Background Paper to the Follow-up Meeting of the 2008 UNGA Thematic Debate on Climate change

Global Private Investments and Climate Change

9 June 2008, Trusteeship Council Chamber

UNHQ, New York City

Purpose of the meeting

In a very dense 2008 climate calendar, the objective of this specialized follow up meeting to the 2008 General Assembly thematic debate on climate change is to provide Member States with a debate on the intense reciprocal relationship between private investments and climate change. On the one hand, the meeting will focus on the major impacts private investment choices have on current and upcoming CO2 emissions, and, on the other hand, it will hihglight the impacts that the current and upcoming climate regime will have on investment choices by region, by sector and by asset class.

Extensive research has already been done on how public funding may promote climate-proof and sustainable development, especially in developing countries. Climate risks and opportunities linked to private investments have been made an issue of salience to both companies and investors. However, the links between public decision-making and private investment flows and their implications for global warming need to be further addressed.

Given the magnitude of the issues at stake (both in terms of capital to be invested and CO2 to be emitted), this meeting should provide Member States negotiating the future climate regime, with investors' perspective on the options ahead - be it in their national regulatory capacity or in their international negotiating capacity. Indeed, when making their investment choices, business and investors are concerned with constraints and possibilities, but also with predictability, linked to the climate regime.[1]

To this effect, the President of the General Assembly is inviting a select group of senior financial service executives from different topical and geographical backgrounds. The speakers will provide various perspectives on climate change from the standpoint of analysts, banks, insurers, pension funds and hedge funds. The presentations and discussions will highlight the crucial importance, for investors, of decisions made by Member States on climate change. Member States, in return, will be given an overview, by various types of investors particularly involved in climate issues, of the constraints and potentials they face.

[1] In line with paragraph 11 of the Bali Action Plan which "agrees that the process shall be informed by, inter alia, the best available scientific information, experience in implementation of the Convention and its Kyoto Protocol, and processes there-under, outputs from other relevant intergovernmental processes and insights from the business and research communities and civil society", this meeting aims at supporting and facilitating ongoing and future consultations and negotiations.

A growing interest in climate change from various private financial actors

Financial institutions shape our economies in many and varied ways and are also having major yet differentiated impacts on climate change, in particular as they have increasing influence on corporate behaviour through their investment choices. In order to understand these impacts, one must understand the complexity of the finance industry. It is composed of very different actors operating according to different rationales and different time frames, which are crucial to grasping the vast array of their links to climate change. **Banks – both generalist and investment banks –** are the world's major capital providers while **insurers** are the global economy's risk experts, as well as, being major investors in their own right. Institutional investors such as **pension funds**, which are concerned with long-term risks, are exerting increased influence on companies through their investment decisions. **Hedge-funds** are also to be considered in this context, as they have the ability to invest major sums on a very short term basis. Their collective potential impact on the economy is massive, as numbers show: major institutional investors such as pension funds, holding 20% or USD 12.5 trillion of the capital in the USD 54[2] trillion global equity markets, as well as more specialized actors such as private equity houses and hedge funds, are dominant on the investment front.

Financial institutions are also at a crossroad on climate change. The evidence of the economic and financial impacts of global warming are hardening and a select group of banks, insurers and investment institutions, are taking a high profile stance on climate issues. This is in part due to the new evidence spread by the **analysis** emerging from the intergovernmental and public-policy community, detailing the likely economic impacts of climate change, as well as the increasing estimated costs of addressing the threats. Three main sources contributed to this raising awareness:

- A report[3] by UK economist Lord Nicolas Stern highlighted that with a 5-6 degree centigrade warming a real possibility for the next century models were estimating an average 5-10% loss in global GDP with poorer countries suffering costs in excess of 10% GDP. Equally, the Stern Review suggested that early action with strong mitigation policies could yield net benefits of USD 2.5 trillion. A recent report[4] by Stern shows that the risks seem even greater than anticipated in the original Stern Review. Nevertheless, even if one goes for parameter values implying less weight on richer generations than associated with the base case of the Stern Review, then the costs of no or delayed action can be much higher than those of timely action, particularly when the greater risks which we now see are taken into account.

- In 2007 a report[5] for the United Nations Framework Convention on Climate Change (UNFCCC) stated that in 2030 additional global investment and financial flows of USD200-210bn would be necessary just to return emissions to current levels. It was estimated that this would equate to 0.3-0.5% of estimated global GDP and 1.1-1.7% of global investment in 2030.

[2] McKinsey Global Institute (January 2008) *Mapping Global Capital Markets: Fourth Annual Report*, downloaded from http://www.mckinsey.com/mgi/reports/pdfs/Mapping_Global/MGI_Mapping_Global_full_Report.pdf 29.5.2008.
[3] Stern, Nicholas (2006) *The Stern Review: The Economics of Climate Change*, HM Treasury, United Kingdom.
[4] Stern, Nicholas (April 2008) *Key Elements of a Global Deal on Climate Change*, The London School of Economics and Political Science, downloaded from www.lse.ac.uk/collections/climateNetwork/publications/KeyElementsOfAGlobalDeal_30Apr08.pdf 29.5.2008.
[5] United Nations Framework Convention on Climate Change (UNFCCC) (October 2007) *Investment and Financial Flows to Address Climate Change*, downloaded from http://unfccc.int/resource/docs/publications/financial_flows.pdf 29.5.2008.

▪ Also, in 2007 the Intergovernmental Panel on Climate Change (IPCC) presented its Fourth Assessment Report[6] which warned that continued greenhouse gas emissions at or above current rates would accelerate warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century.

The arrival of these three reports, coming within a relatively short period of time, resonated strongly with leading private financial service institutions and accelerated their already mounting concerns over the potential economic and financial liabilities associated with climate change. In a summary report[7] presented by a group of financial institutions to the UN climate negotiations in Bali, Indonesia, in December 2007, a group of banks, insurers and asset managers noted that: *"All three – Stern, the IPCC and the UNFCCC – lead to the conclusion that strong and early action to reduce emissions is critical and can dramatically limit the costs of addressing the problem. It is very likely that the benefits of strong and early action far outweigh the economic costs of not acting. Furthermore, not only mitigation, but also adaptation is essential as climate change is already happening and developing countries will be worst affected."*

Responding to the challenges of climate change

Financial institutions and other investors are vital to foster vibrant, long-term, liquid carbon markets and to further stimulate investment in climate-friendly technology. In order to be able to perform these functions, financial institutions have consistently called for reduced policy uncertainty around the evolution of the international climate regime that can act to mobilize greater volumes of private capital and deepen the nascent carbon markets.

Integration of climate factors into all lending, insurance and investment decisions is far from guaranteed. Engagement of the broader financial services sector is crucial to help provide the finance and investment flows needed to embed climate-friendly technologies in the global market. However, several recent studies conclude that, in general, financial sector engagement is still weak and the quality of their management of climate change risks and opportunities below average. One explanation advanced for the hitherto rather limited engagement of financial sector institutions relates to the uncertainty and slow pace of development of the climate policy framework that forms the basis for carbon markets. As a result, a survey of business leaders recently found that nearly two thirds agreed that "uncertainty over government policy is making it difficult to plan strategies for corporate sustainability."[8]

The crucial impact of private investments on climate change

Climate change has moved to the top of the public policy agenda, both internationally and in national capitals. It has become a major financial issue for Member States, but also for other stakeholders.

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[6] Intergovernmental Panel on Climate Change (IPCC) *4th Assessment Report (4AR)*, downloaded from http://www.ipcc.ch/ipccreports/ar4-syr.htm 29.5.2008.
[7] United Nations Environment Programme Finance Initiative (December 2007) *Carbon Crunch: Meeting the Cost*, downloaded from . http://www.unepfi.org/fileadmin/documents/CEObriefing_carbon_crunch.pdf 29.5.2008.
[8] The Economist Intelligence Unit (Feb 2008) *Doing good: Business and the sustainability challenge*, downloaded from http://a330.g.akamai.net/7/330/25828/20080208191823/graphics.eiu.com/upload/Sustainability_allsponsors.pdf 29.5.2008.

In particular, the private sector has become a major actor of the climate change debate, as it is at the core of the problem as much as it can also provide solutions. Both for the challenges it poses and the opportunities it provides, key industries (such as energy, transportation, construction, etc.) are addressing climate change in their business strategy and activity. They have thus quickly been recognized by public decision makers as one major set of actors in the climate discussions. However, the private sector is broad and there are other, less visible actors. One such group are private investors, principally because they could provide the major source of finance needed to address climate change.

According to a recent UNFCCC report, the vast majority – up to **86 per cent** – of the global finance flows needed to respond to climate change will indeed come, not from bilateral donors or multilateral organizations, but from private investment sources.[9] In particular due to their increasing influence on corporate behaviour, financial institutions, as the world's major capital providers, as well as, insurers and institutional investors, hold a pivotal position in this context.

The fact that total investment in new physical assets is projected to triple between 2000 and 2030 provides a window of opportunity today to direct finance and investment flows into new facilities that are more climate friendly and resilient.[10] A large share of these investment and financial flows will be in developing countries. The UNFCCC report concludes that the investment decisions that are taken today will affect the world's emission profile in the future. Private investors will therefore play a key role in shaping the transition to a low-carbon economy worldwide.

Serving as a follow-up conference to the General Assembly Thematic Debate on *Addressing Climate Change: The United Nations and the World at Work* (Feb. 11- 13), and drawing on conclusions derived from the Investors Summit held at the UN Headquarters the following day (Feb 14th), the purpose of this specialized meeting is to foster dialogue between private investors and public decision makers. In particular, it is aimed at considering how financial institutions react to and are being impacted by the current and forthcoming climate regimes. Accordingly, the meeting should provide information on and promote awareness about how financial institutions integrate climate change related risks and opportunities in their operations and investment decisions. This in turn should stimulate open discussions between Member States and private investors on their respective roles in promoting innovation, investment in clean technologies, technology diffusion and transfer, among other areas.

The various impacts of investment choices on climate change

Financial institutions and other investors have a vital role and growing self-interest in securing timely, practical and cost-effective solutions to mitigate climate change, to promote early responses to the economic and investment aspects of adaptation and to transform the global financial architecture to one that supports a low carbon economy.

Pension funds are developing an interest in incorporating climate related assessments of their portfolios, as their long-term perspective makes them both more susceptible to risks and opportunities. Accordingly, several pension funds are at the forefront calling for

[9] United Nations Framework Convention on Climate Change (UNFCCC) (October 2007) *Investment and Financial Flows to Address Climate Change*, downloaded from http://unfccc.int/resource/docs/publications/financial_flows.pdf 29.5.2008.
[10] United Nations Framework Convention on Climate Change (UNFCCC) (October 2007) *Investment and Financial Flows to Address Climate Change*, downloaded from http://unfccc.int/resource/docs/publications/financial_flows.pdf 29.5.2008..

environmental impacts to be made an investment parameter in its own right. By focusing on environmental, as well as, financial returns they employ an innovative investment strategy. Recent reports have shown that such a strategy may not be at odds with profit maximisation.[11] Consequently, a sustainable approach to investment, also known as 'green investing', could also be used by hedge fund and other investors with a shorter investment perspective. Indeed, the strong and growing investor appetite for green investments in recent statistics reveal that the proportion of net inflows into equity funds that was directed to ecological or environment products across Europe grew from 2.6 per cent in 2006 to 15.2 per cent in 2007.[12]

The reasons for incorporating climate change into investment choices are obvious in a few key sectors, such as the **energy sector**. To meet upcoming estimated needs, new global energy supply is expected to require more than USD 20 trillion of capital investment over the next 25 years. Choices made by investors are thus critical as they will directly influence the quantity of greenhouse gases to be released into the atmosphere. In this respect, investment trends in renewable energy are indicative. In 2006, between USD110-125 billion was invested in 120 gigawatts (GW) of new power generation globally. Approximately a quarter of this investment, USD30.8 billion was in renewable energy excluding large hydropower. In terms of new generating capacity, renewable energy provided 14-15 per cent of total power sector investment, with wind alone accounting for the largest share of it. Financial institutions are thus very much involved in the process that is currently shifting investment patterns from business-as-usual onto a path leading to a low-carbon economy.

The impact of climate change on investment choices

For global financial services and the investment community, climate change presents both major **risks** and potentially lucrative **opportunities**. Each public and private financial institution has its own investment criteria, procedures and guidelines that determine how and where it makes investments for the benefit of its stakeholders. The financial industry has a two-fold obligation. On the one hand, it needs to prepare itself for the negative effects that climate change may have on its business and on its customers. On the other hand, it can significantly help mitigate the economic risks and enter the low-carbon economy by providing appropriate products and services.[13]

The financial sector is making a push to reduce its own direct impact through, for example, carbon neutral initiatives. However, many question the fact that the financial sector's role should end there. Some suggest that it should go further and attempt to influence the greenhouse gas emissions of key stakeholders, such as their clients. Actions by financial institutions that attempt to influence the emissions behaviour of their clients include carbon disclosure and mitigation actions as part of the client review process; measurement of the collective GHG emissions intensity of a portfolio; full disclosure of financial risks from climate change for publicly traded companies; favourable financing solutions to fund development of relatively lower emitting technologies; and, investments in low-emissions housing.

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[11] United Nations Environment Programme Finance Initiative and Mercer (2007) *Demystifying Responsible Investment Performance. A review of key academic and broker research on ESG factors*, downloaded from http://www.unepfi.org/fileadmin/documents/Demystifying_Responsible_Investment_Performance_01.pdf 29.5.2008.

[12] Thomas, Farley (27 March 2008) *Different shades of green,* Financial Adviser.

[13] WWF and Allianz (June 2005), *Climate Change & the Financial Sector: An Agenda for Action*, downloaded from http://www.wwf.org.uk/filelibrary/pdf/allianz_rep_0605.pdf 29.5.2008.

As far as **risks** are concerned, global annual economic losses resulting from extreme weather events and natural disasters have been predicted by a group of financial institutions in 2002 to approach USD150 billion per year by 2012. As a result insurers, re-insurers and banks could be put at risk of insolvency. The estimated figure was surpassed in the year 2005 and more recent scenarios estimate an economic loss of up to USD1 trillion in a given year stemming from climate related disasters by 2040. In addition, to this financial risk derived from natural hazards reinforced by climate change, national and international policy frameworks for climate mitigation are increasingly bearing on investment choices. Moreover, over the long-term climate change impacts pose a real business risk, which can be expected to influence investment decisions with respect to sectors and asset classes. Uncertainty, too, is an issue. Reducing uncertainty, the institutions stress, will act to mobilize greater volumes of private capital. The tone of the finance sectors call for action from the political and policy communities has intensified in the past 12 months as witnessed by a declaration made ahead of the G8 meeting in Germany in June 2007 when a group of finance sector CEOs stated: "there has been a seismic shift in how climate change is perceived, and is widely considered to be the greatest market failure ever. This is in part due to the fact that many of the effects of climate change are beginning to manifest, and that the threats posed by continued warming will affect—and even possibly disrupt—the operation of markets, societies, ecosystems and cultures."[14]

At the same time, climate change creates **opportunities** for new industrial sectors, trading in carbon markets, and risk mitigation instruments. Climate-related risks and rewards are increasingly seen by some financial institutions as part of a global financial future. An increasing number of financial institutions are hence investing in new products and services to serve growing client demands associated with carbon markets, renewable energy and clean energy technologies, as well as, addressing their own climate-related risk management needs.

One of the most obvious opportunities lies with channelling investments to renewable **energy**, cleaner energy and adaptation technologies and energy efficiency projects. By 2007, the renewable energy sector had doubled its electricity generating capacity since 2004, and saw the sector's annual investment figure reach nearly USD 150 billion for the first time.[15] In the same year, according to a new finding by the World Bank, global carbon markets had reached USD 64 billion[16] and these nascent markets have been predicted to increase exponentially if they are underpinned by the evolution of a market supporting policy framework.

These investments together with the multitude of different policy initiatives and responses to climate change will each have employment consequences. In addition, the pace of **job creation** in lower-carbon sectors ("green jobs") is likely to accelerate in the years ahead. According to a recent study by the United Nations Environment Programme (UNEP) globally around 300,000 workers are employed in wind power and more than 100,000 in solar photovoltaics (PV). By 2007, the renewable energy sector globally accounted for 2.4 million jobs[17]. In China, the USA and Europe more than 600,000 people are employed in the solar thermal industry – by far most of them in China. Almost 1.2 million workers are estimated to be employed in biomass in Brazil, the USA, Germany and China. Overall, the number of people employed in the renewable energy sector is presently around 2.3 million. There is also

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[14] United Nations Environment Programme Finance Initiative and 23 CEOs of financial institutions (June 2007) *Declaration on Climate Change by the Financial Services Sector*, downloaded from www.unepfi.org/fileadmin/statements/cc_statement_jun2007.pdf 29.5.2008
[15] The Economist 2 May, 2008.
[16] United Nations Framework Convention on Climate Change (UNFCCC) (October 2007) *Investment and Financial Flows to Address Climate Change*, downloaded from http://unfccc.int/resource/docs/publications/financial_flows.pdf 29.5.2008.
[17] REN21(February 2008) *Renewables 2007 Global Status Report*, downloaded from http://www.ren21.net/pdf/RE2007_Global_Status_Report.pdf 29.5.2008.

significant job creation potential in energy efficiency projects, including in construction and retrofitting of energy efficient buildings, as well as in sustainable transport.

Moreover, a significant number of financial institutions are mobilizing investments and directing financial flows into **carbon funds**. The global carbon market has been dominated by the sale and re-sale of European Union Allowances under the EU Emission Trading Scheme (ETS) at a value of USD 50 billion. Project-based activities through the Clean Development Mechanism (CDM) stand at a value of USD12.8 billion. Both markets grew sharply since 2004. Increasing numbers of private and public financial institutions also provide investment money for carbon funds that invest in emission reduction credits. More money is also flowing into the process of developing and commercializing CDM projects. Developing countries may not have benefited equally from the services financial institutions offer to address climate change, including insurance services. There also is a general lack of climate change capacity and knowledge within financial institutions, which is especially felt in developing countries.

To summarize, if financial institutions make the investment decisions, it is national governments that set the rules for the markets in which they invest and operate. Hence, Member States must be aware of their role in the multifaceted and complex relationship between global private investments and global climate change./.

