. FDI tends to rise and fall with financial cycles and be risk adverse (UNCTAD, 2006). It is also selective—FDI will only flow to those countries where relatively strong enabling conditions for investment exist. These include stable political environments, strong legal systems, macro-economic stability, available skilled labour and good institutions. Since many of the poorest countries do not have these basic governance conditions, ODA remains an important source of funding for technology transfer for these countries (Ellis *et al.*, 2007).

It is difficult to obtain data on private sector investments for facilities and equipment in the energy and industrial sectors which may have an effect on GHG emissions. However, data are available from UNEP and New Energy Finance (2007) for sustainable energy investments, particularly renewables. These data indicate that investment in sustainable energy is rapidly increasing, with US\$117 billion of new investment in 2007, which was 41 per cent more than 2006.⁶ This amount beat a forecast of US\$85 billion for 2007 by a wide margin.

Additional insights from the UNEP and New Energy Finance (2007) about recent trends in financing for sustainable energy financing are listed below.

- Venture capital and private equity have increased significantly from US\$2.7 billion in 2005 to approximately US\$8.5 billion in 2007, and look set to continue this growth in 2008. Venture capital activity has moved up the maturity spectrum, with later funding rounds attracting most investment.⁷
- R&D increased to US\$16.3 billion in 2006, from US\$13 billion in 2005. EU-27 lags in new technology investment, which may be due to the comparatively low level of private sector involvement. Business funds 55 per cent of R&D in the EU, as compared with 64 per cent in the United States and 75 per cent in Japan.
- Public market activity for new equity investments surged in 2007, up from US\$10.3 billion in 2006 and from US\$4.3 billion in 2005. A significant portion of new Initial Public Offerings (IPOs) went into solar and wind companies.

6 Preliminary data presented by Eric Usher, UNEP, Paris (who was one of the authors of the UNEP/New Energy Finance study) to an IPCC meeting on a scoping study for renewable technologies in Lubeck, Germany, January 2008.

7 Preliminary data presented by Eric Usher, UNEP, Paris to IPCC meeting on a scoping study for renewable technologies in Lubeck, Germany, January 2008.

- New asset financing in renewable energy generating plants in 2007 was US\$56 billion, an increase from US\$39 billion in 2006. New generating capacity is being financed by banks, bonds and stock markets.
- Mergers and Acquisitions (M&A) activity was up 34 per cent in 2006, with deals valued at US\$16.9 billion. Most activity was in the wind sector—more than 40 per cent of deals by value. Leading players in the renewable energy sector are taking strategic stakes. Increasingly, manufacturing companies are looking to vertical integration to secure supplies of key components. There is a trend towards companies in developing countries acquiring assets in OECD countries, suggesting a buy rather than build approach. Widespread availability of cheap capital is enabling this strategy.
- Capital is shifting to developing countries, which saw higher private investment in 2006. This reflects stronger FDI, as well as private capital mobilization within emerging markets. China, India and Brazil are major producers of and markets for sustainable energy, with China leading in solar, India in wind and Brazil in biofuels. However, barriers to FDI remain, such as restrictions on foreign ownership in China, causing a prevalence of foreign-local joint ventures. Developing countries face the challenge of fast-growing energy demand combined with less mature capital markets—which skews investment towards conventional, mostly fossil-fuel generation.
- As of 2006, the two richest energy entrepreneurs in the world were Tulusi Tanti – Suzlon (India) and Zhengrong Shi – Suntech Power (China); the largest wind power company by capitalization is Suzlon, and the largest recipients of venture capital money were the United States and China.

These investments are being stimulated by a variety of policies in some countries⁸ at the national, sub-national and local level. Examples of policies, regulations and rules are listed below:

- renewable performance standards;
- performance standards for new facilities;
- green power purchasing requirements;
- interconnection standards;
- net metering rules;
- generation disclosure rules;
- contractor licensing;

8 Targets for future shares or amounts of renewables exist in 58 countries of which 13 are developing countries. Thirty-six countries have developed feed-in tariff policies, 44 countries, states and provinces have enacted renewable performance standards, and mandates for blending biofuels have been enacted in 11 developing countries in Latin America and Asia.

- equipment certification; and
- access laws/guidelines/zoning codes/building permits.

Investment is also being stimulated by numerous financial incentives, such as,

- feed-in tariffs;
- rebates;
- grant programs;
- loan programs;
- bonds;
- production incentives;
- government purchasing programs;
- equity investments, including venture capital; and
- insurance programs.

The United States, with a long-established venture capital base, dominated the venture capital markets. Since 2000, U.S. corporations have attracted over US\$6 billion in venture capital/equity funding, more than nine times countries such as Spain and Australia. China ranked third. Investors may have been encouraged by its strong economic growth and the government's commitment to look for clean energy opportunities and desire to boost domestic technology innovation.

German companies took the largest share of public market fund raising in 2006, reflecting strong biofuels activity and continued solar growth, boosted by its production subsidy programs. In the areas of public market investments, Norway ranked third due to the IPO of its REC Company which raised over US\$1 billion.

4.5 Investments in carbon capture and storage

Another technology area growing in importance as countries strive to begin to make the transition to a low-carbon economy is carbon capture and storage (CCS). Many countries' plans for emission reductions, at least up to 2050, include substantial CO₂ reductions through this technology. CCS is moving through the stages of technology development (see Figure 1, Chapter 4), but as with any new technology, a financial gap exists between the cost of a plant with CCS and what would otherwise be built to produce the same industrial outputs.

The European Commission (2008a) reports that at current technology prices, the up-front investment costs for CCS are about 30 to 70 per cent (i.e., several hundred million dollars per plant) greater than for standard plants and operating costs are currently 25 to 75 per cent greater than in non-CCS coal-fired

plants. These costs are expected to substantially decrease as the technology is proven on a commercial scale. The IPCC (2005: 10) notes that over the next decade, the cost of CCS could be reduced by 20 to 30 per cent, and more should be achievable by new technologies that are still in the R&D phase.

This technology appears to be entering a phase of rapid growth; the IEA (2008) RD&D projects database lists 16 commercial projects, 11 demonstration projects and 103 R&D projects. With this growth will come substantial investment, from both public and private sectors. Aker, a Norwegian company developing CCS, predicts that the total market for CCS will be worth US\$1.5 to US\$2 trillion per year (Acher, 2008).

The IEA and the Carbon Leadership Sequestration Forum (IEA and CLSF, 2007) list 18 proposed full-scale CCS projects for power generation, although three have since been cancelled. The costs, where known, range from US\$680 million to US\$2.5 billion. Of the 15 projects, five are planned for the United Kingdom, two in each of Germany and Norway, and one in each of Australia, Canada, China, Netherlands and Poland.

The public and private sectors are active in CCS developments, with the multinational oil and gas companies being the main private sector players. Governments are often partners in R&D efforts and are investing resources in the technology. The Dutch government has announced approximately US\$45 million in funding for three pilot CCS projects. The government of the United Kingdom is committed to backing the construction of one of the world's first commercial-scale coal-fired CCS projects within seven years; although no estimate of cost has been issued. The EU has proposed measures to support the development of carbon sequestration, including up to 12 CCS demonstration projects by 2015. This is based on a recommendation by the European Technology Platform for Zero Emission Fossil Fuel Power Plants, which also proposed wide deployment and retrofitting of existing power plants by 2020 (Thorvik, 2007). Norway has embarked on a significant CCS program, with the government proposing to spend over US\$200 million on R&D in 2008 (Ministry of Petroleum and Energy, 2007). Four OPEC nations have contributed US\$750 million to a research fund for CCS. While the United States is active in this area, progress on CCS suffered a recent setback. In February 2008, the Department of Energy cancelled FutureGen, a CCS public-private partnership, citing increasing costs. The Energy Department has proposed a new plan to provide US\$1.3 billion for the CCS components of multiple facilities.

There is growing interest in collaboration in CCS projects with developing country partners. StatoilHydro of Norway has partnered with India to develop CCS. China-EU cooperation includes the Near Zero Emissions Coal Demonstration initiative, which plans to develop a CCS demonstration project in China by 2020. China's 11th Five-Year Plan supports the development of CCS, although they have stated that near future activities in China will depend on aid and technology from the international community (Fu, 2007).

4.6 Export crediting agencies

Export crediting agencies (ECAs) and investment insurance agencies are government institutions that act as finance companies for private domestic entities who conduct business abroad. ECAs provide government-backed loans, guarantees and insurance covering both commercial and political risk. They are another source of government/private funding and currently finance or underwrite about US\$430 billion of business activity abroad. About US\$70 billion in annual funding is for developing countries or almost five times the financing provided by the World Bank Group. ECA financing directed to developing countries is concentrated in sectors that have important implications for climate change such as infrastructure, power generation, oil and gas development, and energy intensive manufacturing. ECA financing is generally concentrated in six countries (Brazil, China, India, Indonesia, Mexico and the Philippines) that are major contributors to global GHG emissions, and much of the investment in the power sector has gone to coal-fired and gas-fired plants (Maurer, 2003).