Global Private Investments and Climate Change

June 9 2008 - Programme as of June 3rd

United Nations Headquarters, New York
Trusteeship Council Chamber

10.00 – 10.30 am: **Opening session**

Opening speech by the **President of the General Assembly**

Keynote address by **Ms. Mindy Lubber**, President of Ceres, Director of Investor Network on Climate Risk

10.30 – 12.30 am: **Panel and Discussion**

Moderator: **Mr. Jeffrey Ball**, Wall Street Journal

1. **Mr. Martin Kuscus**, Chairperson of the first Board of Trustees for the South African Government Employee Pension Fund

2. **Mr. Pierre Lagrange**, Co-Founder and Managing Director of GLG Partners LP

3. **Mr. James Cameron**, Vice Chairman of Climate Change Capital

4. **Mr. Oliver Bäte**, Chief Operating Officer and Member of Board of Management of Allianz SE

5. **Mr. Jack Rivkin**, Chief Investment Officer, Neuberger Berman, a Lehman Brothers Company, and member, Lehman Brothers Climate Change Council

12.30 – 1.00 pm: **Closing remarks**

A **business** perspective: **Mr. Naveen Jindal**, Executive Vice Chairman and Managing Director of Jindal Steel & Power Limited

An **analyst's** perspective: **Ms. Diana Farrell**, Director of McKinsey Global Institute

The **United Nations**' perspective: **Mr. Paul Clements-Hunt**, Head of the UNEP Finance Initiative

Summary of the General Assembly Specialised Meeting
"Global Private Investments and Climate Change"
New York, 9 June 2008

Opening session

1. The **President of the General Assembly** underlined the need to deepen our understanding on how the private sector relates to climate change issues in view of the massive additional financing needed to address climate change. He stressed that a recent UNFCCC report indeed estimates that up to 86 per cent of the global financial flows needed to respond to climate change will have to come from private investment sources. Therefore, aware of the fact that public financing will not be sufficient and the largest part of the global finance needed to respond to climate change will come from private investment sources, this meeting of the General Assembly was convened to constructively engage financial institutions playing a key role in every major investment decision. The President emphasized that investment decisions taken today will inevitably affect the world's emission profile in the future. It is therefore crucial to understand the way in which private investors can affect climate change through their investment choices, as well as what risks and opportunities they perceive with respect to the current and developing climate change regime.

2. In her keynote speech, **Ms. Mindy Lubber**, President of Ceres and Director of the Investor Network on Climate Risks (INCR), emphasized that climate change is a 'material' financial issue with vast implications for companies and investors. She underlined that climate change was not only about economic risk but presented enormous opportunities for companies and investors, in particular because of the rising demand for cleaner, low-carbon, energy-efficient technologies and products among countries and consumers. The International Energy Agency recently estimated that the world will have to invest as much as $50 trillion through 2050 in new energy infrastructure and equipment in order to reduce carbon dioxide levels to half of today's levels. She noted that the global clean energy investments had quadrupled in the past four years, to $150 billion in 2007. She emphasized that a strong, equitable international framework to reduce greenhouse gas emissions was essential to correct the significant market failure resulting from not putting a price on GHG emissions.

Panel

3. The panel, moderated by **Mr. Jeffrey Ball** from the Wall Street Journal, comprised the following speakers: **Mr. Martin Kuscus**, Chairperson of the first Board of Trustees for the South African Government Employee Pension Fund; **Mr. Pierre Lagrange**, Co-Founder and Managing Director of GLG Partners LP; **Mr. James Cameron**, Co-Founder and Vice Chairman of Climate Change Capital; **Mr. Oliver Bäte**, Chief Operating Officer and Member of Board of Management of Allianz SE and **Mr. Jack Rivkin**, Chief Investment Officer, Neuberger Berman, a Lehman Brothers Company, and member, Lehman Brothers Climate Change Council.

4. Each of the speakers represented various types of financial institutions, including investment banks, insurances, hedge funds and pension funds. The speakers discussed the role of the private sector investments in relation to climate change with an emphasis on how to encourage Member States of the United Nations to develop and provide incentives to strengthen sustainable investments, which would yield both environmental and financial returns.

5. It was underlined that climate change will have impacts on long-term investment value and returns. It was also mentioned that a new investment paradigm is emerging that demands integration of non-traditional risks, such as climate risks. The financial services and investment community was responding to these new challenges. One example mentioned is the Principles for Responsible Investment – an investor framework to consider environmental, social and governance issues – which has been signed by some 340 institutional investors from more than 30 countries, representing US$14 trillion in assets. A related issue concerned the disclosure of environmental, social and governance performance, e.g. as a standard listing requirement for stock exchange listings or via the Global Reporting Initiative. In this respect, some panellists called for worldwide mandatory disclosure.

6. Environmental and climate change investments have the opportunity to become a mainstream activity and as such could significantly change corporate activity. In the end, good environmental reporting and practices could become a proxy for good management and operational performance. All panellists stressed that individuals and investors alike have a responsibility to be aware of how behaviour and choices eventually generate carbon emissions. In particular, the benefits from improving energy efficiency were emphasized.

7. It was noted that the capital presently available in public hands is not commensurate to the challenges posed by climate change. Accordingly climate change must be placed in the context of the financial markets; capital markets will be crucial and the carbon markets will need a quantum leap to address climate change. Carbon prices need to become global, credible, long-term and equitable. Panellists referred to the strong growth of carbon markets in recent years; however, Africa as a region still stands to benefit from the emergence of carbon as a new asset class, as well as from the Clean Development Mechanism.

8. Technological breakthroughs are required to narrow the investment gap, e.g. in technologies for retrofit of existing power plants, adaptation and energy efficiency technologies, carbon capture and storage.

9. On the future, it was stressed that climate change as a global phenomenon demands a global response from governments with the imperative for international cooperation. Several panellists stated that the global climate regime needs to provide stability and long-term planning security and regulation if it is to successfully attract the needed private investments to address climate change. In particular, one panellist pointed out that current legal structures and framework incentives have not facilitated enough growth in

the European Emissions Trading System. Although increasing by 55 per cent from 2006 to 2007, to EUR 28 billion, it has been estimated that clean energy investments must still rise significantly in order to move more rapidly to a low-carbon economy by 2020. Accordingly, the panellist called for governments to provide more stable and smarter regulatory regimes.

Discussion

10. During the ensuing interactive dialogue with member states and special guests, the following issues were raised:

11. Panellists highlighted significantly expanded global liquid carbon markets and a carbon tax as possible policy options to address climate change. One speaker however underscored that carbon markets on a global level are more efficient and politically viable than a carbon tax. In response, one delegation further emphasized the need for governments to take into account all possible outcomes of a policy such as a carbon tax including its effects on employment and social development.

12. Some delegations highlighted the centrality of the principle of common but differentiated responsibility as a tenet of the debate at the UNFCCC and asked whether the historical responsibility by industrialized countries was a factor for the private investment sector. In responding, panellists underscored their strong awareness of the principle. However, panellists explained that for the private sector all kinds of incentives are of importance to produce returns.

13. Speakers and special guests underscored that many economic incentives to lower greenhouse gas emissions can be put in place today. As one example the congestion charge and its extensions for the city of London was mentioned. Energy efficiency standards for buildings and appliances were raised as practicable examples of immediate steps that could be taken to reduce emissions.

14. The debate focused on how governments may promote sustainable investments across regions and asset classes. On the total of their investments, panellists noted that only a small percentage at this stage are socially responsive, including investments in clean technologies for mitigation and in adaptation technologies. These investments focus on Europe, East Asia, mostly China, and increasingly on North America. The energy technologies invested in comprise mainly of wind and solar.

15. On clean technologies and technology transfer, one speaker highlighted the importance of access to cleaner technologies for developing countries to address the twin challenges of climate change mitigation and adaptation. One panellist, however, questioned the focus on technology transfer and recommended to instead focus on the economic transactions that bring technologies with them.

16. One delegation highlighted the need for public investment in research and development of innovative technologies, and also raised a question on the importance of sound and stable carbon markets and the potentially disruptive role of speculation. In response, the panellists mentioned the European Emissions Trading System which had already seen speculation. Panellists underlined that speculation in carbon markets will not diminish the validity of the process. It was noted that the carbon markets are in a nascent stage now, and that market mechanisms need regulatory frameworks in order to function optimally.

Closing remarks

17. The closing remarks were given by **Ms. Diana Farrell**, Director of McKinsey Global Institute; **Mr. Naveen Jindal**, Executive Vice Chairman and Managing Director of Jindal Steel & Power Limited and **Mr. Paul Clements-Hunt**, Head of the UNEP Finance Initiative.

18. Addressing the topic from the business perspective, as opposed to an investment perspective, one of the concluding speakers underlined the need for prompt and practical action from government. Climate change was no longer a fringe issue, but increasingly a matter of strategic concern for business. Another speaker stressed that demand side energy efficiency investments were the single most important action that could be taken even before the adoption of new climate change rules. The speaker emphasized how the focus on energy efficiency could generate low-carbon economic growth. The final speaker noted that climate change was a two-headed coin for the financial services industry: on the first side the financial institutions see the emergence of enormous risks – the "carbon crunch" – and on the other second side the evolution of a carbon market. Finally, looking ahead to Copenhagen, the need for the policy and the investment communities to intensify their dialogue and work together more closely was emphasized.

THE PRESIDENT
OF THE
GENERAL ASSEMBLY

1 May 2008

Excellency,

As you may recall, on February 11-13th of this year, the General Assembly held a High-Level Thematic Debate on climate change entitled "*Addressing Climate Change: The United Nations and the World at Work*." The panel discussions and statements made by Member States confirmed the urgency with which we need to confront climate change. In particular, Member States expressed a strong interest in a follow-up meeting focusing on the private sector in this context.

Recent research on the role of the private sector in climate change has shown that the role of private investment is of utmost importance in order to find timely, practical and cost-effective solutions to mitigate climate change and adapt the global financial architecture. Indeed, according to the UNFCC, private investment is crucial as it will constitute up to 86% of the financial responses to the challenges posed by climate change.

It is therefore my honour to invite you to participate at a General Assembly follow-up meeting focusing on investment and climate change, to be held on the 9th of June 2008. I would appreciate if your Excellency could attend in person.

The meeting will feature speakers from different segments of the investment community, including, among others, representatives from banks, insurance companies and pension funds. They will address the reciprocal links between private investment and public decision-making in the context of climate change. When making investment choices, business and investors are indeed concerned with constraints and possibilities, but also with predictability of the policy framework. This event should provide both investors and Member States an opportunity to exchange views and raise awareness about the scale of impact transnational flows of capital have on climate change and vice-versa.

A detailed program of the event as well as a background paper will follow in due time.

Please accept, Excellency, the assurances of my highest consideration.

Srgjan Kerim

All Permanent Representatives and
Permanent Observers to the United Nations
New York

THE PRESIDENT
OF THE
GENERAL ASSEMBLY

27 May 2008

Excellency,

Please find enclosed the detailed programme and background document for the meeting of the General Assembly on Global Private Investments and Climate Change, to be held on 9 June 2008 in the Trusteeship Council Chamber from 10 AM to 1 PM.

As previously announced, this follow up meeting to the High-Level Thematic Debate on Climate Change held in the General Assembly in February will comprise a panel discussion. A select group of renowned senior financial service executives from different topical and geographical backgrounds have been invited to provide various perspectives on climate change from the standpoint of banks, insurers, pension funds, hedge funds and analysts. The presentations and discussions will highlight the crucial importance decisions made by Member States on climate change have for investors. Member States, in return, will be given an overview of the challenges and opportunities various types of investors face in the current climate change context.

Following the presentations, Member States, as well as special guests from the private sector, civil society, media and the United Nations system, will have the opportunity to exchange views with the speakers on how to most effectively address climate change within the context of private investments and public decision-making. Given the informal and interactive character of the debate, spontaneous and brief interventions are encouraged.

I very much look forward to your personal participation in this important event.

Please accept, Excellency, the assurances of my highest consideration.

Srgjan Kerim

All Permanent Representatives and
Permanent Observers to the United Nations
New York

United Nations Framework Convention on Climate Change

INVESTMENT AND FINANCIAL FLOWS

TO ADDRESS CLIMATE CHANGE

UNFCCC

UNFCCC

United Nations Framework Convention on Climate Change

INVESTMENT AND FINANCIAL FLOWS TO ADDRESS CLIMATE CHANGE

FOREWORD

The spectre of climate change that is unfolding now is undeniably a cumulative impact of anthropogenic interference in the climate system over the last two centuries. The science is clear and the policy community is being increasingly convinced and galvanised into action to address this emergent challenge in light of the associated economic and human dimensions.

The impacts of climate change ranging from sea level rise, melting ice caps and glaciers, severe weather events, drought, flooding, warming, subtle changes in ecosystems – will impinge on every aspect of society and economic life. The costs of inaction will more than outweigh the costs of action. There is only a narrow window of opportunity to redress the situation. The Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report has underscored that mitigation efforts in the next 15–20 years will have a large impact on opportunities to achieve lower stabilization levels and have the potential to minimize major climate change impacts.

Failure to mitigate now through modifications in development pathways will lock the world into scenarios of emissions, implying more adverse climate change impacts, thereby leading to higher costs for adaptation. Underpinning this urgent need to modify development and emission pathways is the role of technology and additional financing and investment.

In recognition of the relevance and importance of the financing and investment dimension, the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), requested the Secretariat to analyse and assess investment flows that will be necessary to address climate change mitigation and adaptation in an effective and meaningful way, with a special focus on developing countries' needs. This publication is the culmination of the assessment undertaken by the Secretariat.

The analysis indicates that additional investments required to bring the emissions to current levels are small in relation to estimated global gross domestic product (GDP) (0.3–0.5 per cent) and global investment (1.1–1.7 per cent) in 2030. A conscious effort will have to be made to redirect traditional investment flows to climate-friendly alternatives. With appropriate policies and/or incentives, part of the additional investment and financial flows needed could be covered by the currently available sources. A judicious interplay of tools at our disposal including carbon markets, the financial mechanism of the Convention, ODA, national policies and, in some cases, new and additional resources, will be needed to mobilize the necessary investment and financial flows to address climate change.

The mechanisms in the Convention and Kyoto Protocol need to be expanded and other solutions considered for meeting future mitigation, adaptation and technology needs. While it is important to acknowledge that solutions for improving investment and financial flows are complex, it is critical that some widely supported, relatively simple and actionable themes be developed around which the structure of the post-2012 agreement can be shaped.

While undertaking this assessment, it also became apparent that costs of and investments for adaptation is still poorly understood, and there exists a crying need to step up efforts in this regard. This inadequacy, however, does not undermine the urgent need to invest in climate proofing and enhancing adaptive capacities of sectors, communities, regions and nations.

In many ways, this publication provides an initial assessment of the financial architecture required for developing a post 2012 regime and presents an overview of what level of resources and measures would be needed for successfully financing the international response to climate change, for making future climate change policies a success and ultimately, for crafting a climate-secure world for all.

As the first ever effort to collect and present data on projected, climate-related investments under reference and mitigation scenarios, the preparation of this paper was possible only due to the collaboration and support extended by different international financial institutions, UN agencies, intergovernmental organizations and non-governmental organizations, other relevant agencies, and representatives of the private sector and civil society.

I would also like to thank all the experts who provided invaluable comments during the conceptualization phase of the project, and on the various technical papers prepared as a part of this exercise. This extensive network of experts and institutions created, to my mind, represents an important resource for the Parties for any further work on investment and financial flows to address climate change.

Finally, I would like to place on record the generous contributions made by the Governments of Norway, Denmark and the Netherlands, which allowed this paper become a reality.

Yvo de Boer, *Executive Secretary*
United Nations Framework Convention on Climate Change
October 2007

EXECUTIVE SUMMARY

1. INTRODUCTION AND BACKGROUND

1. The UNFCCC secretariat has launched a project in 2007 to review existing and planned investment and financial flows in a concerted effort to develop an effective international response, with particular focus on the needs of developing countries. This work was mandated by COP 12 and is to result in inputs to COP 13 (December 2007), for its deliberations on the fourth review of the financial mechanism, and to the fourth workshop on dialogue on long-term cooperative action to address climate change by enhancing implementation of the Convention (August 2007).

2. This technical background paper reviews and analyses existing and projected investment flows and financing relevant to the development of an effective and appropriate international response to climate change, with particular focus on the needs of developing countries. It provides an assessment of the investment and financial flows that will be necessary in 2030 to meet worldwide requirements for mitigating and adapting to climate change under different scenarios of social and economic development, especially as they impact the well-being of developing countries. In particular it provides:

- Information on current investment and financial flows in as much detail as is available;
- Projection of investment and financial flows by major sources to address adaptation and mitigation needs in 2030, including:
  - Projections of future investment and financial flows under a reference scenario;
  - Projections of future investment and financial flows under a greenhouse gas (GHG) emissions mitigation scenario;
- A summary of priorities identified by Parties not included in Annex I to the Convention (Non-Annex I Parties) as part of the UNFCCC process;
- An analysis of the potential role of different sources of investment and financing and their future potential.

3. The paper draws on existing work and analysis wherever possible. Existing work used for the analysis includes the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), the World Energy Outlook (WEO) of the International Energy Agency (IEA), the Stern Review and other published literature.

4. To ensure that this analysis is beneficial to the UNFCCC process, the secretariat has collaborated with a number of international financial institutions (IFIs), United Nations agencies, intergovernmental organizations (IGOs) and non-governmental organizations (NGOs), other relevant agencies, and representatives of the private sector and civil society. These organizations and representatives were invited to share their experiences and views on existing and planned investment flows and finance schemes in the context of consultations. Four consultative meetings with such stakeholders have been held.

2. KEY FINDINGS

5. *The additional estimated amount of investment and financial flows needed in 2030* to address climate change is large compared with the funding currently available under the Convention and its Kyoto Protocol, but small in relation to estimated global gross domestic product (GDP) (0.3 – 0.5 per cent) and global investment (1.1 – 1.7 per cent) in 2030.

6. In many sectors the lifetime of capital stock can be thirty years or more. The fact that total *investment in new physical assets is projected to triple between 2000 and 2030* provides a window of opportunity to direct the financial and investment flows into new facilities that are more climate friendly and resilient. The investment decisions that are taken today will affect the world's emission profile in the future.

7. *When considering means to enhance investment and financial flows to address climate change in the future,* it is important to focus on the role of *private-sector* investments as they constitute the largest share of investment and financial flows (86 per cent). Although Official Development Assistance (ODA) funds are currently less than 1 per cent of investment globally, ODA represents a larger share of the total investments in some countries such as in Least Developed Countries (LDCs) (6 per cent).

8. Particular attention will need to be given to *developing countries,* because although they currently

account for only 20 – 25 per cent of global investments, their expected rapid economic growth means that they will require *a large share of investment and financial flows.*

9. With *appropriate policies and/or incentives,* a substantial part of the additional investment and financial flows needed could be covered by the currently available sources. However, *improvement in, and an optimal combination of, mechanisms,* such as the carbon markets, the financial mechanism of the Convention, ODA, national policies and, in some cases, *new and additional resources,* will be needed to mobilize the necessary investment and financial flows to address climate change.

10. *The carbon market,* which is already playing an important role in shifting private investment flows, would have to be significantly expanded to address needs for additional investment and financial flows. *National policies* can assist in shifting investments and financial flows made by private and public investors into more climate-friendly alternatives and optimize the use of available funds by spreading the risk across private and public investors. *Additional external funding for climate change mitigation and adaptation will be needed,* particularly for sectors in developing countries that depend on government investment and financial flows.

11. If the funding available under the *financial mechanism* of the Convention remains at its current level and continues to rely mainly on voluntary contributions, it will not be sufficient to address the future financial flows estimated to be needed for mitigation and adaptation.

12. Several *other options* for generating additional funds have been suggested. Some of these options, such as the expansion of the carbon market and the auction of allowances for emissions, could generate revenues commensurate with the additional needs.

2.1. MITIGATION

13. It is estimated that global additional investment and financial flows of USD 200 – 210 billion will be necessary in 2030 to return global greenhouse gas (GHG) emissions to current levels. In particular:

- *For energy supply,* investment and financial flows of about USD 67 billion would be reduced owing to investment in energy efficiency and biofuel of about USD 158 billion. About USD 148 billion out of USD 432 billion of projected annual investment in power sector is predicted to be shifted to renewables, carbon dioxide (CO_2) capture and storage (CCS), nuclear energy and hydropower. Investment in fossil fuel supply is expected to continue to grow, but at a reduced rate. Currently most of the power sector investment is made by government-owned or private, usually regulated, electric utilities, and is made domestically in most regions;
- *For industry,* additional investment and financial flows are estimated at about USD 36 billion. More than half of the additional investment is for energy efficiency, one third for installation of CCS and the rest for reduction of non-CO_2 gases, such as N_2O and other GHG high global warming potential;
- *For buildings,* additional investment and financial flows amount to about USD 51 billion. Currently commercial and residential energy efficiency investment comes from building owners and is financed domestically;
- *For transportation,* additional investment and financial flows amount to about USD 88 billion. Efficiency improvements for vehicles and increased use of biofuels are likely to require government policies, but the investment would come mostly from the private sector;
- *For waste,* additional investment and financial flows are estimated at about USD 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);
- *For agriculture,* additional investment and financial flows are estimated at about USD 35 billion. Non-CO_2 emissions from agriculture production could be reduced by about 10 per cent at cost of USD 20 billion in 2030. With a concerted international effort and an annual investment of about USD 15 billion agroforestry could be expanded at a rate of about 19 million ha per year by 2030;
- *For forestry,* additional investment and financial flows are estimated at about USD 21 billion. An indicative estimate of the cost of reducing deforestation and forest degradation in non-Annex I Parties to zero in 2030 is USD 12 billion. The estimated investment and financial flows in 2030 to increased GHG removals by sinks through sustainable forest management is USD 8 billion and the estimated investment and financial flows needed for afforestation and reforestation is USD 0.1 – 0.5 billion;
- *For technology research and development (R&D) and deployment,* additional investment and financial flows are estimated at about USD 35 – 45 billion. Government spending on energy R&D worldwide has stagnated, while private sector spending has fallen.

Government budgets for energy R&D and support for technology deployment need to double, increased expenditures in 2030 are expected at USD 10 and 30 billion respectively.

14. Investment and financial flows for mitigation in developing countries are likely to be particularly cost effective. While *investment flows in non-Annex I Parties are estimated at about 46 per cent* of the total needed in 2030, the *emission reductions achieved by the countries amount to 68 per cent* of global emission reductions.

15. The *entities that make the investment decisions are different in each sector, and the policy and/or financial incentives needed will vary* accordingly. For example:

- Increased energy efficiency is best achieved through appropriate policies or regulations (the investments are internal and often incremental, and have short payback periods, but adoption is hampered by recognized barriers);
- Shifting investment in the power sector to CCS and low GHG emitting generation technologies will need both policies and, more importantly, financial incentives which make these technologies economically more attractive than high GHG emitting technologies. This requires national or international policy frameworks, such as carbon markets and higher feed-in tariffs;
- Financial incentives will be needed to achieve significant reductions in emissions through reduced deforestation and forest management.

16. Currently most of the investment in mitigation measures is domestic; however, ODA plays an important role in Africa and the LDCs. *With appropriate policies and/or incentives, a substantial part of the additional investment and financial flows needed could be covered by the currently available sources. However, there will be a need for new and additional external sources of funds dedicated to mitigation.*

17. The *Global Environment Facility (GEF), as an operating entity of the financial mechanism of the Convention,* has allocated over USD 3.3 billion to projects addressing climate change since its inception (1991), with further co-financing of USD 14 billion. Most of the funding has been for renewable energy and energy efficiency projects. The GEF share of total multilateral and bilateral funding between 1997 and 2005 is 1.6 per cent. The next replenishment of the GEF trust fund should be concluded at the end of 2009.

18. The *carbon market* and policies to promote renewables are already playing an important role in shifting investment flows. This is indicative of how quickly investment flows can respond to changes in policies and incentives.

19. It is estimated that the clean development mechanism (CDM) project activities in the pipeline in 2006 will generate investment of about USD 25 billion, of which approximately 50 per cent represents capital invested in unilateral projects by host country project proponents. Renewable energy and energy efficiency projects account for 90 per cent of the overall investment.

20. The supply of Kyoto units will be abundant compared with to the level of compliance demand for the period 2008 – 2012. The voluntary market could represent about 15 per cent of the total carbon market.

21. The low estimate of compliance demand by Parties included in Annex I to the Convention (Annex I Parties) in 2030 is a market of USD 5 – 25 billion per year, which is basically a continuation of the current flow of projects. The high estimate of compliance demand is a market of USD 100 billion per year; to meet this demand, a large fraction of the potential emission reductions, from all existing and some new categories of projects, would need to earn emission reduction credits.

22. All Parties need to adopt *climate change policies.* International coordination of policies in an appropriate forum is often effective. Areas where international coordination would be beneficial include:

- Technology R&D and deployment;
- Energy efficiency standards for internationally traded appliances and equipment.

23. Funding from external sources will play an important role in helping developing countries formulate and implement national policies.

2.2. ADAPTATION

24. The global cost of adaptation to climate change is difficult to estimate, largely because climate change adaptation measures will be widespread and heterogeneous. More analysis of the costs of adaptation at the sectoral and regional levels is required to support the development of an effective and appropriate international response to the adverse impacts of climate change.

Nevertheless it is clear that a large amount of new and additional investment and financial flows will be needed to address climate change adaptation.

25. Estimated overall *additional investment and financial flows needed for adaptation in 2030* amount to several tens of billion United States dollars. In particular:

- About USD 14 billion in investment and financial flows are estimated to be needed for *agriculture, forestry and fisheries* (AFF):
  - About USD 11 billion is estimated to be needed for production and processing, most of which is expected to be financed by domestic private sources;
  - About USD 3 billion is estimated to be needed for research and development (R&D) and extension activities. Based on current trends, it can be expected that public sources of funding will need to cover a large part of this additional need.
- The additional investment needed in *water supply infrastructure* in 2030 is estimated at USD 11 billion, 85 per cent of which will be needed in non-Annex I Parties. About 90 per cent of the cost for all aspects of water resource use is currently covered by public domestic funding sources and 10 per cent by external public funding sources and this trends in unlikely to change significantly by 2030;
- The costs of treating the increased cases of *diarrhoeal disease, malnutrition and malaria* due to climate change are estimated at USD 5 billion in 2030. This additional need for financial flows will occur solely in developing countries and corresponds to the current annual ODA for health. The additional cost is likely to be borne mainly by the families of those affected. Where private individuals cannot cope with the additional cost of treatment, additional public financing will be necessary;
- The investment needed in 2030 for *beach nourishment and dykes,* is estimated to be about USD 11 billion. About half of the global investment would be needed in non-Annex I Parties. Efforts to protect *coastal areas* from coastal storms and sea level rise are typically undertaken by governments. The necessary public resources for coastal zone adaptation are likely to be available in developed and some developing countries. However, deltaic regions, particularly the large coastal deltas in Asia and Africa as well as the small island developing States, may have significant problems in raising the required investment and financial flows to respond to sea level rise;
- The additional investment needed to adapt *new infrastructure* vulnerable to climate change is estimated at USD 8–130 billion, which is less than 0.5 per cent of global investment in 2030. The extra cost is likely to be met in the same manner as the overall infrastructure cost.

26. The change in investment and financial flows for adaptation that will need to occur in developed and developing countries varies by sector. *A significant share of the additional investment and financial flows will be needed in non-Annex I Parties (USD 28–67 billion).*

27. *Private sources* of funding can be expected to cover a portion of the adaptation costs in sectors (such as *AFF and infrastructure*) with privately owned physical assets, in developed countries, in particular. However, public resources will be needed to implement policies or regulations to encourage the investment of private resources in adaptation measures especially in developing countries. Public domestic resources will also be needed to cover adaptation costs related to climate change impacts on public infrastructure.

28. *For all sectors, additional external public funding is likely to be needed for adaptation measures.* Such additional funding will be needed in particular for sectors and countries that are already highly dependent on external support, for example in the health sector in least developed countries, or for coastal infrastructure in developing countries that are highly vulnerable to sea level rise. *Current mechanisms and sources of financing are limited and it is likely that new sources of funding will be required.*

29. The *funds that are managed* by the *GEF that are* available for adaptation projects, including the Strategic Priority on Adaptation (SPA) of the GEF Trust Fund, the Special Climate Change Fund (SCCF) and the Least Developed Countries Fund (LDCF), amount to over USD 275 million. Since 2005 the GEF has provided USD 110 million for adaptation projects.

30. The *level of funding for the Adaptation Fund* under the Kyoto Protocol depends on the quantity of certified emission reductions (CERs) issued and their price. Assuming annual sales of 300–450 million CERs and a market price of USD 24, the Adaptation Fund would receive USD 80–300 million per year for the period 2008–2012. Funding for the Adaptation Fund post 2012 depends on the continuation

of the CDM and the level of demand in the carbon market. Assuming a share of proceeds for adaptation of 2 per cent continues to apply post 2012, the level of funding could be USD 100–500 million per year in 2030 for a low demand by Annex I Parties for credits from non-Annex I Parties, and USD 1–5 billion per year for a high demand. This will still be less than the amount likely to be needed.

31. *Bilateral contribution* for adaptation is estimated to have been in the order of USD 100 million per year between 2000 and 2003.

32. *National policies* may also play an important role in ensuring that the use of resources for adaptation purposes, both public and private, is optimized. In particular, there is a need for:

- Domestic policies that provide incentives for private investors to adapt new physical assets to the potential impacts of climate change;
- National policies that integrate climate change adaptation in key line ministries;
- Local government adaptation policies in key sectors.

33. Although the additional investment and financial flows needed for adaptation described above are significant, *the value of the climate change impacts that those expenditures would avoid could be larger*. This study does not estimate the total value of impacts avoided by adaptation to climate change, so it does not determine whether benefits of avoided damage exceed the adaptation costs. Existing estimates of the future damage caused by climate change vary substantially; however, available studies yield three important common findings:

- Damages increase with the magnitude of climate change. The more that climate changes, typically measured as the increase in global mean temperature, the greater the damage;
- Investment needs for adaptation would almost certainly increase substantially in the latter decades of the twenty-first century. They will be particularly high if no mitigation measures are implemented;
- On average, developing countries suffer more damage as a percentage of their GDP than developed. countries, which implies that damages and benefits are not distributed evenly.

INVESTMENT AND FINANCIAL FLOWS TO ADDRESS CLIMATE CHANGE

Background paper on analysis of existing and planned investment and financial flows relevant to the development of effective and appropriate international response to climate change

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ACRONYMS AND ABBREVIATIONS

AAU	assigned amount unit (equal to one metric tonne of carbon dioxide equivalent)
ABI	Association of British Insurers
ACT	Australian Capital Territory
AFF	agriculture, forestry and fisheries
AI Parties	Parties included in Annex I to the Convention
AR4	Fourth Assessment Report of the IPCC
AUD	Australian dollar
BAPS	Beyond the Alternative Policy Scenario
BAU	business as usual
BIS	Bank for International Settlement
CAIT	Climate analysis indicators tool
CCLA	Climate Change Levy Agreements
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CCS	carbon dioxide capture and storage
CCX	Chicago Climate Exchange
CDIAC	carbon dioxide information on analysis center
CDM	clean development mechanism
CER	certified emission reduction (equal to one metric tonne of carbon dioxide equivalent)
CGIAR	Consultative Group on International Agricultural Research
CH_4	methane
CHP	combined heat and power
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
COP	Conference of the Parties
CRS	creditor reporting system
CT	combustion turbine
DAC	OECD Development Assistance Committee
DALY	disability adjusted life year
DAYCENT	daily service of century model
DIVA	Dynamic Interactive Vulnerability Assessment tool
DNDC	denitrification decomposition model
DOE	designated operational entity
DSM	demand side management
EAs	enabling activities
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EE	energy efficiency
EEA	European Environment Agency
EIB	European Investment Bank
EMF	Energy Modeling Forum
EPPA	emissions prediction and policy analysis
eq	equivalent
ERPA	emission reduction purchase agreement
ERU	emission reduction unit (equal to one metric tonne of carbon dioxide equivalent)
ETS	emissions trading scheme
EU	European Union
EUA	European Union allowances
EUR	euro
FAO	Food and Agriculture Organisation of the United Nations
FAOSTAT	Food and Agriculture Organisation Statistical Database
FDI	foreign direct investment
FRA 2005	Global Forest Resources Assessment 2005
FRCs	forest retention certificates
FRIS	forest retention incentive scheme
G8	Group of Eight
GBD	global burden of disease
GBI	global environmental benefit index
GBP	pound sterling
GDP	gross domestic product
GEF	Global Environment Facility
GEF 1	first replenishment of the GEF
GEF 2	second replenishment of the GEF
GEF 3	third replenishment of the GEF
GEF 4	fourth replenishment of the GEF
GEF 5	fifth replenishment of the GEF
GFCF	gross fixed capital formation
GHG	greenhouse gas
GTCC	gas turbine combined cycle
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HCFC	hydrochlorofluorocarbon
HFC	hydrofluorocarbon
HVAC	heating, ventilation and air conditioning
IATAL	international air travel adaptation levy
ICAO	International Civil Aviation Organisation
IEA	International Energy Agency
IETA	International Emissions Trading Association
IFC	International Finance Corporation
IFI	International Financial Institution
IMF	International Monetary Fund
IGO	Intergovernmental organization
IMO	International Maritime Organisation
INC	initial national communication
IPCC	Intergovernmental Panel on Climate Change
IRR	internal rate of return
ITTO	International Tropical Timber Organisation
IUCN	International Union for the Conservation of Nature and Natural Resources
JI	joint implementation
JISC	Joint Implementation Supervisory Committee
LAC	Latin America and the Caribbean
lCER	long term certified emission reduction
LDCF	Least Developed Countries Fund
LDCs	least developed countries

ACRONYMS AND ABBREVIATIONS

LNG	liquified natural gas
LPG	liquified petroleum gas
LULUCF	land use, land-use change, and forestry
M&A	mergers and acquisitions
MDB	multilateral development bank
MDGs	Millennium Development Goals
MOU	memorandum of understanding
N_2O	nitrous oxide
NAI Parties	Parties not included in Annex I to the Convention
NAPA	national adaptation programmes of action
NC	national communication
NEF	New Energy Finance
NFP	national forest programme
NGO	non-governmental organization
NSW	New South Wales
NTFP	non-timber forest products
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development
OP	operational programme
PCF	Prototype Carbon Fund
PDD	project design document
PDF	project development facility
PE	private equity
PFC	perfluorocarbon
PIF	project identification form
PRODEEM	Programme for Energy Development of States and Municipalities
PROFOR	Program on forests
RAF	resource allocation framework
R&D	research & development
RE	renewable energy
REDD	reducing emissions from deforestation in developing countries
RET	renewable energy technology
RGGI	regional greenhouse gas initiative
RMS	Risk Management Solutions
RMU	removal unit (equal to one metric tonne of carbon dioxide equivalent)
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCCF	Special Climate Change Fund
SD-PAM	Sustainable development policies and measure
SDR	special drawing right
SFM	sustainable forest management
SIDS	small island developing States
SPA	strategic priority on adaptation
SRES	Special Report on Emissions Scenario
STRM	short-term response measures
tCER	temporary certified emission reduction
T&D	transmission and distribution
TNA	technology needs assessment
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP FI	United Nations Environment Programme Finance Initiative
UNEP SEFI	United Nations Environment Programme Sustainable Energy Finance Initiative
UNFCCC	United Nations Framework Convention on Climate Change
UNSTAT	United Nations Statistics Division
US EPA	United States Environmental Protection Agency
USD	United States dollar
VAT	value added tax
VC	venture capital
WB	World Bank
WBCSD	World Business Council on Sustainable Development
WEC	World Energy Council
WEO	World Energy Outlook
WG	Working Group
WHO	World Health Organisation
WRI	World Resources Institute
WSSD	World Summit on Sustainable Development

UNITS OF MEASURE

b	billion
cm	centimeter (10^{-2} meter)
EJ	10^{18} Joule
G	giga (1×10^{9})
GJ	10^{9} Joule
h	hour
ha	hectare
m	million (1×10^{6})
m^3	cubic meter
MJ	10^{6} Joule
ppmv	part per million by volume
t	tonne
T	tera (1×10^{12})
toe	tonne oil equivalent
W	watt
°C	degree Celsius

I. INTRODUCTION

1. This technical background paper reviews and analyses existing and projected investment flows and financing relevant to the development of an effective and appropriate international response to climate change, with particular focus on the needs of developing countries. It provides an assessment of the investment and financial flows that will be necessary in 2030 to meet worldwide requirements for mitigating and adapting to climate change under different scenarios of social and economic development, especially as they impact the well-being of developing countries. In particular it provides:

- Information on current investment and financial flows in as much detail as is available;
- Projection of investment and financial flows by major sources to address adaptation and mitigation needs in 2030, including:
  - Projections of future investment and financial flows under a reference scenario;
  - Projections of future investment and financial flows under a greenhouse gas (GHG) emissions mitigation scenario;
- A summary of priorities identified by Parties not included in Annex I to the Convention (Non-Annex I Parties) as part of the UNFCCC process;
- An analysis of the potential role of different sources of investment and financing and their future potential.