The ability of ECAs to finance more sustainable projects is somewhat limited by international norms that govern their operation,⁹ but there is an 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. ECAs respond to directives and policies from finance ministries and foreign ministries responsible for international negotiations, where the debate on improved standards for climate change issues could be addressed. Concerned constituencies at domestic and international levels could also engage in the ECA reform debate and make improved environmental standards, particularly for climate change issues, a priority.

There has been some attempt at reform, including the *Arrangement on Guidelines for Officially Supported Export Credit*, under which OECD countries agreed to special financial terms for renewable energy and water projects (OECD, 2007). This agreement aims to promote the use of renewable energy resources and help increase access to safe drinking water in line with commitments made at the 2002 Johannesburg World Summit on Sustainable Development and with the Millennium Development Goals.

5.0 The role of Canada

5.1 Canadian finance and investment support to international climate change efforts

Canada supports international climate change efforts through its development assistance program, including financial contributions to the GEF, World Bank,

9 For example, ECAs of the OECD countries abide by the terms of the *Arrangement on Guidelines for Officially Supported Export Credit* that was established in 1978 to prevent ECAs from distorting capital markets and competing with commercial financial institutions.

United Nations programs, regional development banks and other international institutions. In addition to the contributions of the Canadian International Development Agency (CIDA) and the Department of Foreign Affairs and International Trade (DFAIT), many other departments and agencies make contributions to international organizations.

Canada's Fourth National Report on Climate Change: Actions to Meet Commitments under the United Nations Framework Convention on Climate Change (Government of Canada, 2006: 169–184) outlined the country's support to fulfil its obligations under Article 4 of the Convention.¹⁰ Canada provided support for the implementation of the UNFCCC through the GEF, where the Canadian contributions for the first three replenishment periods were as follows: 1994–1998 First Replenishment – \$111 million; 1998–2002 Second Replenishment – \$122.09 million; 2002–2006 Third Replenishment – \$158.94 million. As of April 2006, Canada had contributed \$6 million to the SCCF and \$10 million to the LDCF. In Bali in December 2007, Canada announced a \$7.5 million contribution to the SCCF, allocating \$5 million to adaptation and \$2.5 million to technology transfer. This contribution makes Canada the second largest donor to the SCCF after the United Kingdom.

Canada's financial contributions to multilateral institutions and processes totalled \$301.74 million in 2003–04, a considerable drop from the previous four fiscal years, when contributions averaged \$565.66 million per fiscal year (see Annex 2 for details). The figures also include core contributions to the UNFCCC, UNDP and UNEP, and support to multilateral development banks. The 1999–2000 total includes a contribution of \$14.53 million to the World Bank's Prototype Carbon Fund.

In addition, Canada provided bilateral and regional financial contributions through CIDA. Canada's estimated funding for programs and activities in developing countries and countries with economies in transition related to the implementation of the UNFCCC in 2004–05 totalled \$28.77 million; with two-thirds directed to mitigation activities and the remainder to adaptation projects (see Annex 3 for details). This was a significant drop from the previous four years, when support to climate change activities averaged \$44.17 million per year. The most prominent initiative to support climate change activities was the Canada Climate Change Development Fund (CCCDF), a \$100 million program that was administered by CIDA and ran from 2000 to 2006.

The largest contributions by sector for bilateral and regional financial contributions through CIDA over the 2000 to 2005 period were energy, industry and forestry, comprising 47, 20 and 15 per cent of total mitigation funding, respectively. Forty per cent of total contributions were programmed through regional

10 The information provided in this section is taken from Canada's fourth national report on climate change (Government of Canada, 2006) unless otherwise noted.

programs; and the top bilateral recipients of climate change-related assistance were China, Egypt and India, receiving 12.3, 5.6 and 5.5 per cent, respectively, of total bilateral and regional contributions for the five year period. Bangladesh was the largest recipient of bilateral aid for adaptation.

Total Canadian ODA contributions have increased over the five year period from 2000–01 to 2004–05, from \$2.586 billion to \$4.145 billion (CIDA, 2006); while bilateral and regional contributions related to the implementation of the UNFCCC have declined from \$37.348 million to \$28.765 million in the same time period (see Annex 3). Given that these data have been obtained from different sources using different methodologies, the data may not provide a complete and comprehensive picture of development or other assistance directed at mitigating climate change. Nevertheless such data provide order of magnitude estimates that may be compared with other sources of funding.

Canada's ODA has never come close to the target of 0.7 per cent of gross national income (GNI); the UN target established in 1969 by an expert commission headed by former Canadian Prime Minister Lester Pearson. In 2006, Canada was the ninth largest donor among members of the Development Assistance Committee (DAC) in terms of net amount and ranked 16th when ODA is measured as a proportion of GNI (i.e., 0.29 per cent) (OECD-DAC, 2007: 8).

5.2 Canada and the carbon market

While the carbon market can play a role in encouraging investments in climate-friendly technologies in developing nations, there has been very little recent activity in the CDM by Canadians, despite significant growth in the carbon market over the past few years. Canadian companies had very high involvement in the early years of the carbon market, purchasing 31 per cent of GHG emission reductions in the market in 2001–02 (Lecocq and Capoor, 2003); but of late, Canadian buyers have been conspicuous by their absence. There were no purchases of note by Canadians in 2006, largely a result of uncertainty regarding Canada's climate change regulatory framework, and by the declared policy of the government to limit industry's access to CDM credits, without clearly defining, yet, what the rules for engagement with the CDM will be. Some Canadian demand could enter the CER market with the new Canadian regulatory framework that incorporates emissions trading and allows CERs for up to 10 per cent of the projected shortfall. Firms may choose to meet compliance obligations through contributions to a Technology Fund at a rate of \$15 per tonne of CO₂-eq from 2010 to 2012, and \$20 per tonne in 2013 (with the rate escalating yearly at the rate of growth of nominal GDP thereafter). This might be a low enough price for companies to question whether the transaction costs associated with CDM are worth the effort. Capoor and Ambrosi (2007: 21) note that there is a growing North American market for project offsets, perhaps in anticipation of emissions trading schemes in Canada and the United States.

5.3 Canadian investments in climate-friendly technologies

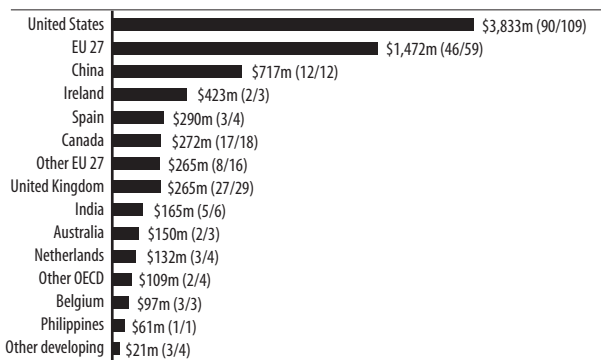
There are a number of government-supported programs to support clean technologies. Sustainable Development Technology Canada (SDTC) was established by the Government of Canada in 2001 to finance and support the development and demonstration of clean technologies including those that propose solutions to the issue of climate change. Since April 2002, the SDTC has completed eleven funding rounds, committed \$308 million to 137 clean technology projects, and leveraged \$722 million from project consortia members, for a total portfolio value of \$1.03 billion. SDTC is also the manager of the next-generation renewable fuels fund, which is supported by \$500 million in funding from the Canadian government.

The federal government has also allocated \$100 million for clean transportation initiatives, and established a \$1.5 billion trust fund to support provincial and territorial projects to help reduce GHG emissions and air pollution.

Actions at the provincial level have resulted in increases in public funding for climate change. For example, British Columbia has established a \$25 million clean energy fund, and Alberta has a \$200 million energy innovation fund.