2. This paper has been prepared as background information for three papers requested by the Conference of the Parties at its twelfth session (COP 12):

- A paper that provides an analysis of existing and planned investment flows and finance schemes relevant to the development of an effective and appropriate international response to climate change for the consideration by the fourth workshop on the dialogue on long-term cooperative action to address climate change by enhancing implementation of the Convention (the Dialogue)[1];
- Two papers for the consideration by the Subsidiary Body for Implementation (SBI) in its fourth review of the financial mechanism of the Convention at its twenty-seventh session,[2] namely:
  - A technical paper reviewing the experience of international funds, multilateral financial institutions and other sources of funding that may be used to meet current and future investment and financial needs of developing countries for the purposes of meeting their commitments under the Convention;
  - A report prepared in collaboration with the Global Environment Facility (GEF) secretariat, on the assessment of the funding necessary to assist developing countries.

3. To ensure that this analysis is beneficial to the UNFCCC process, the secretariat has collaborated with a number of international financial institutions (IFIs), United Nations agencies, intergovernmental organizations (IGOs) and non-governmental organizations (NGOs), other relevant agencies, and representatives of the private sector and civil society. These organizations and representatives were invited to share their experiences and views on existing and planned investment flows and finance schemes in the context of consultations.

4. Four consultative meetings with such stakeholders have been held. Two consultative meetings were held in Bonn, Germany, with experts and representatives of IFIs, United Nations agencies, IGOs and NGOs to discuss the role of international public financing activities in addressing climate change (5 – 6 February and 26 – 28 March 2007). Another two consultative meetings were held in London, United Kingdom (20 and 21 June 2007), in collaboration with representatives of the private financial sector (including investment banks, venture capital firms, private funds, insurers and reinsurers) and the insurance sector.[3]

5. The paper draws on existing work and analysis wherever possible. Existing work used for the analysis includes the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), the World Energy Outlook (WEO) of the International Energy Agency (IEA), the Stern Review and other published literature.[4]

6. This paper is divided into nine main parts:

- An introduction to the overall methodology and scenarios used in the paper and a summary of overall current investment and financial flows (chapters II and III);
- An analysis of needs and corresponding investment and financial flows for climate change mitigation, including needs and flows related to technology research and development (R&D) (chapter IV);
- An analysis of needs and corresponding investment and financial flows for climate change adaptation (chapter V);
- A summary of priorities related to mitigation and adaptation identified by non-Annex I Parties under the UNFCCC process (chapter VI);
- An analysis of the potential of carbon markets (chapter VII);
- An overview of financial assistance under the Convention (chapter VIII);
- An analysis of the potential for enhanced investment and financial flows (chapter IX).

[1] FCCC/CP/2006/5, paragraph 61.

[2] These papers should be made available in the last quarter of 2007 as documentation for consideration at SBI 27. Please refer to decision 2/CP.12 for details of the mandates.

[3] In collaboration with the World Business Council on Sustainable Development (WBCSD), the United Nations Environment Programme Finance Initiative (UNEP FI), the United Nations Environment Programme Sustainable Energy Finance Initiative (UNEP SEFI), the European Carbon Investors and Services, the International Emissions Trading Association (IETA) and the World Energy Council (WEC).

[4] For detailed information, please refer to the list of database and references in annex II.

II. METHODOLOGY

7. This paper presents a snapshot of current investment and financial flows based on available data. Future investment and financial flows are based on specific reference and mitigation scenarios.

8. It is important to note that the analysis in this paper does not provide for an estimate of total cost of climate change mitigation or of the total cost of adaptation to impacts of climate change.

2.1. INTERPRETATION OF INVESTMENT AND FINANCIAL FLOWS

9. The analysis presented in this paper uses the following definitions for investment and financial flows:

- *An investment flow* is the initial (capital) spending for a physical asset;
- *A financial flow* is an ongoing expenditure related to climate change mitigation or adaptation that does not involve investment in physical assets.

2.2. METHODOLOGY OVERVIEW

10. Conceptually, the methodology employed is simple. Relevant investment and financial flows are projected for selected scenarios. These future flows are compared with the current flows and the current sources of funds because projections of the sources of future flows are not available from the scenarios.

11. Investment and financial flows are analysed for the following mitigation and adaptation sectors:

- Mitigation sectors: energy supply, industry, transportation, buildings, waste, agriculture and forestry;
- Adaptation sectors: agriculture, forestry and fisheries (AFF); water supply; human health; natural ecosystems; coastal zone; infrastructure.

12. The analysis covers the investment and financial flows needed in 2030. This is an optimal time period for an analysis of investment flows. The level of detail available from published scenarios declines sharply as the time horizon is extended beyond 2030.

13. This analysis was disaggregated to the extent possible. Limited availability of data, especially in terms of regional detail, led to most of the results being compiled under the following regional groupings: Organisation for Economic Co-operation and Development (OECD) North America, OECD Pacific, OECD Europe, transition economies, developing Asia, Latin America, Africa and Middle East (see ANNEX I).

14. Unless otherwise specified, all monetary values have been converted to 2005 United States dollars (2005 USD).

2.3. SCENARIOS

15. Existing scenarios had to be used because the time and resources needed to develop new scenarios were not available. There is no single scenario that covers all GHG emissions and sinks for which climate impacts have been modelled. The scenarios were selected based on their suitability for the analysis, the detail they provide on estimated investment and financial flows, and how representative they are of the literature.

2.3.1. SCENARIOS USED FOR THE MITIGATION ANALYSES

16. Any analysis of future investment and financial flows requires a reference scenario and a mitigation scenario that reflects an international response to climate change. The mitigation analysis uses a scenario that would return emission level in 2030 to 2004 level.

17. The reference scenario used in this analysis consists of:

- The energy-related carbon dioxide (CO_2) emissions of the IEA World Energy Outlook (WEO) 2006 reference scenario (IEA, 2006);
- The baseline non-CO_2 emissions projections from the United States Environmental Protection Agency (US EPA) extrapolated to 2030 (US EPA, 2006);
- Current CO_2 emissions due to land use, land use change and forestry (LULUCF);
- Industrial process CO_2 emissions from the World Business Council on Sustainable Development (WBCSD) (WBCSD, 2002).

18. The mitigation scenario consists of:

- The energy-related CO_2 emissions of the IEA WEO 2006 Beyond The Alternative Policy Scenario (BAPS) scenario (IEA, 2006);
- The US EPA baseline non-CO_2 emissions projections minus the reductions possible at a cost of less than USD 30 per t CO_2 eq;
- Potential CO_2 sinks increases due to agriculture and forestry practices;
- Industrial process CO_2 emissions from WBCSD (WBCSD, 2002).

19. The WEO provides a comprehensive reference cenario of energy supply and demand and the associated GHG emissions and investments. With the cooperation of the IEA, the cumulative investment estimates were converted to annual investment flows. In addition, the OECD provided preliminary estimates of the projected investment flows in 2030 based on the OECD ENV-Linkages model calibrated to this scenario.[5]

20. The BAPS scenario is the most aggressive mitigation scenario considered by the IEA. It returns global energy-related CO_2 levels to current levels by 2030. With the cooperation of the IEA, the BAPS scenario was disaggregated into the same regions as those of the reference scenario and the cumulative investment estimates were converted to annual investment flows.

21. The reference and BAPS case do not consider the need for increased electricity access in developing countries. From the policies and the level of investment reflected in these scenarios the IEA estimates that about 1.4 billion people will remain without access to electricity in 2030. Universal electricity access by 2030 would require an additional annual investment of USD 25 billion.

22. The US EPA projections of non-CO_2 emissions are the most comprehensive available in the literature. The US EPA provides marginal abatement curves for the cost of reducing emissions of non-CO_2 gases by sector and by region. The marginal cost increases sharply after USD 30 per t CO_2 eq for most of the curves. Thus, the emissions reduction possible at a cost of less than USD 30 per t CO_2 eq is approximately the maximum.[6]

23. No baseline scenarios with forest use, rates of change and fluxes are available in the literature. Thus, the reference scenario assumes that GHG emissions from the forestry sector in 2030 are the same as in 2004. The mitigation scenario includes the potential sinks created through reduced deforestation, forest management and afforestation/reforestation.

24. The A1 scenario in the WBCSD report Towards a Sustainable Cement Industry (WBCSD, 2002) is adopted as the reference scenario for the analysis on industrial process CO_2 emissions. Within the literature, a 7 per cent worldwide technical potential by 2020 was identified, of which the responding emissions were selected for as mitigation scenario of industrial process CO_2 emissions in this paper.

2.3.2. SCENARIOS USED FOR THE ADAPTATION ANALYSES

25. The analysis of investment and financial flows needed for adaptation to climate change was based on emissions scenarios for which climate change impacts could be inferred and responses to the climate impacts could be projected, so that the associated investment and financial flows could be estimated. The scenarios were selected based on their suitability for the analysis, the detail they provide on estimated investment and financial flows, and how representative they are of the literature. The following scenarios have been used for different sectors:

- IPCC SRES A1B and B1 scenarios are used for the water supply and coastal zones sectors (Nakićenović N. and Swart R. (eds). 2000);
- For the human health sector, the scenarios used were based on variations from the IPCC IS92a: a scenario resulting in stabilization at 750 ppmv CO_2 eq by 2210 (s750), and a scenario resulting in stabilization at 550 ppmv CO_2 eq by 2170 (s550) (Leggett *et al.*, 1992). These scenarios were used in the context of a World Health Organization (WHO) study on the global and regional burden of disease (GBD) (McMichael AJ *et al.,* 2004);
- Projected investment in physical assets for 2030 from the OECD ENV-Linkage model were used as the basis for estimating additional investment and financial flows needed in the agriculture, forestry and fisheries (AFF) and infrastructure sectors. The projected investment in physical assets for 2030 based on the OECD ENV-Linkage model corresponds to the projection of the IEA WEO reference scenario.

[5] OECD. ENV-Linkages Model calibrated to the IEA WEO 2006 Reference scenario. Personal communication with Philip Bagnoli at OECD. For information, see CHAPTER III.3.

[6] At a cost of USD 60 per t CO_2 eq the reduction would be only a slightly larger.

2.4. PROJECTED GREENHOUSE GAS EMISSIONS

26. FIGURE II-1 shows the GHG emissions by sources for the reference (RS) and mitigation (MS) scenarios used in the mitigation analysis. Global emissions rise from 38.91 Gt CO_2 eq in 2000 to 61.52 Gt CO_2 eq in 2030 under the reference scenario. The mitigation scenario reduces the projected emissions in 2030 to 29.11 Gt CO_2 eq. Energy-related emissions account for 65.9 per cent of the total in 2030 under the reference scenario; industrial process CO_2 (3 per cent), non-CO_2 gases (21.7 per cent) and LULUCF (9.4 per cent) make up the balance. The mitigation scenario reduces energy-related emissions projected under the reference scenario by 35 per cent, industrial process CO_2 emissions by 11 per cent, non-CO_2 gases emissions by 25 per cent and LULUCF emissions by 252 per cent (see TABLE 5-ANNEX V).

27. FIGURE II-2 shows total energy supply and the related GHG emissions under the reference and mitigation scenarios used in the mitigation analysis. Energy efficiency is a major component of the mitigation scenario; energy demand in 2030 is 15 per cent lower than under the reference scenario, representing a 6 Gt CO_2 eq reduction in annual emissions. Decarbonisation of energy supply, including the use of renewables, nuclear energy and CO_2 capture and storage (CCS), also plays a major role in returning emissions to the 2004 level in 2030 under the mitigation scenario, reducing annual emissions by 8 Gt CO_2 eq.

Figure II-1. Total greenhouse gas emissions under reference and mitigation scenarios

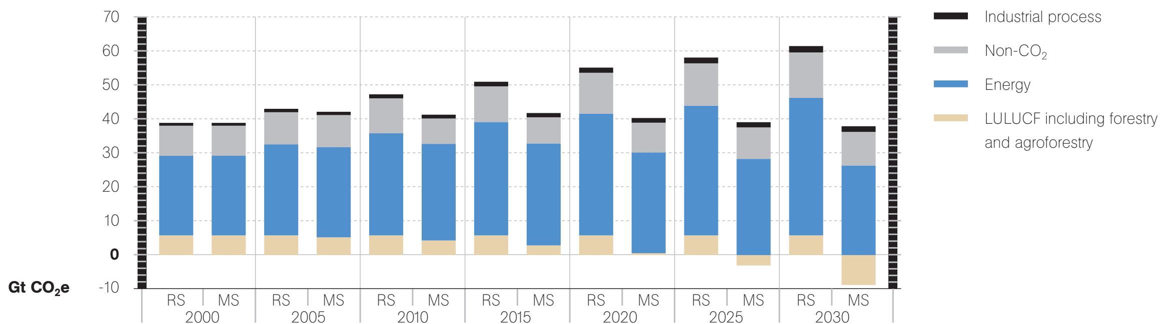
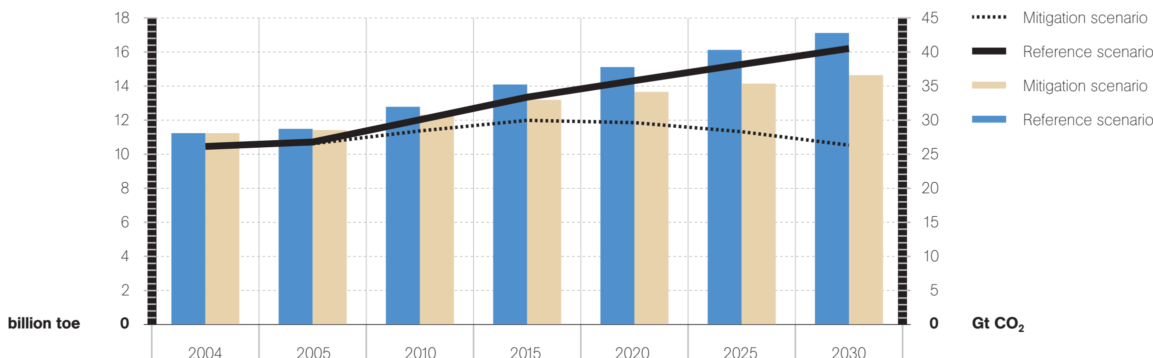


Figure II-2. Energy supply and related greenhouse gas emissions under the reference and mitigation scenarios



2.5. COMPARISON WITH THE SCENARIO LITERATURE

28. FIGURES II-3 and II-4 compare the emissions and driving forces of the scenarios used for the analysis.

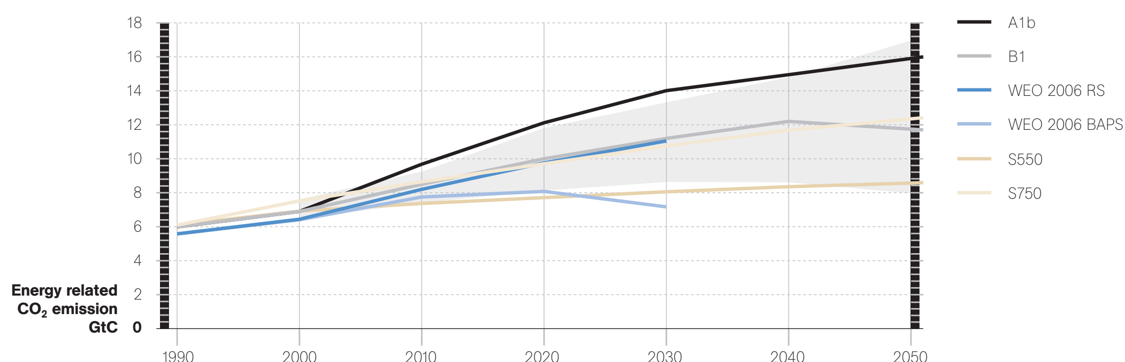
29. As shown in FIGURE II-3, emissions under IEA WEO reference scenario, the IPCC SRES B1 scenario and the 750 parts per million by volume (ppmv) stabilization scenario (s750) used in the GBD study are close to each other in 2030. The shaded area in FIGURE II-3 represents the standard deviation of the scenarios available in the literature. The emission path of the three scenarios mentioned above lies in the middle of this shaded area and can thus be considered moderate estimates.

30. Under the reference scenario used for the mitigation analysis, the stabilization of atmospheric concentration of CO_2 will occur at over 650 ppmv. FIGURE II-3 also shows that, the WEO 2006 BAPS case used for the mitigation analysis results in emission levels equivalent to current levels, this corresponds to a the stabilization of atmospheric concentration of between 550 and 450 ppmv.

31. The IPCC SRES A1B and the 550 ppmv stabilization scenarios (s550) from the GBD study used in the adaptation analysis for some sectors result in emission levels that are respectively higher and lower than the level of the B1 scenario.

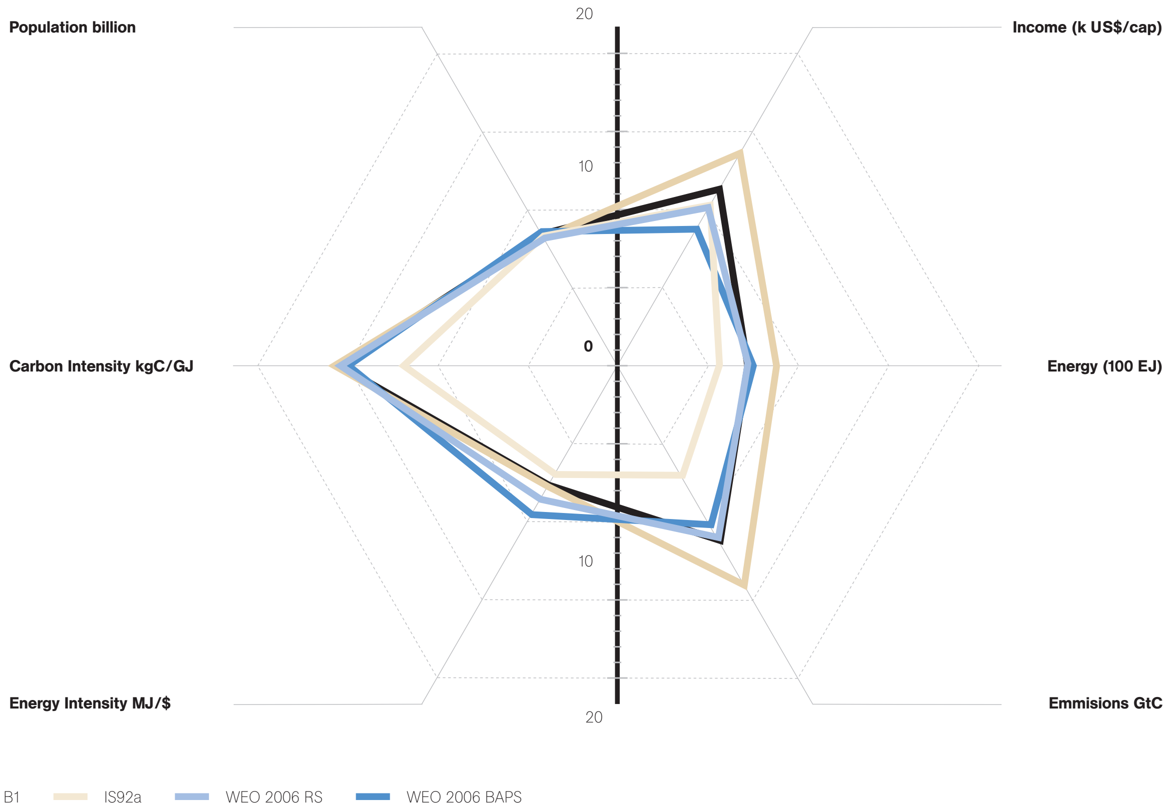
32. FIGURE II-4 shows the variation in the driving forces of the different scenarios used. The driving forces for the WEO reference scenario are virtually identical to those for the B1 scenario, as might be expected since the emissions of those scenarios are virtually identical (see FIGURE II-3). The A1B scenario has higher per capita income than the WEO reference scenario, which leads to more energy use and higher emissions as shown in FIGURE II-3. The WEO 2006 BAPS case has the same population and per capita income as the reference scenario, but lower energy intensity and lower carbon intensity, leading to less energy use and lower GHG emissions.