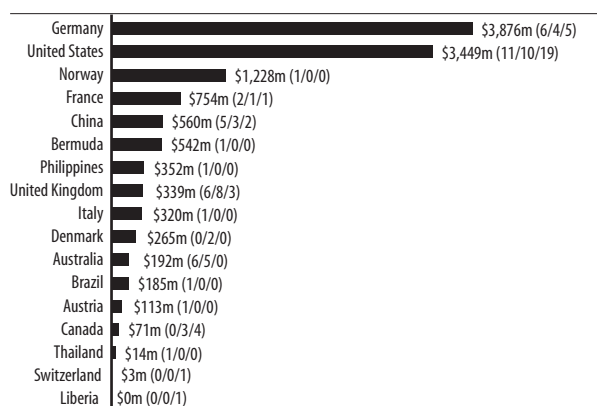
According to UNEP and New Energy Finance (2007), Canada ranked sixth among countries in the area of venture capital and private equity investment for sustainable energy technologies in 2006, trailing behind the United States, the EU 27, China, Ireland and Spain (see Figure 1). In regard to public market fund raising for sustainable energy technology in 2006, Canada ranked 14th behind the developing countries of China, Philippines and Brazil (see Figure 2).

Figure 1: Venture capital and private equity investment by country 2006 (US\$)



Source: UNEP and New Energy Finance, 2007, p. 24.

Figure 2: Public market investment by country 2006 (US\$)



Source: UNEP and New Energy Finance, 2007, p. 30.

5.4 Canadian energy R&D

In 2004, Canadian R&D expenditures on renewable resources and energy conservation made up 21.6 per cent of total energy R&D spending (Table 5). GHG reduction technologies compete with conventional technologies such as fossil fuels and energy transportation and transmission for R&D funding. R&D expenditures on renewable resources and energy conservation dropped between 2002 and 2004 from approximately 40 per cent to 20 per cent of total funding. In the same period, R&D aimed at increasing fossil fuel supply rose from \$209 million to \$361 million, making it the most significant technology area for energy R&D expenditures in 2004.

Table 5: Canadian energy R&D expenditures, by area of technology, 2000, 2002 and 2004

Area of Technology	\$ millions			% of total		
	2000	2002	2004	2000	2002	2004
Renewable resources	78	95	83	11.0	13.2	11.0
Energy conservation	208	120	80	29.3	16.6	10.6
Transportation and transmission	157	85	71	22.1	11.8	9.4
Fossil fuels	161	209	361	22.6	29.0	47.9
Nuclear	47	95	44	6.6	13.2	5.8
Other	33	86	115	4.6	11.9	15.3
Total	711	721	755	100.0	100.0	100.0

Source: Statistics Canada, 2005 and 2007.

While businesses tend to be the major source of industrial R&D funding in Canada (in 2006, 56 per cent of all Canadian R&D), financial support for GHG

reduction technology development in 2004 came primarily from the federal government. In regard to energy, R&D funded by companies (76 per cent of energy R&D) tended to focus on fossil fuels. The government sector funded a total of \$28 million on energy R&D, with \$6 million directed to renewable energy and conservation, and \$13 million on cross-cutting research, which includes energy systems analysis, and R&D on the environment, climate change, energy storage and alternative transportation fuels (Statistics Canada, 2007).

5.5 Canadian investments in CCS

Commercial application of CCS is hindered by a financial gap in a number of countries, including Canada, where the potential for capturable CO₂ could be as high as one-third to one-half of the country's projected GHG emissions in 2050. The EcoEnergy Carbon Capture and Storage Task Force (2008) recommended that a collaborative public-private partnership be formed to help establish CCS in Canada. They also recommended that Canadian governments invest \$2 billion in CCS, which would leverage an industry investment of roughly \$2 to 4 billion. The government of Alberta has made an initial investment in this area, committing \$100 million to study CCS.

The Task Force noted that the public investment of \$2 billion is needed in the short term as investments continue to be made in the Canadian energy sector. Electricity markets across the country, including coal-dependent Alberta, Saskatchewan, Ontario, Nova Scotia and New Brunswick require new capacity to satisfy increasing demand and replace plants that are reaching retirement. Over \$150 billion in capital spending has been announced for the oil sands alone. The Task Force noted that if the government fails to demonstrate its seriousness regarding CCS, these facilities will be built with conventional technology, thus making them costly to retrofit with CCS technologies in the future. Government support and funding will be needed to assist new facilities in accommodating CCS.

There is activity in CCS, with Canada being the home to one of the world's largest global carbon storage projects, the IEA GHG Weyburn-Midale CO₂ Monitoring and Storage Project, an eight year, \$80 million international project. The project is operated in conjunction with \$2 billion CO₂ floods in Saskatchewan, where huge volumes of the gas are captured from an industrial source and injected to enhance oil production. The project is funded by 15 public and private sector institutions, including governments from Canada, the United States and the European Community and industry participants from Canada, the United States, Japan and France (Petroleum Technology Research Centre, 2008).

Enbridge announced plans in 2008 to lead a group of 19 energy companies—including ATCO Power, BP Canada Energy, Chevron Canada Resources, EnCana, TransCanada, Opti Canada, and Penn West Energy Trust—in a Canadian CCS project. In 2008, \$750,000 will be spent to identify two or three

suitable sites, and in 2009, the group plans to start work on a single pilot project where a storage site would be designed to receive injected CO₂. The cost for the pilot plant is projected to be \$30 million to \$50 million. The pilot project will be operated for two to three years, before construction of the large-scale, long-term, commercial storage operation, the costs being pegged at over \$200 million (Erlich, 2008).

5.5 Export Development Canada

Export Development Canada (EDC) is Canada's export crediting agency, offering financing, insurance and risk management solutions to help Canadian exporters and investors expand their international business. Every year, EDC is used by over 6,400 Canadian companies and their global customers in up to 200 markets worldwide. It was not possible to determine the volumes of EDC business directed toward sustainable energy, as EDC discloses information on its insurance and financing activities in a manner that aims to protect the competitive position of its customers. Of the \$56 billion in aggregate business volume for the nine-month period ending September 2007, \$9 million was in alternative fuels and \$6 million in renewable energy, compared to \$10,224 million in the oil and gas sector, and \$2,393 million in the power sector (EDC, 2007).

6.0 Elements of an international approach to financing and investment for climate change

The sources of financing discussed above are likely to remain the main sources of capital for mitigation and to some extent for adaptation in the future. While each source is likely to play a unique role, private sector investments constitute up to 86 per cent of investment and financial flows and are likely to be the most important means to enhance response to climate change (mitigation and adaptation) in the future (UNFCCC, 2007d: 170). Potential has also been shown by the carbon market created by the Kyoto Protocol, particularly by allowing for cheaper implementation of emission reduction commitments, while generating financing for sustainable development and adaptation in developing countries. In this regard, the CDM has potential to leverage domestic and international investments and be expanded in the future.

However, private sector investment and the carbon market are unlikely to meet the needs of some countries. For many developing countries, in particular the least-developed countries, increased ODA and concessional financing will be required. Recently a number of governments and institutions have indicated a willingness to pledge new funds, for example:

- Japan is considering a US\$10 billion fund and recently pledged US\$2 billion to the Asian Development Bank for climate change mitigation technologies (Government of Japan, 2008).
- The United Kingdom has pledged US\$1.5 billion over the next three years for an environmental transformation fund focusing on projects that sup-

port development and poverty reduction through environmental protection; it will also help poor countries tackle climate change (Government of United Kingdom, 2008).

- The World Bank has assembled a new US\$300 million Forest Partnership Programme to encourage reductions in the rate of deforestation and has proposed a Carbon Partnership Facility (CPF). This public-private partnership will work with client countries to promote low-carbon sustainable development and raise the level of carbon financing to a larger scale (World Bank, 2007).
- Norway pledged US\$500 million per year to support efforts to reduce the rate of deforestation (Government of Norway, 2007).
- The United States is promoting the creation of a US\$2 billion fund (over the next three years) for the development of clean energy technologies in developing countries (Government of the United States, 2008).
- Canada announced a \$7.5 million contribution to the SCCF in 2007, allocating \$5 million to adaptation and \$2.5 million to technology transfer.

These pledges by developed countries may help to set a constructive tone for future negotiations. Nevertheless, it can be expected that discussions aimed at a comprehensive post-2012 climate change regime will need to focus on developing and expanding a combination of all available funding tools and financial mechanisms. These could include instruments for:

- promoting shifts in investment and financial flows to more climate-friendly and climate-proof investments;
- scaling up international and public capital dedicated to climate-friendly and climate-proof investments;
- optimizing the allocation of the funds available by spreading the risks across private and public investors, including by providing incentives for private investment in the early deployment of new technologies; and
- expanding available mechanisms (e.g., market-based mechanisms created under the Kyoto Protocol), maximizing synergies and complementarities (e.g., the Adaptation Fund and CDM) and establishing new financing tools.

6.1 Options for financing mitigation, adaptation and technology cooperation in developing countries

A number of innovative financing options have been proposed that could be used to generate the new and additional funds needed to assist adaptation and mitigation efforts in developing countries. A variety of options could be on the table when negotiations on new ways to finance mitigation, adaptation and technology cooperation measures in developing countries begin in earnest. These could include various levies such as on international transfers of carbon

credits, aviation taxes and international carbon taxes. These are discussed briefly below.

6.1.1 A two per cent levy on international transfers of ERUs, AAUs and RMUs

This levy would be similar to the current two per cent levy on CERs intended to raise revenues for the Adaptation Fund. The UNFCCC (2007d: 203) has estimated that US\$10 to 50 million could be raised annually from 2008 to 2012 through the levy on ERUs, AAUs and RMUs, with proceeds after 2012 dependant on the size of the carbon markets. A levy applied to all future credits generated through international emissions trading would be relatively simple to administer, with the experience of the levy under the CDM able to provide guidance. While not generating the large flows of financing needed to address the climate change problem, such a levy could be put in place relatively quickly. On the other hand, it could in theory have a negative impact on emissions trading, and therefore lead to higher mitigation costs in developed countries.

The BASIC Project (2006) has proposed three mechanisms for raising funds for adaptation: continuation of the two per cent levy on CERs; a new two per cent levy on voluntary emission reductions (VERs); and a share of developed countries' financial commitments as decided by the COP/MOP.¹¹ Gupta (2003) proposed that a levy be placed on all of the Kyoto Mechanisms, and Jaeger (2003) suggested that a levy on emissions trading could be used to provide insurance and compensation for damages. However, most economists would argue that taxes should be placed on harmful substances/projects/technologies and not on things deemed to be "good," i.e., efforts to reduce emissions. Consequently, such measures could be seen as counterproductive. Müller (2006) suggested that a levy on CDM projects boils down to developing countries paying for adaptation projects, since in its absence the amount of the levy would go to the seller of the CERs.

6.1.2 Aviation tax

An aviation tax could be placed on all or some international airline flights. Such a tax would be a means to reduce emissions from aircraft as well as raise funds for climate change. This option has generated interest because it would be simple and easy to administer by national authorities. It also attracts attention because emissions associated with international air transport represent three per cent of total GHG emissions, are rising rapidly and are not included within national GHG emission inventories or subject to any current international mitigation mechanism. Müller and Hepburn (2006) suggest a low levy of US\$6.50 per passenger flight, which could generate US\$10 to 15 billion

¹¹ The BASIC Project's VERs are a proposed new type of commodity derived from sectoral or national "no lose" commitments taken by developing countries. The scale of funding that could be generated through this proposal is uncertain, in part because the proposal suggests that the amount of CERs and VERs to be traded will be capped.

annually. The tax could be global, despite international disparities in per capita emission figures, because revenues from the levy would be returned to developing countries for adaptation or carbon mitigation finance. The administration of funding generated through the levy could take place through the Kyoto Protocol Adaption Fund or another mechanism.

While this proposal is controversial, Chile, Côte d'Ivoire, Congo, Korea, France, Madagascar, Mauritius and Niger have established a precedent by collecting an "international solidarity contribution" on airline flights (Leading Group, 2007). France's tax is going toward a new global health fund, and Chile's revenues will be split between the fund and the promotion of domestic tourism. The introduction of this levy demonstrates that aviation taxes can be introduced unilaterally or by like-minded groups of nations.

The solidarity levies, while raising funds for international development, have not impacted airplane travel as they have been set at a low level (Leading Group, 2007). For an international aviation tax to drive emission reductions in this sector, a higher levy rate will need to be applied, with a corresponding increase in the provision of funding for adaptation and/or technology.

6.1.3 Designated proceeds from the auctioning of emission allowances

Many countries and regions have or are establishing emissions trading systems, and movement to auctioning of emission allowances offers opportunity to generate revenues for mitigation and adaptation actions in developing countries. The European Commission's (2008b) *20 20 by 2020* proposes that the EU ETS move to auctioning of allowances in 2013. This auctioning process would generate significant revenues for Member States, and the proposal suggests that 20 per cent of the auctioning income be used to support the process of adjustment to a low carbon economy, supporting R&D and innovation and providing support for developing countries. The German government has agreed to dedicate a portion of the proceeds from its future auction of emission allowances for adaptation projects in developing countries.

A number of bills that propose cap and trade systems are before the U.S. Congress. Some of these include that a portion of revenues from auctioning of emission allowances be allocated for international efforts. For example, the Lieberman-Warner bill, *America's Climate Security Act*, directs the EPA to allocate 2.5 per cent of each year's account to reduce tropical deforestation in other nations. The bill also includes a provision for a portion of auctioning revenues to be allocated to an international climate change adaptation and national security program that will support mitigation, adaptation and technology transfer efforts with LDCs.

6.1.4 Global carbon tax

A global carbon tax seems to be more ambitious, since it would be imposed on top of several pre-existing taxes and emissions trading under the Kyoto

Protocol, and in conjunction with, subsidies on various fuels in some countries. Proposals have been put forward in this regard; for example the Government of Tuvalu (2005) has suggested that a levy on fossil fuel sales in Annex I countries could be used to fund a Climate Change Insurance Fund designed to meet the restorative costs of the impacts of climate change (and there is nothing to prevent such funds from being used more broadly for mitigation and technology transfer). Schroeder (2006) notes that a small tax the equivalent of US\$0.05 per U.S. gallon would raise about US\$60 billion for global purposes and would barely be noticed by consumers. However, such a tax would do little to curb emissions in developed countries, would be viewed negatively by some countries that depend on tourism and would generally be perceived by consumers as simply a means to raise revenue for governments.

Theoretically, carbon taxes offer the advantage of simplicity. As emphasized by Nordhaus (2006), unlike the quantitative approach under the Kyoto Protocol, with taxes there are no country emission quotas, there is no emissions trading and there are no base period emission levels. Furthermore, the approach would be spatially efficient among countries that have a harmonized set of taxes.

Despite those numerous theoretical advantages, when applied to climate change, carbon taxes have, notwithstanding, been politically unacceptable to some developed countries in an international context—even more so than quantified objectives. Furthermore, it seems clear that developing countries would be unwilling to adopt such an instrument because of the costs of action it would impose on them in comparison to the actual situation in which they do not face any constraint. If harmonized at the international level, taxes also raise sovereignty concerns. Moreover, taxes also meet opposition at the domestic level from various vested interest groups in virtually every country (Philibert *et al.*, 2003). In fact, as emphasized by Jacoby and Ellerman (2004) the argument for the use of a price instrument (i.e., a carbon tax) for controlling GHG emissions is very strong. However, economic reasoning notwithstanding, the dominant choice almost everywhere in the world still seems to be the quantity instrument (i.e., emission reduction targets).

In response to this apparent contradiction between efficiency and political reality, a wide variety of hybrid options have been proposed. They include various forms of indexed or dynamic targets, and the introduction of caps on the price of carbon traded internationally, often also called “safety valves.” In fact, as explained by Philibert (2006), a hybrid framework could evolve from a quasi-tax to a quasi-pure quota, if Parties appropriately manage their targets and the price cap level over time. Indexed targets would adjust assigned amounts to the evolution of some economic variables. Price caps would relax the emission objectives if the international carbon price reaches some agreed level. Jaccard (2006: 309) suggested that the price cap could even be designed to climb over time in conjunction with a reduction in the emission cap so that the environmental effectiveness of the policy increases at a pace consistent with the time needed for

innovation and commercialization of new technologies, and the natural turnover rate of equipment, buildings and infrastructure. Thus, these options would by design reduce the uncertainty on the cost encountered by countries.

In the context of a mandatory cap and trade system, a price cap also referred to as a “safety valve” or “trigger price” would specify a maximum market price at which additional emission allowances would become available to prevent the price from rising any further. This would ensure that emission reductions only occur if they were cheaper than the price cap; otherwise one would buy these additional allowances.

A price cap is not a policy innovation; it has close and well established relatives. It is similar to a per-unit penalty found in cap and trade systems where the penalty is set at a high enough level that it is unlikely to be triggered. If the price is set sufficiently low so that emissions commonly exceed the quantity limit, it resembles an emissions tax (Jacoby and Ellerman, 2004: 481).

The concept of the price cap may take three different forms in an international agreement:

- governments implement the price cap at the domestic level, issuing supplementary permits at an agreed upon international price (IEA, 2002: 126);
- 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.

In regard to generating revenue for mitigation, adaptation or technology transfer, if the costs turn out to be higher than expected, supplementary permits could be delivered by governments or some international entity. A portion of the revenues from the sale of these permits, which might be substantial but also unpredictable, could be allocated to mitigation, adaptation and technology transfer efforts in developing countries, in a manner similar to that for proceeds from allowance auctioning.