Figure II-3. **Emissions projections of the scenarios used for the analyses and the scenario literature**



Note: Based on IEA 2006; Nakićenović *et al.*, 2006; IPCC, 2007c.

Figure II-4. **Comparison of the main driving forces of greenhouse gas emissions under different scenarios in the literatures**



III. CURRENT AND REFERENCE SCENARIO INVESTMENT AND FINANCIAL FLOWS

33. As mentioned in CHAPTER II, the investment flows analysed in this paper focus on capital spending for new physical assets, and financial flows relate to mitigation and adaptation activities that do not involve an investment in new physical assets. This chapter discusses how data for current investment flows were compiled and adjusted for purchases and sales of financial assets where appropriate. It then provides an overview of current investment and financial flows. Next, projected investment and financial flows under the reference scenario are summarized. Finally, interpretation of the estimates is addressed.

3.1. DATA ON CURRENT INVESTMENT FLOWS

34. The investment in new physical assets during a given year is reported in the national accounts of countries as "gross fixed capital formation" (GFCF). The sources of the investment and the economic sectors in which the investments were made are also reported.

35. The sources reported in the national accounts are the entities – governments, corporations or households – responsible for the investments, not the sources of the funds.[7] A government, for example, could fund an investment with tax revenue or with new debt in the form of bank loans or bonds. Similarly, a corporation could fund an investment from internal savings, new debt or new equity. The debt or equity can come from within the country or from other countries.

36. Data are also available on funds obtained from other countries during the year; specifically equity foreign direct investment (FDI)), international debt, and official development assistance (ODA) in the form of grants and concessionary loans.[8] Data on how investors raise funds domestically – through internal savings, loans, or equity – are not available. The amount funded domestically is calculated by subtracting the foreign funds from the total investment (GFCF).

37. The data on GFCF, FDI, international debt, and ODA are discussed in turn. These data are all on a calendar year basis. The most recent year for which national accounts data is available for a large number of countries is 2000.

3.1.1. GROSS FIXED CAPITAL FORMATION

38. GFCF is the most comprehensive and consistent measure of current investment in physical assets available. It is the spending on new physical assets in a country during a specified year.[9] Many countries report the sources and/or economic sectors of GFCF based on internationally agreed definitions; the four sources and 10 economic sectors are listed in TABLE III-1.

Table III-1. **Sources and sectors for gross fixed capital formation**

Sources	Economic sectors
Households	Agriculture, hunting, forestry and fishing
Government	Mining and quarrying
Financial corporations	Manufacturing
Non-financial corporations	Electricity, gas and water supply
	Transport, storage and communications
	Financial intermediation real estate, renting and business activities
	Construction
	Wholesale retail trade, repair of motor vehicles, motorcycles, etc., hotels and restaurants
	Public administration and defence, compulsory social security
	Education, health and social work, other community, social and personal services

39. Total GFCF is available for almost all countries for 2000. Values for the remaining countries were estimated based on the country's gross domestic product (GDP) and per capita GDP. GFCF by source and by sector was reported by just over 50 countries for 2000, but those countries account for 85–90 per cent of global GFCF. For countries with incomplete or missing data for GFCF by sources or sectors, the values were estimated as described in ANNEX II.

40. The 10 economic sectors for which GFCF (and FDI) data are available do not always match the sectors used for the mitigation and adaptation analyses. Agriculture and forestry, for example, are analysed separately in this paper but are part of the same economic sector for GFCF and FDI data calculations. Those data issues are addressed in the respective mitigation and adaptation sector analyses.

3.1.2. HOUSEHOLDS

41. Households are individuals. They invest in housing, farms, vehicles and facilities for small businesses. Households are responsible for 15–35 per cent of total global investment, all of which is assumed to come from domestic sources. However, remittances by family members working in foreign countries are substantial for some countries and could help fund household investment in the recipient countries.

3.1.3. GOVERNMENTS

42. Governments are the national, provincial, state and local governments of a country.[10] They invest in long-lived assets that provide local public benefits, such as transportation infrastructure, water supply, schools and hospitals, coastal infrastructure, and natural ecosystems. They channel their investments into their most pressing development priorities. High social returns are sought, such as economic growth, jobs, improved national security, improved health of citizens and a cleaner environment. Governments often use a long timeframe to evaluate the expected returns from their investments. They often try to reduce the risk of an investment not performing as expected by relying on proven technologies.

43. Governments are typically responsible for 10–15 per cent of total investment in physical assets in a country. Over 90 per cent of the funds that governments invest come from domestic sources such as the taxes and fees they collect. They may borrow funds from domestic or foreign sources. International borrowing by governments amounts to less than 10 per cent of their investment in new physical assets.

44. Operational spending by governments such as health care spending and funding for energy research may also contribute to climate change adaptation or mitigation. The Government of India estimates that adaptation expenditures related to agriculture, water supply, health and sanitation, coastal zones, forests, and extreme weather events amounted to between 3 and 5 per cent of central government spending over the five years prior to fiscal year 2005/2006 and 8 per cent during that year.[11]

3.1.4. FINANCIAL CORPORATIONS AND NON-FINANCIAL CORPORATIONS

45. Financial corporations are entities such as banks and insurance companies that provide financial services to non-financial corporations, households and governments. They also invest in physical facilities, such as buildings, using funds raised domestically or from foreign sources. They are responsible for 1–7 per cent of the investment in new physical assets.

46. Non-financial corporations produce goods, such as fossil fuels, and non-financial services, such as communications services. They need physical facilities such as commercial buildings, industrial plants, and telecommunications facilities to provide the goods and services they offer.

47. Since investment in physical assets by financial corporations is small relative to the investment from other sources, it is combined with investment by non-financial corporations for the analysis. Together these sources are responsible for 50–75 per cent of the total investment in new physical assets. All FDI is assumed to go to corporations. FDI as a share of total investment by corporations varies widely across regions. International debt as a share of total investment by corporations also varies widely across regions.

3.1.5. FOREIGN DIRECT INVESTMENT

48. FDI tends to be made by multinational corporations seeking to establish or expand operations overseas. As it is an equity investment, lenders of FDI seek a higher return than most lenders, but also accept higher risks.

49. FDI is reported by several sources, which were compared and consolidated as discussed in ANNEX II. The data cover both equity investment by multilateral operating companies in new physical assets and acquisition of existing physical and financial assets. Globally, purchases and sales of existing assets are approximately equal. But for an individual country, purchases and sales of existing physical and financial assets can be a large component of FDI.[12]

50. Since the analysis focuses on investment in new physical assets, two values of total FDI are compiled for each country:

- Inward FDI as reported: equity investment in new physical assets and acquisition of existing physical and financial assets in the recipient country;
- Adjusted FDI: inward FDI as reported minus the value of international purchases in the recipient country, plus the value of international sales in the recipient country due to mergers and acquisitions (M&A).

51. Data on inward FDI, but not M&A, are available by sector. As a result, FDI estimates for some sectors or regions are either large or small relative to the investment in new physical facilities.

52. Data on inward FDI are not available by source, so it is assumed that all inward FDI goes to corporations.

3.1.6. INTERNATIONAL DEBT

53. International debt includes loans provided by commercial banks and the sales of bonds in the capital market. Commercial bank loans generally cover periods from a few days to a few years. Bonds generally have a longer maturity, ranging up to decades. Debt provides finance to borrowers that have a demonstrated capacity to repay the loan with interest. Lenders generally want little risk and are prepared to accept lower returns than equity investors.

54. Data on international debt are published by the Bank for International Settlements (BIS). They cover only debt issued by banks in 40 large lending countries, so total international debt is understated, but there is no basis for estimating the foreign borrowing not covered by this source. Data on new international debt borrowed or issued by governments and corporations are available for each year. Data on foreign borrowing are available by sectors.

55. There is no guarantee that international debt is invested in new physical infrastructure; the corporations and governments that borrow the money could use it for operating purposes. International debt represents almost 20 per cent of total global investment and a reasonable share of the total investment made by governments and corporations. Assuming that international debt is used for operational purposes would simply increase the funds raised from domestic sources.

3.1.7. OFFICIAL DEVELOPMENT ASSISTANCE

56. ODA is bilateral or multilateral assistance provided on concessional terms. Bilateral assistance is provided by the government of another country, as a grant that does not need to be repaid, or as a loan with concessional terms. Multilateral assistance usually takes the form of a loan with concessional terms from an IFI. The primary objective of ODA is to alleviate poverty but some of the funding is invested in new facilities or spent in ways that contribute to climate change mitigation or adaptation.

57. The OECD collects extensive data on bilateral and multilateral ODA. Only the investment component of ODA is included in the investment flows; analyses of financial flows consider all of the relevant ODA flows. ODA data are available by sector. While some ODA funds go to non-governmental entities, all ODA is assumed to go initially to governments in the recipient countries. The investment component of ODA amounts to between 1 and 7 per cent of total investment in new physical assets in developing country regions.

58. Analyses of financial flows consider the relevant ODA flows, not just the investment component.

[7] Determining the sources of funds is complex. For example, a household may use a mortgage from a bank to help fund its purchase of a house. The bank could be considered the source of the mortgage funds, but the bank gets those funds from deposits by households and corporations.

[8] The carbon markets, which were negligible source of investment funds in 2000, have grown rapidly since discussed in CHAPTER VII.

[9] GFCF also includes the net change in inventories during the year. This is excluded where it is reported separately. It is usually of the order of 1 or 2 per cent of the total, so where it cannot be excluded it does not greatly distort the figures.

[10] Financial and non-financial corporations, such as oil companies or electric utilities, owned wholly or in part by governments are included in those source categories.

[11] Presentation "India: Adaptation Approaches and Strategies" made by R. Ray, Deputy Secretary, Ministry of Environment and Forests, Government of India, during the third workshop of the dialogue on long-term cooperative action to address climate change by enhancing implementation of the Convention (22 May 2005), see: http://unfccc.int/files/meetings/dialogue/application/pdf/india_-_adaptation.pdf>.

[12] For example, in a small country with a large international financial sector, FDI can be much larger than the GDP. In such cases, the FDI is obviously not all invested in new physical assets in the country.

59. The original data are reported by the 22 members of the Development Assistance Committee (DAC) of the OECD and by the European Commission (EC) to the Creditor Reporting System (CRS) Aid Activity database. The CRS also includes data from multilateral organizations, although these are not obligated to report to the OECD.

60. Some donors do not supply data to the OECD. The major gaps in bilateral ODA reporting post 1999 come from Japan and the EC. The former does not report technical co-operation activities; the latter does not report activities financed through its budget.

3.1.8. DOMESTIC FUNDS

61. Most of the funds invested in new physical assets are raised domestically; 50 – 90 per cent in most regions. Systematic data on the sources of these funds are not available. Instead, the domestic funds invested by households, governments and corporations are estimated.

62. All investment by households is assumed to originate domestically from savings or as debt from friends or financial institutions.

63. Over 90 per cent of the funds invested by governments are raised domestically. These funds may come from tax or other revenue, be borrowed from domestic financial institutions or come from the sale of bonds in the domestic market.

64. Although corporate investment includes substantial amounts of foreign equity and international debt, over half of the funds that corporations invest globally originate 7flow, commercial loans or the sale of bonds or equity in domestic financial markets. Corporations and their domestic sources of funds are adjusted to the country risk and have first-hand knowledge of the local market. They may also find it easier to raise funds domestically since they are known to the local financial community.

3.1.9. OVERVIEW OF CURRENT INVESTMENT FLOWS

65. Table III-2 provides an overview of the investment flow data available, together with the sources of the data and the key assumptions. The same information, apart from the adjusted FDI and adjusted domestic sources, is available for each of the 10 economic sectors in table 35-annex V.

66. The sources of global investment flows in 2000 are summarized in table III-3. Total global investment in 2000 was USD 7,750 billion, or about 21 per cent of global GDP. Almost 60 per cent of the funds invested were raised domestically, with FDI and foreign debt accounting for just over and just under 20 per cent respectively. ODA fund invested in physical assets represent less than 1 per cent of the total investment.

67. The regional distribution of current investment is presented in table 3-annex V. Governments provide a higher than average share of the investment in Africa, while households provide less. Investment funded through ODA accounts for over 6 per cent of the total in least developed countries (LDCs), 2 per cent in Africa and about 1 per cent in other developing country regions. Foreign debt is significant in Latin America and OECD regions. FDI is significant in OECD regions, Latin America and developing Asia. Adjustments for purchases and sales makes the most difference in OECD regions.

68. Table 1-annex V summarizes commercial financing by sector and region for 2000 and 2005. The data cover projects partly funded by loans from commercial banks. Such projects represent almost 30 per cent of the investment in the electricity, gas distribution and water supply sector and about 15 per cent of the transportation, storage and communications sector. The table shows the debt: equity ratio for projects in each sector. Table 2-annex V shows the same data by region for 2000.

Table III-2. **Overview of investment flow data**

Source		Total/Sector		Notes
Households	Total investment	A	GFCF data	Assumed to be entirely domestic
Corporations	Total investment	B	GFCF data	
	Domestic funds	C	Calculated (B – D – G)	
	FDI	D	UNCTAD data	Assumed to be all non-financial corporations
	Adjusted domestic funds	E	Calculated (B – F – G)	
	Adjusted FDI	F	UNCTAD data	Adjusted for mergers and acquisitions; not available by sector
	Foreign debt	G	BIS data	
Government	Total investment	H	GFCF data	
	Domestic funds	I	Calculated (H – J – K)	
	Foreign debt	J	BIS data	
	ODA	K	OECD data	Assumed to be all government
Total	Total investment	A + B + H		
	Domestic funds	A + C + I		
	FDI	D		
	Adjusted domestic	A + E + I		
	Adjusted FDI	F		
	Foreign debt	F + J		
	ODA	K		

Abbreviations: BIS= Bank for International Settlement, FDI = Foreign Direct Investment, GFCF = Gross fixed capital formation, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development, UNCTAD = United Nations Conference on Trade and Development.

Note: Please refer to ANNEX II and TABLES 1–4-ANNEX V for detailed information on the above definition and calculation.

Table III-3. **Sources of investment in 2000**

Source		Amount (2000 USD billion)	Amount (2005 USD billion)	Share of total (in percentage)
Households	Total investment	1,814	2,045	26
Corporations	Domestic funds	1,429	1,611	21
	FDIa	1,540	1,736	22
	Foreign debt	1,156	1,303	17
	Total investment	4,125	4,649	60
Government	Domestic funds	850	959	12
	Foreign debt	71	80	1
	ODA	16	18	0
	Total investment	937	1,056	14
Total	Domestic funds	4,093	4,614	60
	FDI[a]	1,540	1,736	22
	Foreign debt	1,226	1,382	18
	ODA	16	18	0
	Total investment	**6,875**	**7,750**	**100**

Source: Estimations by UNFCCC secretariat based on data from UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.

[a] May not include all international equity investments by financial corporations, organizations, funds, limited partnerships and other entities, for example through project finance.

3.2. CURRENT FINANCIAL FLOWS

69. Current financial flows are specific financial flows relevant to climate change mitigation or adaptation that do not involve investment in physical assets. Information on financial flows supported by climate change funds established by the Convention and its Kyoto Protocol can be found in chapters VII and VIII. Information on current financial flows relevant to specific mitigation or adaptation measures is discussed in the analysis for the relevant sector.

3.3. INVESTMENT FLOWS NEEDED IN 2030

70. Projections of future investment flows are available by economic sector, but not by source. Projections of future FDI, international debt and ODA are also not available. In addition, the economic sectors for which current and future investment flows are available do not always coincide with those relevant to the analysis of climate change mitigation and adaptation. This means that the future investment flow projected for a sector was assessed on the basis of the current sources of investment for the sector.

71. The reference scenario used for the mitigation analysis includes the IEA WEO 2006 reference scenario and, as shown in chapter II, the WEO scenario is close to most of the scenarios used in the adaptation analysis. Preliminary estimates of new investment calibrated to the WEO scenario are available from the OECD's ENV-Linkages model. The projected investment in new physical assets in 2030 from that calibrated model is USD 22,270 billion. This means that total investment, adjusted for inflation, is projected to grow at a rate of 4 per cent per year, which is high by historical standards, due to economic growth over the period.

72. Global investment by sectors for 2000 and 2030 is summarized in table III-4. The data for 2000 come from the sources described earlier in this chapter, while the 2030 figures come from the OECD ENV-Linkages model. The OECD ENV-Linkages model projects investment for 26 economic sectors, which do not match exactly the 10 economic sectors for which current investment flows are available.

73. The proportion of investment made in primary sectors – agriculture, forestry, fishing and mining – is projected to decline although the amount invested will increase substantially: a typical pattern for economic growth. The apparent decline in the proportion of investment made in electricity supply, gas distribution and water supply will be analysed further in the energy supply chapter (chapter IV.4.1). Significant increases in investment are projected for the transportation, storage and communications sector and the financial intermediation, real estate, renting and business activities sector.