6.1.5 Other innovative funding mechanisms

Other innovative financing mechanisms include the following:

- *Levy on Marine Bunker Fuels*. Like their aviation counterparts, marine bunker fuels are excluded from emission controls under the Kyoto Protocol. Introducing a levy on marine bunker fuels could address this gap in the international climate regime, but would need to be carefully designed to prevent reduced trade flows from developing countries and ensure compliance with existing rules of the World Trade Organization (Cosbey, 2007).
- *Currency Transaction Development Levy*. Hillman *et al.* (2006) have proposed that a 0.005 per cent levy be applied on all foreign exchange transac-

tions in a particular currency, regardless of where the transaction takes place.¹² It is suggested that income from this levy be directed towards the provision of clean water and sanitation, providing human resources for health, and supporting an expanding UN Central Emergency Response Fund—all actions that would enhance adaptive capacity and disaster response in developing countries. But there is nothing to preclude agreement that such funds be directed to support climate change efforts.

- *Adaptation and/or Technology Credits.* Initial discussion has taken place on the use of market mechanisms to encourage adaptation and technology. Such credits would be introduced and traded between Parties, but the establishment of such a scheme would be challenging due to the need to quantify adaptation and technology actions and translate the actions into a fungible commodity. This approach would also be challenging due to uncertainty regarding transaction costs (Kantha *et al.*, 2006).
- *Establishment of a non-compliance fee.* This idea is based on the Brazilian Proposal introduced at COP-3 (1997) that inspired formation of the CDM. Bouwer and Aerts (2006) have suggested that a “non-compliance fund” be financed through fees from non-compliant Parties and used to finance clean development. The proposal directly links the burden of funding mitigation or adaptation to those countries that did not keep their mitigation commitments. This proposal was not acceptable to developing countries prior to COP-3 and is not likely to be received more favourably at the current time.

As noted previously, the introduction of each of these various financing mechanisms would face a number of technical and conceptual issues. However, a more critical issue is likely to be their political acceptability. By moving outside of domestic taxation systems, these levies could relieve pressure on national budgets and might better reflect the polluter pays principle (Müller and Hepburn, 2006), but negotiating such a levy may prove extremely difficult because of the precedent that such measures would set. Their introduction would need to overcome opposition on the part of industry and concerns that they might imply responsibility for the adverse affects of climate change. So too would be a need to address concerns related to the feasibility of their introduction and the questions relating to burden-sharing, if only a handful of countries were to introduce such a levy.

6.2 Insurance and risk transfer options

Two unique options to address adaptation in a post-2012 adaptation regime are insurance pools and alternative risk transfer mechanisms. Within the insurance pool model, the international community would make regular

¹² By unilaterally applying this levy to transactions in individual currencies, it is estimated that US\$2.07 billion could be generated if applied to British Pounds and US\$4.3 billion if applied to Euros (Hillman *et al.*, 2006).

contributions to a multilateral fund that could support impact relief at the international, regional, national and local level. The AOSIS proposal, first proposed in 1991, envisions mandatory contributions from industrialized countries (determined by equal weighting of their GHG emissions and GNP) being pooled in a common international fund that would compensate victims of sea-level rise (Hamilton, 2004; Muller, 2002). Similarly, Germanwatch (2005, in Bals *et al.*, 2005) proposed to cover the cost of sudden-onset risks to public infrastructure, such as floods and windstorms, through payments from developed countries. IIASA has proposed a two-tiered model that would involve contributions from developed and developing countries. The first tier consists of a global relief fund; the second would support insurance initiatives undertaken by developing countries themselves (Linnerooth-Bayer and Mechler, 2005). Insurance pools can also be developed at the regional level, such as through Regional Catastrophe Insurance Schemes;¹³ at the national level through Public-Private Insurance Partnerships;¹⁴ and at the local level through micro-insurance schemes.¹⁵

Alternative risk transfer mechanisms have been developed by financial institutions to reduce exposure to climate change impacts (UNEP-FI, 2005). These mechanisms include catastrophe bonds, weather derivatives and weather hedges. Interest in weather derivatives in particular is growing due to its potential for reducing the risk of farmers in developing countries. Public-private partnerships could encourage the introduction of these mechanisms in developing countries by subsidizing premiums or providing back-up capital. For example, the World Bank currently backstops the Turkish Catastrophe Insurance Pool, a national insurance program against earthquakes (Burton *et al.*, 2006).

In the future, insurance and risk transfer mechanisms could play a larger role in providing routine, predictable funding for climate disaster assistance (Burton *et al.*, 2006). This support would leave developing countries less reliant on debt financing and international donations, increasing their overall adaptive capacity (Bals *et al.*, 2005).

13 *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, 2006). This type of insurance pool is currently being explored for the Caribbean and Pacific regions. These risk pools could be backed by a regional facility that could provide reinsurance services.

14 *Public-Private Insurance Partnerships*: 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, mutually beneficial activities are undertaken such as hazard assessments.

15 *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.

7.0 Reflections and implications for Canada

Investments in sustainable energy technologies are growing rapidly based on projections provided by the IEA, expectations of resource depletion, concerns over energy security concerns and constraints on carbon that are emerging in many countries. In this context, public investments in sustainable energy technologies are outstripping other sources of financing such as development assistance and the carbon market in several emerging developing countries. In the case of Canada, private sector financing along with targeted government-funded R&D are likely to be the main sources of financing for climate change activities.

7.1 Creating a proper policy framework

Packages of policies and rules in developed and some developing countries are stimulating significant investments in renewable technologies. In 2006, renewables accounted for 14 to 15 per cent of newly installed generating capacity and 18 per cent of investment globally. Wind generation investment is now the highest amongst climate mitigation technologies. While renewables remain a little more expensive, savings in fuel costs, and other benefits are making them attractive in many countries.

Canada may wish to review its policies and rules so as to stimulate additional venture capital for companies and private sector investments in the generation of electricity by renewable technologies. For example, the Clean Air Renewable Energy Coalition has recommended expanding the current ecoENERGY for Renewable Power to a target of 12,000 MW by extending the application date to 2015. This would build momentum for the green power industry in Canada, helping to provide investment in environmental technologies, diversifying Canada's energy supply, providing for regional economic developing and competitiveness, and reducing GHG emissions.

Similarly, Canada may wish to consider how to help developing countries learn from the experience of others in order to develop appropriate policies and rules that can stimulate private sector investments in renewable technologies.

CCS is likely to play a significant role in Canada's efforts to reduce GHG emissions, requiring public-private partnerships and the proper regulatory framework to move this nascent technology forward. Other countries are making public investments and developing commercial frameworks for the first few projects.

Canada may wish to consider providing regulatory clarity and public funding to leverage private investment in CCS. The recommendations of the EcoENERGY Task Force on Carbon Capture and Storage provide a collaborative framework for action.

The global carbon market has been developing rapidly and is highly likely to evolve further in the next few years. In Canada, the modalities for the federal emissions trading system are being developed and are likely to provide clarity

in regard to use of the CDM. Clear direction and regulatory certainty could help to increase Canadian investments in CDM projects.

To ensure that such project-based credits are acceptable to Canadians, Canada could consider encouraging CDM investments in sectors with high sustainable development benefits and in countries with which it wishes to develop strategic alliances.

7.2 Stimulating investments in Canada

Capital has been shifting to several newly emerging developing countries. This reflects stronger FDI and private capital mobilization within emerging markets. China, India and Brazil are major producers of and markets for sustainable energy, with China leading in solar, India in wind and Brazil in biofuels.

Canada may wish to consider whether it wants to aim for a significant global market share of investments in renewables and if so how it wishes to do so.

International R&D efforts are likely to be part of a post-2012 program. They will require funding mainly from developed countries. There is however evidence that the large emerging developing countries are also increasing their strategic investments in R&D. For example both India and China have contributed US\$1 billion each to the ITER project.

In this environment, Canada may wish to re-evaluate its level of support and priorities, in particular, for energy R&D and whether and how it wishes to participate in future international R&D partnerships. Focused support for CCS R&D at home and in international partnerships could assist Canada in being a global leader in CCS technical capabilities and expertise.

7.3 Filling the gap in financial support for developing country actions and the role and nature of development assistance

While the degree of development assistance has been level for the last 10 years, in recent months a number of governments have indicated a willingness to pledge new funds (Tirpak and Adams, forthcoming). Some of these funds will be passed to the Multilateral Development Banks; others may emerge as bilateral programs. While this approach provides visibility for donors and may lead to greater innovation, it may also create a challenge for developing countries wishing to access such funds. It may also alter how negotiations are to be conducted under the UNFCCC as many developing countries would prefer to negotiate a single financing package leading up to COP-15. Also, as noted above, a number of options for additional financing to fill the mitigation and adaptation funding gap in developing countries will need to be discussed in the climate change negotiations.

Canada may wish to analyze the need for additional climate change funding in developing countries and consult with other developed countries to create a common approach to the upcoming negotiations.

In this context, the level of support by and focus of Export Development Canada may wish to be evaluated, for example, to determine whether it should allocate a larger part of its portfolio to renewable energy, energy efficiency and CCS technologies.

Private sector investment and the carbon market are unlikely to meet the needs of all countries. For many developing countries, in particular for the LDCs, increased levels of ODA and concessional financing will be required to promote mitigation and to build capacity to adapt.

Canada may wish to consider what role development assistance should play in its international climate change strategy, the level that would be appropriate for it to have an impact and the means by which it implements its development assistance efforts.

Annex 1: Funds and initiatives of the World Bank

The World Bank (2008) has designed pilot activities that pioneer carbon finance, attracting private and public monies to capitalize carbon funds and creating new carbon assets. Funds and initiatives include:

- *Prototype Carbon Fund:* This fund was the first carbon fund established and is a partnership between seventeen companies and six governments and managed by the World Bank. The PCF became operational in April 2000. Its mission is to pioneer the market for project-based greenhouse gas emission reductions while promoting sustainable development and offering a learning-by-doing opportunity to its stakeholders. The Fund has a total capital of US\$180 million.
- *BioCarbon Fund:* The World Bank has mobilized a fund to demonstrate projects that sequester or conserve carbon in forest and agro-ecosystems. The Fund, a public/private initiative administered by the World Bank, aims to deliver cost-effective emission reductions, while promoting biodiversity conservation and poverty alleviation. The Fund is composed of two Tranches: Tranche One started operations in May 2004, has a total capital of US\$53.8 million and is closed to further participation; Tranche Two was operationalized in March 2007 and remains open to contributions.
- *Community Development Carbon Fund:* The CDCF provides carbon finance to projects in the poorer areas of the developing world. The Fund, a public/private initiative designed in cooperation with the International Emissions Trading Association and the United Nations Framework Convention on Climate Change, became operational in March 2003. The first tranche of the CDCF is capitalized at US\$128.6 million with nine governments and 16 corporations/organizations participating in it and is closed to further subscriptions. The CDCF supports projects that combine community development attributes with emission reductions to create “development plus carbon” credits, and will significantly improve the lives of the poor and their local environment.
- *Country level funds/facilities:* Various countries have discreet facilities to develop projects. The Italian Carbon Fund to purchase greenhouse gas emission reductions from projects in developing countries and countries with economies in transition that may be recognized under such mechanisms as the Kyoto Protocol’s CDM and JI (US\$155.6 million); the Netherlands CDM Facility to support projects in developing countries that generate potential credits under the CDM (US\$264.7 million); the Netherlands European Carbon Facility purchases emission reductions from JI projects only, US(\$56 million); the Danish Carbon Fund - two public sector participants (the Ministry of Foreign Affairs of Denmark and the Ministry of the Environment of Denmark) and private sector participants (DONG Energy, Aalborg Portland, Nordjysk Elhandel, and Maersk Olie og

Gas) (US\$68.5 million); and the Spanish Carbon Fund purchases GHG emission reductions from projects developed under the Kyoto Protocol to (US\$278.6 million).

- *Umbrella Carbon Facility*: The UCF is an aggregating facility to pool funds from existing World Bank carbon funds and other participants for the purchase of emission reductions from large projects. The Facility would have multiple tranches, with the First Tranche dedicated to purchasing CERs from the China HFC-23 projects. The Fund has a total capital of \$719 million.
- *Carbon Fund for Europe*: The Carbon Fund for Europe (CFE) is designed to help European countries meet their commitments to the Kyoto Protocol and the EU ETS. The CFE is a trust fund established by the World Bank, in cooperation with the European Investment Bank (EIB). The Fund will purchase greenhouse gas emission reductions through the Kyoto Protocol's Clean Development Mechanism and Joint Implementation from climate-friendly investment projects from either bank's portfolio as well as self-standing projects. While the World Bank brings its expertise and experience of the carbon market to the CFE, the EIB brings its intimate knowledge of the European economy and a rich project pipeline in developing countries. Through the CFE, the two institutions will complement private sector development in the emerging carbon market and seek ways to support essential private carbon market development.
- *Forest Carbon Partnership Facility*: In December 2007, the World Bank (2007a) announced a new initiative aimed at reducing emissions from deforestation. Nine developed countries pledged US\$155 million to "kick-start" the facility. The initiative is currently supported by Germany (US\$59 million), the United Kingdom (US\$30 million), the Netherlands (US\$22 million), Australia and Japan (US\$10 million each), France and Switzerland (US\$7 million each), and Denmark and Finland (US\$5 million each). U.S.-based Nature Conservancy also pledged US\$5 million. The Facility consists of two separate mechanisms, each with its own trust fund for which the World Bank will act as Trustee:
 - *The Readiness Mechanism* (target size: US\$100 million) will assist approximately 20 countries in preparing themselves to participate in a future, large-scale, system of positive incentives for reducing emissions from deforestation and degradation (REDD). This will include some basic infrastructure capacity building for these countries such as preparing a national REDD strategy, establishing a baseline and putting in place a monitoring system. Indigenous groups and other forest dwellers will participate in the process so they can benefit from future carbon finance flows.

- *The Carbon Finance Mechanism* (target size: US\$200 million) will enable an initial group of these countries that will have successfully participated in the Readiness Mechanism to pilot incentive payments for REDD. The Carbon Fund will remunerate the selected countries or actors within the selected countries, in accordance with negotiated contracts, for emissions reductions that are verified independently.
- *Carbon Partnership Facility* (CPF): This public-private partnership of developed and developing countries promotes low-carbon sustainable development and raises carbon finance to a scale where the much needed larger impact of carbon markets on GHG reductions becomes possible. Sellers will be supported by the program preparation fund and can benefit from capacity building, training services, and policy and methodology work. The CPF will provide buyers of emission reductions with an opportunity to receive a relatively certain future large stream of carbon credits to better plan for future compliance obligations; they will thus be able to hedge carbon liabilities while lowering their costs and risks of carbon credit acquisition in an uncertain market. Buyer participants are expected to make a financial contribution to the CPF, and seller participants develop and sell emission reductions during a given period of time. The CPF consists of the:
 - *Carbon Asset Development Fund* that supports the dialogue between buyers and sellers and their mutual effort to identify and develop emission reduction programs; the preparation fund will finance the development of low-carbon programs and the related due diligence; and
 - *Carbon Fund* that purchases carbon credits using financial contributions from developed country governments and the private sector (World Bank 2007b).

The World Bank is also working to fully integrate climate change adaptation into zero-interest loans and grants from its concessional lending arm, the International Development Association, whose clients include LDCs.

Annex 2: Canada's financial contributions to multilateral institutions and programs

Institution or Program	Contribution (millions of Canadian dollars)				
	1999–2000	2000–01	2001–02	2002–03	2003–04
Multilateral Institutions					
1. International Monetary Fund (a)	349.41	365.73	262.02	430.94	147.74
2. World Bank					
– International Development Association (b)	0.00	79.47	14.84	11.67	0.00
– Specific Funds	14.54	1.53	0.00	2.50	0.75
3. African Development Bank (c)	42.81	40.00	54.00	72.00	67.23
4. Asian Development Bank					
– Core Funding (c)	43.06	43.06	97.38	48.69	0.00
– Specific Funds	0.00	0.00	0.00	0.00	0.00
5. European Bank for Reconstruction and Development (d)	7.46	13.52	15.66	21.21	16.67
6. Caribbean Development Bank (c)	4.07	0.00	9.67	18.29	9.02
7. Inter-American Development Bank (c)	2.00	0.00	0.00	0.00	0.00
8. United Nations Development Programme (Core Funding)	41.30	42.30	42.30	44.00	56.50
9. United Nations Environment Programme (Core Funding)	N/A	N/A	N/A	2.52	2.52
10. UNFCCC					
– Core Funding		0.46	0.24	0.25	0.46
– Voluntary Contributions	0.00	0.00	6.39	4.26	0.03
Multilateral Scientific, Technological, and Training Programs					
1. World Meteorological Organization	1.82	1.69	1.44	1.64	1.56
2. InterAmerican Institute for Global Change Research (US\$)	0.05	0.11	0.17	0.12	0.12
3. IPCC (Swiss Francs)	0.09	0.27	0.00	0.70	0.14

(a) Amounts represent payments to the International Monetary Fund's Poverty Reduction and Growth Facility (formally Enhanced Structural Adjustment Facility); amounts do not include contributions to various trust funds held by this organization.