74. The sectoral distribution indicates that the principal sources of GHG emissions and the focus of mitigation efforts – i.e. the agriculture, forestry, mining (oil and gas production), manufacturing, electricity generation, gas distribution, and transportation sectors – receive less than one-third of total investment. It is more difficult to estimate the share by sector of total investment involved in adaptation to climate change, but the agriculture, forestry, fishing, water supply and health care sectors probably receive less than 10 per cent of the total. Buildings and other infrastructure that might be damaged by the impacts of climate change may receive 20–40 per cent of total investment.

75. The relationship between investment and GDP and population by region is shown in table III-5. The shares of population and GDP differ widely, leading to recognized differences in per capita GDP across regions. However, investment in new physical assets is closely related to GDP; in other words, investment as a share of GDP is approximately the same for all regions.

76. There are substantial differences across regions in the sectoral distribution of investment, as shown in table III-5. Overall, developing Asia's share of global investment rises sharply between 2000 and 2030, reflecting its projected rapid growth. The slower economic growths of OECD regions causes their share of global investment to fall. Investment in primary sectors (AFF, and mining and quarrying) declines, as is typical with economic growth. The proportion of investment in primary sectors is highest in Africa (see table 4-annex V). The fastest growing sectors in all regions are transportation and communications and the service sectors.

77. Current and projected investment flows by region for each sector are presented in table 4-annex V. The sectoral pattern is broadly similar across all regions, except that primary sectors attract a larger share of the investment in developing country regions, such as Africa.

Table III-4. **Global investment by sector in 2000 and 2030 (percentage)**

	2000	2030
Agriculture, hunting, forestry; fishing	2.26	1.20
Mining and quarrying	1.80	0.83
Manufacturing	16.78	15.46
Electricity, gas and water supply	3.32	1.65
Construction	11.47	9.45
Transport, storage and communications	8.02	19.06
Financial intermediation; real estate, renting and business activities	5.65	
Wholesale retail trade, repair of motor vehicles, motorcycles, etc.; hotels and restaurants	33.69	39.94
Public administration and defense; compulsory social security	8.03	
Education; health and social work; other community, social and personal services	8.98	
Dwellings	N.A.	12.41
Total in billion USD	**7,750**	**22,270**

Source: Estimations by UNFCCC secretariat based on data from UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS; OECD, ENV-Linkages Model.

Table III-5. **Total current and projected investment by region**

	Current (2000)			Reference scenario (2030)		
Regions[a]	Percentage of world investment	Percentage of world GDP	Percentage of world population	Percentage of world investment	Percentage of world GDP	Percentage of world population
Africa	1.52	1.84	13.37	2.18	2.88	17.60
Developing Asia	10.37	8.23	52.69	27.93	19.71	46.13
Latin America	4.28	4.76	7.01	2.97	4.29	7.19
Middle East	1.80	2.04	2.44	3.57	2.80	3.66
OECD Europe	32.10	28.23	8.68	21.63	21.38	13.16
OECD North America	26.67	35.18	6.83	26.18	36.22	6.50
OECD Pacific	21.87	18.12	3.27	13.32	10.87	2.46
Other Europe	0.02	0.02	0.001	0.25	0.26	0.12
Transition Economies	1.35	1.58	5.71	1.97	1.59	3.18
World	100.00	100.00	100.00	100.00	100.00	100.00
AI Parties	77.60	79.34	20.36	56.65	64.30	20.13
NAI Parties	21.34	19.68	79.07	39.96	32.55	75.14
Least developed countries	0.51	0.56	11.08	N.A	N.A	N.A
World total (billion)	7,750[b]	35,440[b]	6.0[c]	22,270[b]	79,558[b]	8[c]

Sources: UNSTAT, National Accounts Database; World Bank, 2006, World Development Indicator; OECD, ENV-Linkages Model.
Abbreviations: AI Parties = Parties included in ANNEX I to the Convention, GDP = gross domestic product, NAI Parties = Parties not included in ANNEX I to the Convention, OECD = Organisation for Economic Co-operation and Development.

[a] Please see ANNEX I for definitions on regional grouping
[b] United States dollars
[c] Number of people

3.4. FINANCIAL FLOWS NEEDED IN 2030

78. For the analysis of future financial flows needed for mitigation, the reference scenario assumes no new international agreement to address climate change. Thus, the reference scenario has no future financial flows – recurrent expenditures – to reduce emissions or enhance sinks. For the mitigation scenario, current and future financial flows are estimated by sector, specifically for reduction of non-CO_2 emissions in agriculture, reduced deforestation, forest management, extension services for agriculture, and technology research, development and deployment.

79. Climate change would occur under any of the scenarios selected for the analysis of investment and financial flows needed for adaptation. In order to respond to the impact of climate change, additional financial flows would be needed for each sector analyzed but in particular for human health and for R&D in the AFF sector.

3.5. INTERPRETATION OF THE ESTIMATES OF INVESTMENT AND FINANCIAL FLOWS

80. Estimates of investment and financial flows are for a given calendar year. The investments flows estimated correspond to the capital cost of new physical assets. The investments do not include the operating and maintenance costs of the new assets over their lifetime, because the focus is on investment flows and the timing of the operating and maintenance expenditures differs from that of investment.

81. The investment in a new asset is not the same as the annual cost of financing a given asset. For instance, if a water supply system with a capital cost of USD 100 million is needed in 2030, the investment during 2030 is estimated as USD 100 million. However, if that system is financed with a loan repayable over 20 years with a 5 per cent interest rate, the total cost would be USD 160 million and the payments during 2030 would be approximately USD 8 million. The figure used in this analysis is USD 100 million.

82. The analyses in this paper do not provide an estimate of the total cost of climate change mitigation. A comparison of the reference and mitigation scenarios indicates differences in the total investment needed for various types of physical infrastructure and the financial flows needed for various mitigation measures. The sum of those differences is not an estimate of the cost of mitigating climate change nor the cost of adapting to climate change. The analysis does not provide an estimate of the total cost of the adaptation neither. It assesses the order of the magnitude of the additional investment and financial flows that could be needed in 2030 to adapt to the adverse impact of climate change in selected sectors.

83. The change in the total investment and financial flows in measures that affect GHG emissions between the reference and mitigation scenarios should be taken as an estimate of mitigation cost. The scenarios cover only the capital costs and specified financial flows. Operating and maintenance costs of the physical assets are not included. Offsetting savings, such as reduced energy costs, are also not considered. Thus, the mitigation cost could be higher or lower than the investment and financial flows.

84. To estimate the cost of adapting to climate change it is necessary to define a 'base' current or pre industrial climate from which change is measured. Neither is a meaningful option, since further changes to the current climate are already committed. In that case an operational definition of adaptation would be needed, and this is not available in the literature.

IV. AN OVERVIEW OF INVESTMENT AND FINANCIAL FLOWS NEEDED FOR MITIGATION

4.1. INTRODUCTION

85. Investment and finance are critical components of successful economic development. Generating the appropriate levels of capital is already a difficult undertaking when aiming to meet specific social and economic needs, but generating and allocating the investment and financial flows needed to meet the Millennium Development Goals (MDGs) and at the same time to finance significant climate change mitigation will make this task all that much harder.

86. This chapter presents an overview of estimates of investment and financial flows needed to return CO_2 eq emissions to current levels by 2030. The analysis is based on currently available scenarios, as explained below. The results should be considered indicative only.

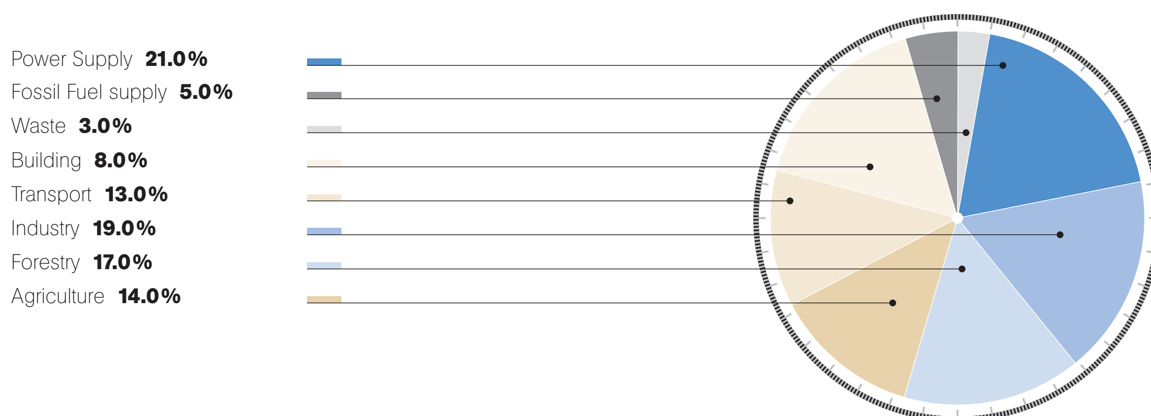
87. The investment and financial flows for mitigation have been estimated for eight major GHG emission sectors identified in the Working Group III contribution to the IPCC AR4 (IPCC, 2007c). The share of anthropogenic GHG emissions in each sector in 2004 is shown in FIGURE IV-5 below.

88. For all sectors (except agriculture and forestry), the estimates presented correspond to the investment and financial flows needed to make possible a shift from the reference scenario to the mitigation scenario. For fossil fuel supply and power supply, total investments needed are estimated for each scenario. For the industry, transportation, buildings and waste sectors, only the additional investments needed for the mitigation scenario is estimated.

89. For the agriculture and forestry sectors both investment flows for agroforestry and afforestation/reforestation and financial flows for reduction of non-CO_2 emissions, reduced deforestation and forest management are estimated. Financial flows are also estimated for mitigation related technology R&D and deployment.

90. The analysis of investment and financial flows for each of the emitting sectors begins with a summary of the projected emissions in 2030 and a review of the current sources of investment. Then the investment flows needed in 2030 are estimated under the reference and mitigation scenarios. Finally, the actions needed to shift investment from the reference scenario to the mitigation scenario are discussed.

Figure IV-5. **Share of global greenhouse gas emissions by major sectors in 2004**



Source: IPCC, 2007c.

4.2. SCENARIOS

91. The reference and mitigation scenarios chosen for the analysis of different sectors are explained in detail in CHAPTER II.3.

92. For most sectors analysed (energy supply, industry, transportation and buildings), the reference scenario, unless otherwise specified, is the IEA WEO 2006 reference scenario (IEA, 2006). Two assumptions underline this scenario: that the global population will increase by approximately two billion people to approximately eight billion by 2030; and that the global average per capita income will rise from USD 9,253 in 2004 to USD 17,196 in 2030. Population and per capita income will both rise more rapidly in developing countries. The IEA estimates of cumulative investment have been converted to annual investment flows. Preliminary estimates of GDP and investment by sector corresponding to this scenario were provided by the OECD from its OECD ENV-Linkages model[13].

93. The mitigation scenario corresponds to the BAPS presented in the IEA WEO 2006. The BAPS assumes the same increase in population and per capita income as the reference scenario, but projects a significantly different pattern of energy demand and supply to return global energy-related CO_2 emissions to current levels (2004) by 2030: energy efficiency is improved significantly to provide the same services with less energy, and the mix of energy sources is changed to reduce emissions further. The IEA provides only global data for the BAPS. These data were disaggregated into the same regions as the reference scenario and the IEA estimates of cumulative investment were converted into annual investment flows.

94. The IEA has estimated in its reference scenario that without new polices and financing, about 1.4 billion people will remain without access to electricity in 2030. The BAPS does not consider this need for increased electricity access in developing countries, but focuses more on the national polices and measures related to energy security and energy-related CO_2 emissions. The additional investment needed to achieve full access to electricity by 2030 is estimated by the IEA as USD 750 billion; that is, an average of about USD 25 billion per year.

95. *For non-CO_2 emissions in the agriculture, waste and industry sectors* the reference scenario is based on projections by the US EPA (US EPA, 2006a). The mitigation scenario includes cost-effective emission reductions estimated using marginal abatement cost curves developed by the US EPA (US EPA, 2006b).

96. *For industrial process* CO_2 emissions the reference and mitigation scenarios are based on a WBCSD report on the cement industry (WBCSD, 2002).

97. *Other emissions and removals by sinks in the agriculture and forestry sectors and emissions by the forestry sector* are assumed to remain constant under the reference scenario. The mitigation scenario reflects emission reductions and removals by sinks potential estimated by the IPCC Working Group III (IPCC, 2007c).

4.3. LIMITATIONS IN ESTIMATING MITIGATION COSTS

98. Given the short time frame in which the analysis had to be undertaken, this study uses existing models and available data. The analysis of specific regions, sectors and technologies are limited by the models and data used.

99. For instance, with regard to *regional analysis*, the models available provide little detail at the country level for some regions, in particular for Africa. It is not possible to separate South Africa's share of activity and emissions from those of other African countries. However, it is acknowledged that, as for other regions, e.g. Latin America and Asia, if the largest emitters are singled out, the investment and financial flows needed for the rest of the region could differ from those of the region as a whole.

100. With regard to *sectors*, the IEA scenarios provide internally consistent projections of energy demand for industry, buildings and transportation and energy supply by fuel type. The scenarios also provide the associated CO_2 emissions and investment by sector in some detail in 2030. As discussed in CHAPTER IV.4.1 on energy supply, estimates of current investment from the IEA scenarios and other sources vary substantially and could not be reconciled.

101. The analysis on investment in transmission and distribution (T&D) is mostly based on the total amount of electricity demand. Projection in the BAPS does not consider the need for increased electricity access in developing countries.

102. Energy efficiency improvement involves actions implemented at millions of specific facilities. The regional figures presented here are derived from global analysis by IEA based on a top down approach, so they should be considered as indicative only.

103. The agriculture and forestry sectors offer both emission reductions and sink enhancement options, of which some require investment and others require ongoing financial flows. It is necessary to draw on multiple, perhaps not fully consistent, sources to estimate the scale of the emission reductions or sink enhancement and the associated investment or financial flows.

104. For agroforestry only global estimates are available.

105. Because models for estimating the mitigation scenario are not available for the forestry sector the analysis is limited to estimating the costs of the different mitigation measures. The cost data varies widely because of different assumptions and the limited information across regions.

106. For some *technologies* still under development little information is available on current practices and/or planning. For instance, knowledge of large-scale deployment of CCS is still limited, though it is assumed to play a key role in the mitigation scenario. The geographic distribution adopted is based on limited storage potential information and growth of fossil fuels fired power plants, which may not reflect the future reality.

4.4. INVESTMENT AND FINANCIAL FLOWS NEEDED FOR MITIGATION

4.4.1. ENERGY SUPPLY

4.4.1.1. INTRODUCTION

107. Combustion of fossil fuels is the largest single source of GHG emissions from human activities, accounting for about 80 per cent of anthropogenic CO_2 emissions (IPCC, 2007c). Extracting, processing, transporting, and distributing fossil fuels also releases GHGs.

108. Energy supply covers the production and transformation of fossil fuels. This includes fossil fuels such as coal, oil, gas, lignite and peat, and transformation of those fuels through petroleum refining, natural gas processing and electricity generation. It also includes nuclear energy, hydropower, wind power and solar power, biomass, including waste, tidal energy, waves and ocean thermal gradients used for electrical power generation, and geothermal energy used for electrical power and heating.

[13] For more information on OECD ENV-Linkages model, please refer to chapter II.3.

4.4.1.2. ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS

RECENT TRENDS IN ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS

109. The world's total primary energy supply reached 11,223 million tonnes of oil equivalent (Mtoe) in 2004 (IEA, 2006), having grown at an average annual rate of 2.2 per cent between 1994 and 2004. In 2004, oil continued to be the world's most important primary energy source, followed by coal, natural gas, nuclear energy, hydropower and advanced renewables (see FIGURE IV-6). The efficiency of conversion of primary energy to electricity varies greatly among these sources; for example, the total electricity generated from nuclear energy and hydropower is about the same, but thermal conversion processes are inherently less efficient.

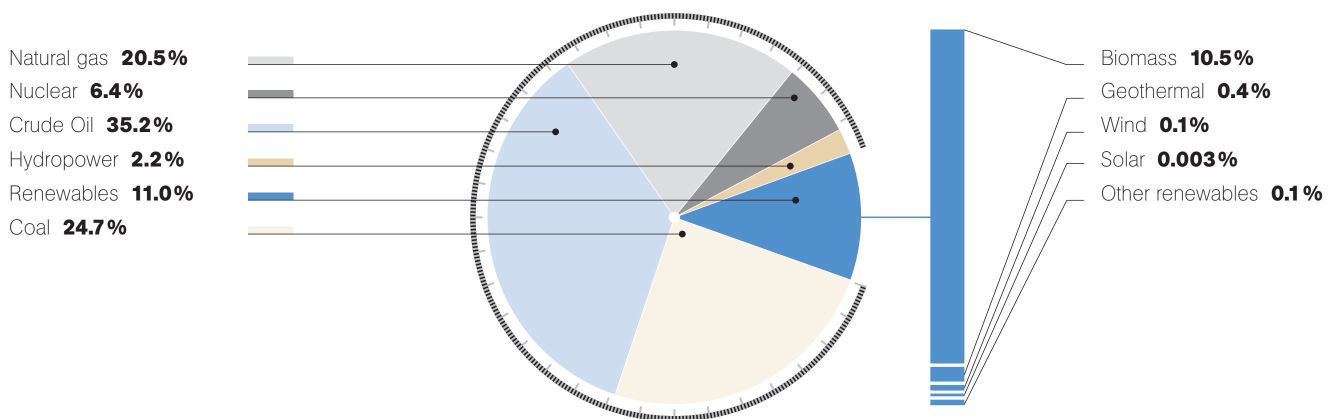
110. Energy supply and consumption are not distributed evenly worldwide. OECD countries, accounting for one sixth of the world's population, consumed around one half of the world's primary energy supply in 2004. Three countries – the United States of America, China and the Russian Federation – were the leading producers and consumers of world energy. These three countries produced 40 per cent and consumed 43 per cent of the world's energy.

111. Electric power production in 2004 was 17,450 terawatt hours (TWh). Approximately 58 per cent was produced in OECD countries, 33 per cent in developing countries and the remainder by transition economies. Power sector growth was 4 per cent per year between 1994 and 2004 but the distribution of growth is highly uneven, with particularly rapid growth recorded in China and some other developing countries. Coal produced 6,944 TWh of electricity in 2004, or 38 per cent of the world's electricity output. It is the dominant fuel for electric power production in China, India, the United States, the Russian Federation, Australia and Indonesia.