(b) Amounts represent encashment of notes for the International Development Association and do not include contributions to various trust funds held by this organization.

(c) Amounts are issuances for concessional funds and represent Canada's core contributions to these organizations.

(d) Amounts are encashment for capital subscription as recorded in Main Estimates.

Source: *Government of Canada, 2006, p. 171*

Annex 3: Summary of Canada's bilateral and regional financial contributions related to the implementation of the UNFCCC

Fiscal Year	Contribution (thousands of Canadian dollars)									
	Mitigation (a,b)					Adaptation (c)				
	Total	Energy	Transport	Forestry	Agri- culture	Waste Manage- ment	Industry	Capacity Building	Coastal Zone Manage- ment	Other
1997/1998	33,512	21,636	590	2,114	1,107	1,118	3,414	3,084	327	122
1998/1999	35,872	20,172	304	3,900	1,962	1,640	3,337	3,741	647	169
1999/2000	42,082	22,504	452	6,042	2,997	1,452	3,136	4,847	334	318
2000/2001	37,458	17,503	702	2,786	2,301	1,397	4,149	7,463	267	890
2001/2002	46,282	13,929	463	5,303	4,088	1,402	5,965	14,031	391	710
2002/2003	45,371	14,813	1,184	4,927	2,893	1,769	5,403	12,162	650	1,569
2003/2004	47,569	11,184	1,064	5,938	3,591	1,088	7,954	13,983	354	2,413
2004/2005	28,765	9,173	1,351	2,290	995	660	4,757	7,866	1	1,671

(a) Mitigation includes capacity building for mitigation.

(b) Project activities identified in the above sectors may relate to one or more sectors.

Source: Government of Canada, 2006, p. 173

References

- Acher, J., 2008. "Saudi, Norway Back Carbon Capture for CDM." *Reuters*. <<http://www.planetark.org/dailynewsstory.cfm/newsid/47025/story.htm>>.
- Bals, C., I. Burton, S. Butzengeiger, A. Dlugolecki, E. Gurenko, E. Hoekstra, P. Höppe, R. Kumar, J. Linnerooth-Bayer, R. Mechler and K. Warner, 2005. *Insurance related options for adaptation to climate change*. The Munich Climate Insurance Initiative.
- BASIC Project, 2006. *The Sao Paulo Proposal for an Agreement on Future International Climate Policy*. A discussion paper prepared for COP-12 and COP/MOP-2, Nairobi, Kenya.
- Bouwer, L.M. and J.C.J.H. Aerts, 2006. "Financing climate change adaptation." *Disasters*. 30(1): 49–63.
- Burton, I., E. Diringer and J. Smith, 2006. *Adaptation to Climate Change: International Policy Options*. Prepared for the Pew Center on Global Climate Change.
- Canadian International Development Agency (CIDA), 2006. *Statistical Report on Official Development Assistance: Fiscal Year 2004–05*. Ottawa: Government of Canada.
- Capoor, K. and P. Ambrosi, 2007. *State and Trends of the Carbon Market 2007*. Washington, D.C.: World Bank.
- Cochran, I. and B. Leguet, 2007. *Carbon Investment Funds: the influx of private capital*. Caisse des Dépôts Mission Climat. <http://www.caissedesdepots.fr/IMG/pdf_07-11_Mission_Climat_Research_Report_12_Carbon_Investment_Funds-2.pdf>.
- Carbon Sequestration Leadership Forum and IEA, 2007. *Near-term Opportunities for Carbon Dioxide Capture and Storage: Summary Report of the Global Assessments Workshop*. Paris: OCED/IEA.
- Cosbey, A., 2007. Personal communication, February 4.
- DFID, 2006. *Eliminating World Poverty: Making Governance Work for the Poor*. White Paper on International Development. London: Department for International Development. <<http://www.dfid.gov.uk/wp2006/>>.
- EcoENERGY Carbon Capture and Storage Task Force, 2008. *Canada Fossil Energy Future: The Way Forward on Carbon Capture and Storage*. Report to: the Minister of Alberta Energy and Minister of Natural Resources Canada.
- Ellis, J., H. Winkler, J. Corfee-Morlot and F. Gagnon-Lebrun. 2007. CDM: Taking stock and looking forward. *Energy Policy* 35: 15–28.
- Ehrlich, D., 2008. "FutureGen migrates north?" *Cleantech*. February 5. <<http://media.cleantech.com/2412/futuregen-migrates-north>>.

European Commission, 2008a. *Questions and Answers on the proposal for a directive on the geological storage of carbon dioxide*. <<http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/08/36>>.

European Commission, 2008b. *20 20 by 2020 - Europe's climate change opportunity*. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. January 23, COM/2008/0030 final.

Export Development Canada, 2007. *Canadian industry sub-sector*. <http://www.edc.ca/english/disclosure_11844.htm>.

Fu, P., 2007. "Status and Perspective on CCS in China." Presentation at the RITE *Carbon Capture and Storage Workshop*. Kyoto, Japan, February 15.

Germanwatch, 2005. *Insuring the Uninsurables. Preliminary thoughts regarding the basic structure of an insurance related mechanism (IRM)*. Internal report.

Global Environment Facility (GEF), 2007. *Status support of the Climate Change Funds as of September 30, 2007*. <[GEF/LDCF.SCCF.3/Inf.2](http://www.gef.org/GEF/LDCF.SCCF.3/Inf.2). November 9, 2007>.

Government of Canada, 2006. *Canada's Fourth National Report on Climate Change: Actions to Meet Commitments under the United Nations Framework Convention on Climate Change*. Ottawa: Environment Canada.

Government of Japan, 2008. *Special Address by H.E. Mr. Yasuo Fukuda, Prime Minister of Japan On the Occasion of the Annual Meeting of the World Economic Forum Congress Center*. Speech. Davos, Switzerland: January 26. <http://www.kantei.go.jp/foreign/hukudaspeech/2008/01/26speech_e.html>.

Government of Norway, 2007. *Three billion kroner towards efforts to prevent deforestation*. Press release, 10 December. <<http://www.regjeringen.no/en/dep/smk/Press-Center/Press-releases/2007/Three-billion-kroner-towards-efforts-to-.html?id=493682>>.

Government of Tuvalu, 2005. "Seminar of Government Experts: Draft Future Actions Strategy - Tuvalu." Presentation made at the *Seminar of Government Experts*, May 16–17. Bonn, Germany.

Government of United Kingdom, 2008. *Environmental Transformation Fund*. Department of Business Enterprise and Regulatory Reform. <<http://www.berr.gov.uk/energy/sources/sustainable/etf/page41652.html>>.

Government of the United States, 2008. *State of the Union Address*. <<http://www.whitehouse.gov/stateoftheunion/2008/index.html>>

Gupta, J., 2003. "Engaging Developing Countries in Climate Change: (KISS and Make-Up!)" in D. Michel (ed.), *Climate Policy for the 21st Century: Meeting the Long-Term Challenge of Global Warming*. Washington, D.C.: Centre for Transatlantic Relations, John Hopkins University. pp. 233–264.

Hamilton, K., 2004. "Insurance and financial sector support for adaptation." *IDS Bulletin* 35(3): 55–61.

Hillman, D., S. Kapoor and S. Spratt, 2006. *Taking the Next Step: Implementing a Currency Transaction Development Levy*. A report commissioned by the Norwegian Ministry of Foreign Affairs.

Hoff, H., L. Bouwer, G. Berz, W. Kron, and T. Loster, 2004. *Risk Management in Water and Climate – the Role of Insurance and Other Financial Services*. International Dialogue on Water and Climate, Delft.

The Netherlands and Munich Reinsurance Company, Munich, Germany. <<http://www.germanwatch-ev.de/download/klak/dwc2003.pdf>>.

International Energy Agency (IEA), 2008. "CO₂ Capture and Storage RD&D projects database." *IEA Greenhouse Gas R&D Programme*. <<http://www.co2captureandstorage.info/search.php>>.

IEA, 2006. *World Energy Outlook 2006*. <<http://www.worldenergyoutlook.org/2006.asp>>

IEA, 2002. *Beyond Kyoto – Energy Dynamics and Climate Stabilisation*, Paris: OECD/IEA.

IEA and Carbon Leadership Sequestration Forum, 2007. *Near-term Opportunities for Carbon dioxide Capture and Storage: Summary Report of Global Assessment Workshop*. Paris: IEA/OECD.

Intergovernmental Panel on Climate Change (IPCC). 2007. *Climate Change 2007: Mitigation of Climate Change*. Working Group III Contribution to the Fourth Assessment Report of the IPCC. Cambridge: Cambridge University Press.

IPCC, 2005. *Carbon Dioxide Capture and Storage: Summary for Policymakers*. A Special Report of Working Group III of the IPCC. Cambridge: Cambridge University Press.