112. Global CO_2 emissions from use of petroleum, natural gas and coal and the flaring of natural gas increased from 20 Gt CO_2 in 1990 to 26 Gt CO_2 in 2004. Emissions from OECD countries account for 49 per cent of the total. The United States, China, the Russian Federation, Japan, and India were the world's five largest sources of energy-related CO_2 emissions in 2004, accounting for 54 per cent of the total, followed by Germany, Canada, the United Kingdom, the Republic of Korea and Italy, which together produced an additional 11 per cent of the global total.

113. In 2004, oil and coal made nearly identical contributions to total CO_2 emissions, around 40 per cent each. CO_2 emissions from use and flaring of natural gas accounted for the remaining 20 per cent of energy related CO_2 emissions. Power sector emissions increased from 7 Gt CO_2 in 1990 to 10.6 Gt CO_2 in 2004, faster than the rate of total emissions growth. Coal is the major source of CO_2 emissions in the power sector, accounting for 71.6 per cent of the total in 2004. Most of the increase (2.9 Gt CO_2) occurred in developing countries.

Figure IV-6. **Global primary energy mix in 2004**



Source: IEA, 2006.

ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS IN 2030 UNDER THE REFERENCE SCENARIO

114. Fossil fuels are projected to remain the dominant sources of primary energy globally (see FIGURE IV-7). Their share of global primary energy mix is projected to rise slightly under the reference scenario from 80 per cent in 2004 to 81 per cent in 2030. Global primary energy demand under the reference scenario is projected to increase by 1.6 per cent per year between 2004 and 2030, reaching 17.1 billion tonne of oil equivalent (Btoe), 53 per cent (6 Btoe) more than in 2004. Over 70 per cent of the increase in global primary energy demand between 2004 and 2030 comes from the developing countries. The increase in the demand of developing countries results from their rapid economic and population growth. Industrialization and urbanization boost demand for commercial fuels.

115. Global electricity demand is projected to increase from 17,408 TWh in 2004 to 33,750 TWh in 2030 under the reference scenario, growing at 2.6 per cent per year on average. This is slower than the GDP growth rate of 3.4 per cent and faster than the total primary energy supply of 1.6 per cent. Developing Asia is the main engine of electricity demand growth. Though world electricity generation almost doubles by 2030, the generation mix remains relatively stable.

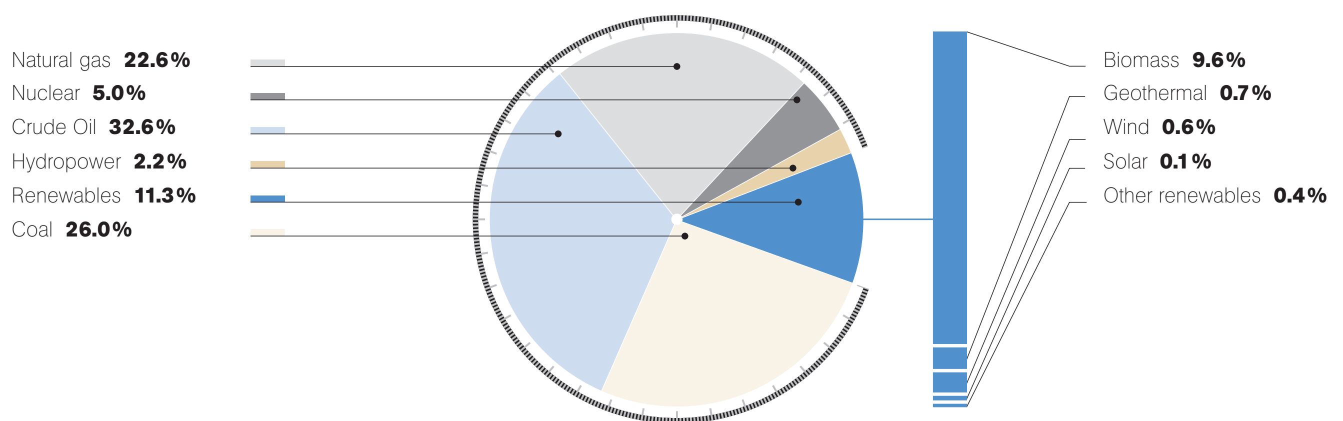
116. Global energy-related CO_2 emissions increase by 1.7 per cent per year between 2004 and 2030 under the reference scenario. They reach 40.4 Gt CO_2 in 2030, an increase of 14.3 Gt CO_2 or 55 per cent from 2004 levels. Developing countries account for over three quarters of the increase in global CO_2 emissions. This increase is greater than the growth in their energy demand, because they use more coal and less natural gas than developed countries.

117. Power generation is projected to contribute just under half the increase in global emissions between 2004 and 2030. By 2030, the power sector accounts for 44 per cent of total emissions, up from 40 per cent in 2004. Continuing improvements in the thermal efficiency of power stations are outweighed by the significant growth in demand for electricity.

ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS IN 2030 UNDER THE MITIGATION SCENARIO

118. Under the mitigation scenario strong policies increase energy efficiency significantly to provide the same services with 15 per cent less energy and shift the energy supply to more climate friendly technologies. Global primary energy demand rises from 11.1 Btoe in 2004 to 14.6 Btoe in 2030, 2.5 Btoe lower than in the reference scenario. Energy demand still grows fastest in developing countries, but increased energy efficiency moderates the growth

Figure IV-7. **Global primary energy mix in 2030 under the reference scenario**



Source: IEA, 2006.

in their demand to 2.7 Btoe. Fossil fuels still play the dominant roles in primary energy supply (see FIGURE IV-8). Their share decreases to 72 per cent in 2030 from 81 per cent under the reference scenario in 2030 and 80 per cent in 2004.

119. Increased energy efficiency also limits the rate of growth of global electricity demand under the mitigation scenario to 27,983 TWh in 2030. The mitigation scenario also assumes a substantial shift in the global electricity generation mix in 2030. As shown in FIGURE IV-9, coal remains the largest source of electricity (and generation capacity increases by 95 gigawatt (GW)) but its share shrinks from 40 per cent in 2004 to 26 per cent in 2030. Gas-fired generation grows rapidly and becomes the second largest source at 21 per cent in 2030. The generation capacity of nuclear energy, hydropower and renewables expands significantly, each representing about 17 per cent of the total in 2030. The mitigation scenario assumes a significant amount of CCS for power plants and industry. By 2030 CCS is added to 70 per cent of the new coal capacity (545 GW) and 35 per cent of new gas capacity (494 GW).

120. Global energy-related CO_2 emissions peak at 30 Gt CO_2 between 2015 and 2020 and decrease to the current levels by 2030 (see FIGURE IV-10). Emissions of OECD countries remain stable from 2004 to 2015 and then decrease to 10 Gt CO_2 by 2030, 7 per cent below their 1990 emissions. Developing country emissions increase by 3.3 Gt CO_2 then start to decline by 2030. The trend for emissions in transition economies is to decrease slightly under the mitigation scenario, rather than increasing slightly under the reference scenario.

4.4.1.3. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS BY SOURCE OF FINANCING

121. This chapter summarizes data on current investment flows related to energy supply. The information on current investment flows relates to economic sectors.

122. Components of energy supply are divided between two economic sectors. Specifically:

- Oil, gas and coal production and petroleum refining are part of the mining and quarrying sector, together with other mining activities;
- Electricity generation, T&D and gas distribution are part of electricity, gas distribution and water supply sector.

123. The electricity, gas distribution and water supply sector accounts for the largest share of energy supply investment. The sources of investment are shown in TABLE IV-6.

Table IV-6. **Investment flows for electricity, gas distribution and water supply in 2000 (percentage), by source and region**

	Total Investment	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	ODA Bilateral total	ODA Multilateral total	Total	Total Investment (USD billion)
Africa	1.83	80.04	0.00	0.00	12.37	7.59	100.0	5
Developing Asia	12.28	75.59	8.57	3.61	7.51	4.72	100.0	32
Latin America	7.46	39.42	28.80	26.71	3.64	1.43	100.0	19
Middle East	1.40	93.29	0.00	0.00	5.88	0.82	100.0	4
OECD Europe	29.23	47.35	15.42	37.18	0.00	0.05	100.0	75
OECD North America	18.85	65.46	22.46	11.54	0.48	0.05	100.0	48
OECD Pacific	26.71	96.97	0.71	2.32	0.00	0.00	100.0	69
Transition Economies	2.20	92.12	2.95	0.72	3.43	0.78	100.0	6
Global Total	**100.00**	**68.81**	**12.19**	**16.44**	**1.67**	**0.88**	**100.0**	**257**
AI Parties	72.49	81.41	0.04	18.52	0.03	0.01	100.0	186
NAI Parties	26.07	77.72	12.63	5.76	0.60	3.29	100.0	67
Least Developed Countries	1.10	63.48	6.28	0.00	12.16	18.09	100.0	3

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I Parites to the Convention, FDI = Foreign Direct Investment, NAI Parties = Parties not included in the Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

Figure IV-8. **Global primary energy mix in 2030 under the mitigation scenario**

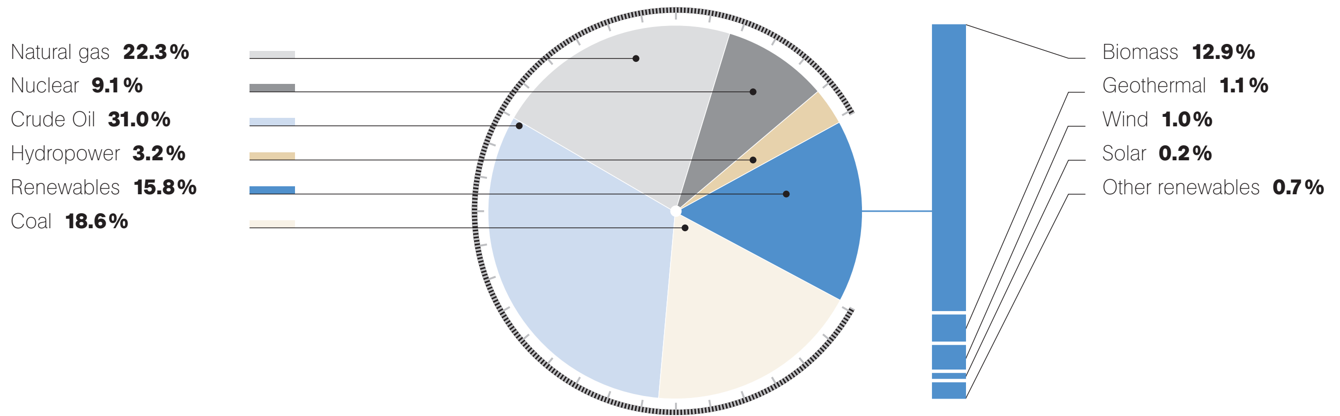
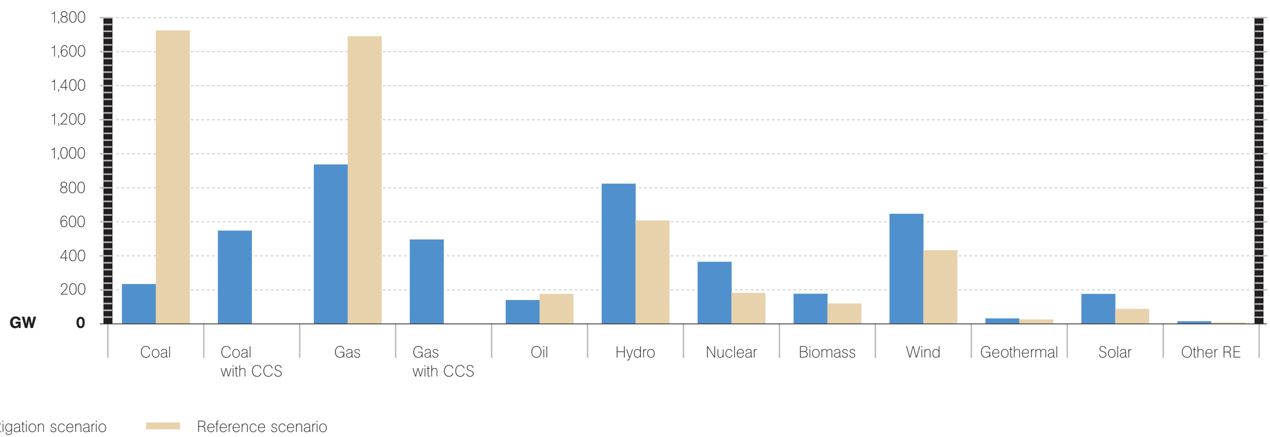
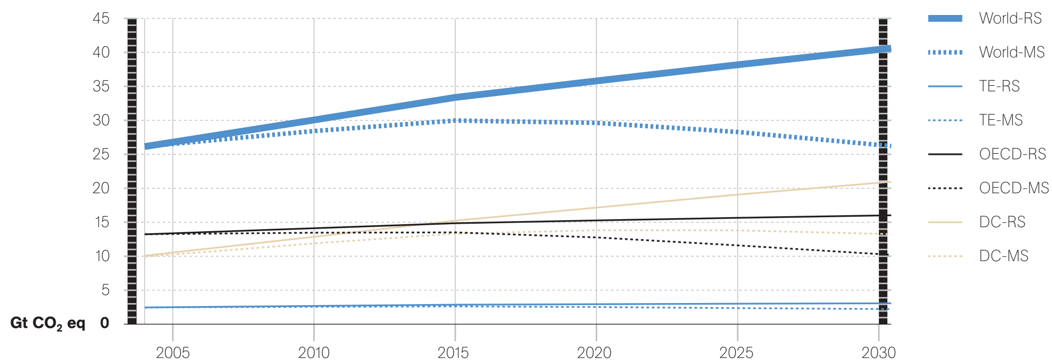


Figure IV-9. **Cumulative capacity additions in the reference and mitigation scenarios, 2004 – 2030**



Abbreviations: CCS = carbon dioxide capture and storage; RE = renewable energy.

Figure IV-10. **Energy-related carbon dioxide emissions under the reference and mitigation scenarios, 2004 – 2030**



Abbreviations: DC = developing countries; MS = mitigation scenario; OECD = Organisation for Economic Co-operation and Development; RS = reference scenario; TE = transition economies.

124. In all regions, the majority of the investment is domestic but foreign equity and debt is also important in developed countries and ODA is important in LDCs. The sources of financing vary, with mostly private financing in the United States and the United Kingdom, a mix of private and government financing in much of Europe, and government funding in transition economies and most developing countries. Much developing country financing, other than in developing Asia, comes through a combination of ODA and loans from the World Bank and regional development banks.

125. Different sources provide somewhat inconsistent estimates of annual investment for different components of energy supply. These are shown in TABLE IV-7.

126. The investment in electricity supply estimated by the IEA, USD 412 billion in 2005 (IEA, 2006) looks high relative to the estimates from the other data sources. Over half of the total IEA estimate is for investment in transmission and distribution (T&D) and that component alone is larger that the total investment estimated by other sources. Thus the explanation of the discrepancy probably lies in the estimated investment in T&D, which may not be adequately addressed in other reports, and those figures should be used with caution.

CURRENT INVESTMENT FLOWS FOR RENEWABLE ENERGY AND ENERGY EFFICIENCY

127. TABLE IV-8 shows the sources of funding for investment in renewable energy and energy efficiency in 2005. Private investment is by far the largest source of investment, USD 28.2 billion of debt and equity out of a total of USD 29.3 billion. Private investment (as measured by New Energy Finance, 2007) is defined as investment made by financial institutions and corporations. It excludes public sector investment and R&D (whether funded by companies or governments). Since most of the investment occurs in OECD countries, it is not surprising that ODA funding for renewable energy is less than 4 per cent of the total.[14]

128. Of the USD 26.8 billion invested in renewable energy in 2005, USD 2.9 billion was provided by venture capital and private equity investors, USD 3.8 billion was raised via the public markets, and USD 20.1 billion was supplied through asset financing. As companies mature, investors can leverage their equity investment with debt. Asset financings typically involve 20–30 per cent equity and 70–80 per cent debt.

129. The range of investment activity reflects the different stages of development of renewable technologies. Wind power is the most mature technology and therefore received the highest proportion of asset finance (USD 18 billion). Solar power received a high proportion of public market investment (USD 2.2 billion) because solar companies were raising capital to expand their manufacturing capacity.

130. Private investment is – and is likely to remain – the main source of financing for renewable energy and energy efficiency. Consequently, renewable energy has flourished in countries with supportive policies such as feed-in tariffs, developed financial markets and active private investors.

131. In developing countries, financing for renewables and energy efficiency tends to come from domestic sources (public and private) and from joint ventures between local and foreign companies, reflecting the higher investment risk of these countries. Multilateral and bilateral funding is also a significant source of investment in developing countries.

132. This situation is changing, particularly in the fast growing emerging markets of China, India and Brazil, which are attracting increasing flows from foreign investors. Their rapidly expanding electricity sectors are also attracting foreign investors. LDCs, such as sub-Saharan Africa, for example, and smaller developing countries still attract limited private sector investment and continue to rely on ODA and soft loans[15] from IFIs such as the World Bank.

133. Production of renewable energy equipment and products is also growing rapidly in China, India and Brazil; photovoltaic cells for solar power in China, wind turbines in India, and ethanol in Brazil. Much of the output of photovoltaic cells and wind turbines and some of the ethanol produced is exported.

134. Developed countries continue to receive most of the private investment (93 per cent) into renewable energy and energy efficiency worldwide. In 2005, the United States attracted the largest investment flows in renewable energy (mainly for wind power) and in energy efficiency (Greenwood C *et al.*, 2007).

[14] Energy efficiency is implicit in CRS database (CRS is the source for ODA data).

[15] Loans at preferential (below market) rates which meet particular economic, social or environmental objectives.