Jaccard, M., 2006. *Sustainable fossil fuels: the unusual suspect in the quest for clean and enduring energy*. Cambridge: Cambridge University Press.

Jacoby, H.D. and D. Ellerman, 2004. *The safety valve and climate policy*. Cambridge: MIT.

Jaeger, C.C. 2003. "Climate Change: Combining Mitigation and Adaptation." In D. Michel (ed.). *Climate Policy for the 21st Century: Meeting the Long-Term Challenge of Global Warming*. Washington, D.C.: Center for Transatlantic Relations. pp. 375–396.

Kartha, S, P. Bhandari, L. van Schaik, D. Cornland and B. Kjellén, 2006. *Adaptation as a Strategic Issue in the Climate Negotiations*. ECP Report No.3.

Lapouge, J., 2006. *Implementing the Solidarity Levy: A worldwide status report and the French experience*. A speech at “Solidarity Levies on Aviation: workshop, The Leading Group, Oslo, 5 December.

Leading Group on Solidarity Levies to Fund Development, 2007. *Declaration on Innovative Sources of Financing for Development by the Leading Group on Solidarity Levies to Fund Development*. October 23.

Lecocq, F. and K. Capoor, 2003. *State and Trends of the Carbon Market 2003*. Washington, D.C.: World Bank.

Linnerooth-Bayer, J. and R. Mechler. 2005. *Disaster Risk Financing for Developing Countries*. IIASA Presentation for the World Bank. Washington, D.C., November 17.

Manning, R., 2006. *OECD Journal on Development: Development Co-operation Report 2006*. Paris: OECD.

Maurer, C., 2003. “Financing Carbon: Export Credit Agencies and Climate Change.” in S. Nakhooda (ed.), *Transition from Fossil to Renewable Energy Systems: What Role for Export Credit Agencies?* Washington, D.C.: World Resources Institute.

Müller, B., 2006. *Adaptation Funding and the World Bank Investment Framework Initiative*. Background Report prepared for the Gleneagles Dialogue Government Working Groups Mexico, June 7–9.

Müller, B., 2002. *An FCCC Impact Response Instrument as part of a Balanced Global Climate Change Regime*. A paper presented at the IIED Special Event at UNFCCC SB 16, Bonn, June 11.

Müller, B. and C. Hepburn, 2006. *IATAL: An outline proposal for an International Air Travel Adaptation Levy*. Oxford Institute for Energy Studies paper EV 36.

Nordhaus, W.D., 2006. *Life After Kyoto: Alternative Approaches to Global Warming Policies*. Prepared for American Economic Association Session on Global Warming and Kyoto Protocol. New Haven: Yale University.

Norway Ministry of Petroleum and Energy, 2007. *The Norwegian government focuses on carbon capture and storage*. Media Release. 05.10.2007. <<http://www.regjeringen.no/en/dep/oed/Press-Center/Press-releases/2007/The-Norwegian-government-focuses-on-carb.html?id=482451>>.

Organisation for Economic Co-operation and Development – Development Assistance Committee (OECD-DAC), 2007. *Final ODA Flows in 2006*. DCD/DAC/RD(2007)15/RD2.

OECD, 2007. *Arrangement on Officially Supported Export Credits – 2007 revision*. TAD/PG(2007)18. Paris: OECD.

Petroleum Technology Research Centre, 2008. Weyburn-Midale CO₂ Project. <http://www.ptrc.ca/weyburn_overview.php>.

Philibert, C., 2006. *Certainty versus Ambition – Economic Efficiency in Mitigating Climate Change*. International Energy Agency Working Paper Series. Paris: IEA.

Philibert, C., J. Pershing J.C. Morlot and S. Willems, 2003. *Evolution of Mitigation Commitments: Some Key Issues*. OECD and IED Information Paper. Paris: OECD.

REN21, 2007. *Renewables 2007: Global Status Report*. a pre-publication summary for UNFCCC COP-13. <http://www.ren21.net/pdf/REN21_GSR2007_Prepub_web.pdf>.

Schroeder, F., 2006. *Innovative Sources of Finance after the Paris Conference: The concept is gaining currency but major challenges remain*. FES briefing paper. New York: Friedrich Ebert Stiftung.

Skees, J, P. Hazell and M. Miranda, 1999. *New Approaches to Crop Yield Insurance in Developing Countries*. IFPRI EPTD discussion paper no. 55. Washington, D.C.

Statistics Canada, 2007. *Industrial Research and Development – 2006 Intentions*, Catalogue no. 88-202-XIE, Ottawa.

Statistics Canada, 2005. *Industrial Research and Development – 2004 Intentions*, Catalogue no. 88-202-XIE, Ottawa.

Thorvik, A., 2007. “EU Climate Change Policy – A Challenge for Norway.” A StatoilHydro presentation at *Norway’s Energy Days*, Oslo, October 17. <http://www.nve.no/energidagene/foredrag/Sesjon_3/3_Thorvik.pdf>.

Tirpak, D. and H. Adams, forthcoming. Bilateral and Multilateral Financial Assistance for the Energy Sector of Developing Countries. *Journal of Climate Policy*.

United Nations, 1997. *Kyoto Protocol to the United Nations Framework Convention on Climate Change*. New York: UN. <<http://unfccc.int/resource/docs/convkp/kpeng.pdf>>.

UN, 1992. *United Nations Framework Convention on Climate Change*. New York:UN. <<http://unfccc.int/resource/docs/convkp/conveng.pdf>>.

UNCTAD, 2006. *World Investment Report 2006*. New York/Geneva: UNCTAD. <http://www.unctad.org/en/docs/wir2006_en.pdf>.

UNEP Finance Initiative, 2005. *The Clean Development Mechanism: The Financial Sector Perspective*. CEO Briefing. January 2005.

UNEP and New Energy Finance Ltd. 2007. *Global Trends in Sustainable Energy Investment*. <http://www.unep.org/pdf/SEFI_report-GlobalTrendsInSustainableEnergyInvestment07.pdf>.

UNEP-Risø Pipeline. 2008. *CDM Pipeline Statistics*. Accessed: February 1, 2008. <<http://cdmpipeline.org/>>.

UNFCCC, 2007a. *Bali Action Plan*. Decision adopted by COP-13 and CMP 3. December 2007. <http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf>.

UNFCCC, 2007b. *Financial Cooperation under the Convention and its Kyoto Protocol*. <http://unfccc.int/files/cooperation_and_support/financial_mechanism/application/pdf/financial_cooperation_under_the_convention_and_its_kyoto_protocol.pdf>.

UNFCCC, 2007c. *Guidance on the registration of project activities under a programme of activities as a single CDM project activity*. Executive Board. Meeting 32. <http://cdm.unfccc.int/EB/032/eb32_repan38.pdf>.

UNFCCC, 2007d. *Investment and Financial Flows to Address Climate Change*. <http://unfccc.int/cooperation_and_support/financial_mechanism/items/4053.php>.

UNFCCC. 2006. *Guidance on the registration of project activities under a programme of activities as a single CDM project activity*. Executive Board, Meeting 28. <http://cdm.unfccc.int/EB/028/eb28_repan15.pdf>.

World Bank. 2008. *Carbon Finance at the World Bank: List of Funds*. <<http://carbonfinance.org/Router.cfm?Page=Funds&ItemID=24670>>.

World Bank 2007a. *Carbon Partnership Facility*. <http://carbonfinance.org/docs/CPF_Booklet.pdf>.

World Bank. 2007b. *Forest Carbon Partnership Facility*. <http://carbonfinance.org/docs/FCPF_Brochure_FCPF.pdf>.



Parties to the United Nations Framework Convention on Climate Change and Kyoto Protocol agreed on the Bali Action Plan in December 2007. The plan sets out a process to negotiate a post-2012 regime by December 2009. This book provides analyses from a Canadian perspective on the four main elements of the Bali Action Plan: mitigation, adaptation, technology development and transfer, and financing and investment.

In this book, IISD examines emerging approaches and options for post-2012 climate change cooperation, focusing on salient Canadian sensitivities and perspectives, and how Canada might contribute to the development of a robust and equitable climate change regime. The first chapter provides context for the analysis by examining the national circumstances in which Canada will develop and negotiate a position under the Bali Action Plan. The second chapter addresses how the post-2012 regime may address the urgent need for mitigation, and the basic fact of economic growth, particularly in developing nations. The analysis includes international and domestic perspectives, describing how the various possible elements of an international agreement fit with Canadian interests. Using this lens, the subsequent chapters look at adaptation, technology, and financing and investment—reviewing the options and assessing how Canadian strengths and interests might best be addressed.