Table IV-7. **Alternative estimates of investment in energy supply in 2000 and 2005 for various components of energy supply (billions of United States dollars)**

Sources							
Component of energy supply	UNCTAD 2000	OECD 2005	IEA 2005	Estimates of investment in renewables and energy efficiency			
Fossil-fired generation	–	–	107.0	–	–	–	–
Large hydro and nuclear generation	–	–	44.1	–	–	–	–
Renewables including small hydro	–	–	35.5	28.2[b]	38[c]	5.7 to 24.2[d]	Up to 2.0[e]
Transmission and distribution	–	–	225.7	–	–	–	–
Total electricity	199[a]	148	412.3	–	–	–	–
Gas distribution	17[a]	13	–	–	–	–	–
Water supply	42[a]	31	–	–	–	–	–
Electricity, gas distribution and water supply	257	191	–	–	–	–	–
Oil supply	–	–	84.5	–	–	–	–
Gas supply	–	–	134.0	–	–	–	–
Coal supply	–	–	20.0	–	–	–	–
Petroleum refining	–	–	29.5	–	–	–	–

Abbreviations: IEA = International Energy Agency, OECD = Organisation for Economic Co-operation and Development, UNCTAD = United Nations Conference on Trade and Development

[a] Based on gross fixed capital formation data by the respective sectors estimated assuming the same shares as the OECD data.
[b] New Energy Finance estimate for 2005. This includes investment from private equity/venture capital, public market and asset financing.
[c] REN21 2006, estimate for 2006 (2006 USD million). This includes only the investment observed in the capital markets. REN21 "Renewables Global Status Report 2006 Update"; Paris: REN21 Secretariat and Washington DC: Worldwatch Institute.
[d] Estimates of the investment for clean development mechanism (CDM) renewable energy and energy efficiency projects registered during 2006 and that entered the pipeline during 2006 respectively.
[e] Estimates of the investment for JI renewable energy and energy efficiency projects that entered the pipeline during 2006.

Table IV-8. **Overview of funding sources in 2005 (millions of United States dollars)**

	Renewable energy			Energy efficiency			
	Source	OECD	Developing	OECD	Developing	Total	Per cent total
Total investment Debt							
Private sector	NEF	9,089	656	41	6	9,791	33.4
Multilateral	CRS	–	386	–	–	386	1.3
Total debt		9,089	1,041.5	40.8	6	10,177	–
Equity							
Total equity (private sector)	NEF	14,107	2,906	1,342	96	17,451	63.0
Grants							
Multilateral (GEF)	GEF	–	42	–	30	71	0.2
Bilateral	CRS	–	601	–	–	601	2.1
Total grants		–	642	–	30	672	–
Total investment		**23,196**	**4,590**	**1,383**	**132**	**29,300**	**–**
Private investment		23,496	3,562	1,383	102	28,242	96.4
Multilateral/bilateral		–	1,028	–	30	1,058	3.6

Abbreviations: CRS = Creditor Reporting System, GEF= Global Environment Facility, NEF = New Energy Finance, OECD = Organisation for Economic Co-operation and Development.

Note: New Energy Finance assumptions on leverage (debt as per cent of whole): Venture capital investment is unleveraged (i.e. all equity and no debt). Private equity investment in companies (expansion capital) is leveraged with 30 per cent debt. Over the Counter (OTC) investments and private investments in public equities (PIPEs) are leveraged with 10 per cent debt. Public market investments are unleveraged, i.e. 100 per cent equity. Asset financing can take different forms: balance sheet finance (corporate finance) and lease/vendor finance at typically 100 per cent equity financed, bond finance is 100 per cent debt, and project finance is based on New Energy Finance standard levels of leverage (wind 74 per cent debt, solar 77 per cent debt, mini-hydro and geothermal 70 per cent debt).

CURRENT ESTIMATES OF ENERGY SUBSIDIES AND POTENTIAL REVENUE OF NON-TECHNICAL LOSSES

ENERGY SUBSIDIES

135. Subsidies are introduced for specific social, economic or environmental reasons, for example to provide affordable energy to low income groups, to stimulate R&D of energy technologies, or to reduce pollution by promoting renewable energy. Data on the cost of subsidies are not routinely collected and reported. Instead, specific studies estimate the value of subsidies, but the studies differ in terms of the subsidies included[16], geographic coverage and the methodology used.

136. Putting a monetary value on some types of subsidies can be extremely difficult. For the purposes of this analysis, given the data availability, the subsidy is estimated as the difference between the actual price (cost) and the baseline price (cost) with no subsidy. The baseline must differentiate the impact on price (production cost) of a particular government intervention that generates the subsidy from the effects of all other factors that influence the price (cost). Empirical studies of subsidies typically use market price (cost) in another jurisdiction as the baseline.

137. Globally, energy subsidies total approximately USD 250 – 300 billion per year excluding taxes (Morgan, 2007). Non-OECD countries receive the bulk of these subsidies and use most of them to lower prices for consumers. In OECD countries, most subsidies are used for production, usually in the form of direct payments to producers or support for R&D. Worldwide, fossil fuels are the most heavily subsidized energy sources; these subsidies total an estimated USD 180 – 200 billion per year. Support to the deployment of low-carbon energy sources currently amounts to an estimated USD 33 billion each year: USD 10 billion for renewables, USD 16 billion for existing nuclear power plants and USD 6 billion for biofuels.

138. The most recent global quantitative analysis of energy subsidies, carried out by the IEA in 2006, measures consumption subsidies – government measures that result in an end-user price that is below the price that would prevail in a truly competitive market – in the twenty non-OECD countries with the largest primary energy consumption. Price controls, often through state-owned companies, are the most common form of energy subsidy. As shown in TABLE 7-ANNEX V, the Russian Federation has the largest subsidies, USD 40 billion per year, most of which go to natural gas. Iran's energy subsidies, mostly for petroleum products, are about USD 37 billion per year. China, Saudi Arabia, India, Indonesia, Ukraine and Egypt have subsidies in excess of USD 10 billion per year.

139. Forty per cent of the subsidies (USD 91 billion) go to oil products with Iran (27 per cent), Indonesia (16 per cent) and Egypt (10 per cent) having the largest shares of the total. Natural gas gets 31 per cent of thesubsidies (USD 70 billion) with the Russian Federation (36 per cent), Ukraine (18 per cent) and Iran (14 per cent) accounting for most of the total. Electricity gets 24 per cent of the subsidies (USD 55 billion) with the Russian Federation (15 per cent), India (10 per cent) and China (7 per cent) having the largest shares. China accounts for most of the coal subsidies; 76 per cent of the total coal subsidies of USD 10 billion.

140. Subsidies resulting from price regulation of road transport fuels are among the easiest to observe and estimate. A recent survey of 171 countries by GTZ (2007) shows that a number of countries subsidize gasoline and diesel net of taxes (see FIGURES 1- and 2-ANNEX V). In 14 countries, gasoline prices (15 countries for diesel) are lower per litre than the international price of crude oil, implying a large subsidy. Prices are below United States retail levels – the benchmark that GTZ used for determining whether fuel is subsidized – in 24 countries for gasoline and 52 countries for diesel.

141. The value of transport fuel subsidies, based on the GTZ data and 2004 consumption data from the IEA, amounts to USD 90 billion using the international fuel price plus a distribution margin as the baseline reported by GTZ (2007). Gasoline subsidies total USD 28 billion and diesel subsidies USD 61 billion. The aggregate amount is exactly the same as the 2006 estimate of the IEA, using a similar methodology, of total oil subsidies in the world's 20 largest consuming countries in 2005.

142. The effects of energy subsidies on GHG emissions are complex. Generally lower fossil fuel prices encourage greater consumption and higher GHG emissions. But subsidizing oil products in developing countries can reduce emissions by curbing deforestation when rural households switch from firewood (von Moltke *et al.*, 2004). Nonetheless, a OECD study (OECD, 2000) estimates that trade liberalisation and elimination of global fossil-fuel subsidies in industry and the power sector would reduce energy-related CO_2 emissions by more than 6 per cent by 2010, while increasing income

by 0.1 per cent (OECD 2000). Similarly, a 1999 IEA study shows that removing consumption subsidies in eight of the largest non-OECD countries would reduce their primary energy use by 13 per cent and reduce their CO_2 emissions by 16 per cent (see TABLE 8-ANNEX V), while GDP rises by 1 per cent. This reduction corresponds to 5 per cent of global emissions.

143. A study by the Australian Bureau of Agricultural and Resource Economics (ABARE) reports a smaller reduction of world emissions; 1.1 per cent by 2010 relative to a reference case if removing fossil fuel consumption subsidies (Sanders and Schneider, 2000). These emission reductions would be largest in transition economies (8 per cent) while emissions would rise slightly in developed countries due to lower international coal prices.

144. The impacts of subsidy removal in OECD countries depend on country-specific circumstances, but an analysis shows that it would not lead to direct increases in prices and thus may not lower consumption or emissions. In Germany, subsidy removal might encourage coal imports because subsidies are paid to producers and coal consumers can choose suppliers. This could drive up international coal prices and thus push down coal demand and related CO_2 emissions.

NON-TECHNICAL LOSSES

145. The metered use of electricity by consumers is less than the electricity supplied by the generators due to T&D losses. T&D losses consist of both technical losses, such as transmission line loss, and non-technical losses, such as theft. Utilities generally try to minimize non-technical losses but some government owned utilities may tolerate non-technical losses as a socio economic policy; that is, a means of providing electricity to low-income groups.

146. Non-technical loss by region is estimated for the analysis. Using T&D losses during 2000, the 71 countries for which data are available are divided into three categories according to their total T&D loss based on a comparative analyse by Smith (Smith, 2004). A pure technical loss is assumed for the countries in each category. The difference between the total T&D loss and the pure technical loss is the estimated non-technical loss. The amount of the non-technical loss is calculated and valued using the average of the industrial and residential electricity price.[17] FIGURE 3-ANNEX V shows the estimated non-technical losses as a percentage of the total electricity supplied.

147. The estimated total revenue lost due to non-technical losses is USD 20 billion. The regional distribution of those losses as shown in FIGURE 4-ANNEX V. Revenue losses are highest in developed countries because their total electricity consumption is high. Countries with estimated non-technical losses in excess of USD 1 billion per year are India, Brazil, the Russian Federation and Mexico. Developing countries account for 57 per cent of the total losses.

[16] The International Energy Agency has defined energy subsidies as any government action that concerns primarily the energy sector that lowers the cost of energy production, raises the price received by energy producers or lowers the price paid by energy consumers (IEA, 1999).

[17] Since the non-technical losses are valued at subsidized prices, they are understated.

4.4.1.4. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

INVESTMENT AND FINANCIAL FLOWS NEEDED UNDER THE REFERENCE SCENARIO

148. Investment in energy supply infrastructure under the reference scenario is projected to be USD 762 billion in 2030 (see TABLE IV-9). The power (including generation, T&D) sector requires USD 439 billion, or 58 per cent of the total. Capital expenditure in the oil industry – oil production, pipelines and other forms of transportation, and refineries amounts to USD 154 billion, just over one-fifth of the total. Gas investment – gas production, pipelines, liquefied natural gas (LNG) and other transportation investment is USD 148 billion, or 19 per cent of the total. Investment in coal supply is about USD 20 billion, or 3 per cent of total energy investment.

149. As shown in TABLE IV-9, more than half of all the energy investment needed worldwide in 2030 is in developing countries, where demand and production increase most quickly. China alone needs to invest about USD 132 billion, 17 per cent of the global total. About USD 283 billion (37 per cent) is needed by OECD countries to replace and expand their facilities.

150. Upstream (production) investment accounts for 73 per cent of the total investment in the oil industry in 2030, 56 per cent of the total in the gas industry, and 100 per cent in the case of coal. Most of the oil industry investment occurs in the Russian Federation and the Middle East. Natural gas investment is concentrated in OECD North America, where demand increases strongly under the reference scenario and where construction costs are high. Almost half of the coal investment occurs in China and one quarter each in North America and Australia.

Table IV-9. **Investment in energy supply needed under the reference scenario in 2030 (billions of United States dollars)**

	Transmission and distribution	Power generation	Coal supply	Oil supply	Gas supply	Total
World	231.0	208.3	19.9	154.2	148.1	761.6
OECD	**71.4**	**93.9**	**6.0**	**44.2**	**67.1**	**282.5**
OECD North America	38.7	40.3	3.1	32.9	45.7	160.7
United States	29.5	34.0	–	–	–	63.5
Canada	3.2	3.7	–	–	–	6.8
Mexico	6.1	2.6	–	–	–	8.7
OECD Pacific	7.9	9.9	1.6	1.8	5.3	26.5
Japan	2.3	5.1	–	–	–	7.4
Korea	3.5	2.7	–	–	–	6.3
Australia and New Zealand	2.0	2.1	–	–	–	4.1
OECD Europe	24.8	43.7	1.3	9.5	16.0	95.3
Transition economies	**10.9**	**11.9**	**1.3**	**24.6**	**22.7**	**71.3**
Russia	4.2	6.2	0.6	18.4	16.9	46.3
Other EIT	6.7	5.6	0.7	6.2	5.7	24.9
Developing Countries	**148.7**	**102.6**	**12.7**	**85.5**	**58.3**	**407.8**
Developing Asia	108.7	72.9	11.5	25.5	17.6	236.1
China	64.5	39.6	9.2	13.5	4.8	131.5
India	26.3	18.3	1.5	1.9	2.1	50.1
Indonesia	4.7	3.7	0.5	1.9	3.3	14.1
Other Developing Asia	13.3	11.3	0.4	8.2	7.4	40.5
Latin America	17.3	13.0	0.4	14.5	10.2	55.5
Brazil	4.6	4.4	0.0	5.3	1.8	16.2
Other Latin America	12.7	8.6	0.4	9.2	8.4	39.3
Africa	13.4	9.5	0.8	18.7	15.9	58.2
Middle East	9.3	7.2	0.0	26.8	14.7	58.0

Abbreviations: EIT = Economies in transition, OECD = Organisation for Economic Co-operation and Development.

151. A total of 5,087 GW of generating capacity is projected to be built worldwide under the reference scenario. More than half of this capacity is located in developing countries. Total power sector investment in 2030, including generation, T&D, reaches USD 439 billion. The largest investment requirements, some USD 104 billion, arise in China. Investment needs are alsovery large in OECD North America and Europe. Investment to replace currently operating capacity accounts for over 40 per cent of total investment in the OECD and over 50 per cent in transition economies, but it is a very small share of total investment in developing countries.

152. Over half of the total investment in 2030, USD 231 billion, is for T&D networks, of which more than two-thirds goes into distribution systems. Despite the significant investment in T&D, the IEA reference scenario projects that 1.4 billion people will not have access to electricity in 2030. The IEA estimates that universal electricity access by 2030 would require an additional annual investment of USD 25 billion. Almost all of this added investment would be needed in sub-Saharan Africa and South Asia.

INVESTMENT AND FINANCIAL FLOWS NEEDED UNDER THE MITIGATION SCENARIO

153. Under the mitigation scenario, the large increase in energy efficiency reduces energy demand and hence projected investment in energy-supply infrastructure. Implementation of the energy efficiency measures requires investments by energy consumers in the industry, buildings and transportation sectors as discussed in CHAPTERS IV.4.2, IV.4.3 and IV.4.4.

154. Investment in energy supply infrastructure under the mitigation scenario is projected to be USD 695 billion in 2030, USD 67 billion (9 per cent) less than under the reference scenario (see TABLE IV-10). The power sector

Table IV-10. **Investment in energy supply needed under the mitigation scenario in 2030 (billions of United States dollars)**

	Transmission and distribution	Change in per cent	Power generation	Change in per cent	Coal, oil and gas supply	Change in per cent	Total	Change in per cent
World	129.8	-44	302.4	45.1	263.2	-18	695.3	-9
OECD	23.1	-68	140.5	49.6	100.4	-14	263.9	-7
OECD North America	14.0	-64	76.8	90.7	71.6	-12	162.3	1
United States	9.1	-69	69.4	104.2	0.0	–	78.5	24
Canada	0.4	-89	3.9	5.5	0.0	–	4.2	-38
Mexico	4.5	-26	3.5	33.4	0.0	–	8.0	-8
OECD Pacific	2.8	-64	16.3	63.4	6.8	-22	25.9	-2
Japan	0.0	-100	7.9	53.6	0.0	–	7.9	6
Korea	2.0	-42	3.5	29.1	0.0	–	5.6	-11
Australia and New Zealand	0.8	-62	4.8	132.6	0.0	–	5.6	37
OECD Europe	6.3	-75	47.4	8.6	22.0	-18	75.7	-21
Transition economies	5.6	-48	17.7	49.6	38.8	-20	62.2	-13
Russia	3.2	-23	10.1	61.9	29.1	-19	42.4	-8
Other EIT	2.4	-64	7.7	35.9	9.7	-23	19.8	-21
Developing Countries	101.1	-32	144.2	40.6	124.0	-21	369.3	-9
Developing Asia	74.9	-31	106.6	46.3	45.6	-16	227.1	-4
China	46.4	-28	64.8	63.8	24.1	-12	135.3	3
India	19.6	-26	24.9	36.4	4.8	-12	49.4	-1
Indonesia	3.4	-26	5.0	35.9	5.0	-13	13.4	-5
Other Developing Asia	5.4	-59	11.8	4.4	11.8	-26	29.0	-28
Latin America	10.3	-40	12.7	-2.4	17.3	-31	40.3	-27
Brazil	1.9	-59	3.4	-22.5	4.5	-37	9.8	-39
Other Latin America	8.4	-34	9.3	8.0	12.8	-29	30.5	-22
Africa	9.9	-27	14.1	49.2	27.5	-22	51.5	-12

Abbreviations: EIT = Economies in transition, OECD = Organisation for Economic Co-operation and Development.

requires about USD 432 billion of investment, 62 per cent of the total. Much of the increased investment in the power sector is for large-scale deployment of CCS from 2020 onwards. Capital expenditure in the oil industry – oil production, pipelines and other forms of transportation, and refineries, amounts to USD 113 billion. Investment in the gas sector – gas production, pipelines, LNG and other transportation is USD 116 billion, about the same as for oil. Investment in coal supply is about USD 12 billion, or 1.7 per cent of total energy investment.

155. The projected decline in T&D investment under the mitigation scenario relative to the reference scenario warrants further analysis. The IEA estimates T&D investment based on generation capacity with one third of the investment for transmission and two thirds for distribution. Increased energy efficiency and wider use of distributed generation[18] should reduce the need for additional T&D capacity under the mitigation scenario, but further analysis is needed to ensure that the lower investment projected is consistent with the level of energy access under the reference scenario.

CHANGES IN INVESTMENT AND FINANCIAL FLOWS BETWEEN THE REFERENCE AND MITIGATION SCENARIOS

156. Figure IV-11 shows the total investment in energy supply needed under the reference and mitigation scenarios.

157. The estimated investment flows for energy supply under the reference and mitigation scenarios in 2030 are shown in table IV-11. The mitigation scenario requires less investment in the production of fossil fuels and associated facilities, and substantial shifts of investments within the power sector.

CHANGE IN INVESTMENT AND FINANCIAL FLOWS NEEDED IN FOSSIL FUEL SUPPLY

158. The investment in fossil fuel supply projected under the reference scenario is USD 322 billion in 2030, of which 6 per cent is for the production of coal, 48 per cent is for oil and 46 per cent for natural gas. Upstream (production) investment accounts for 73 per cent of the total in the oil industry, 56 per cent of the total in the gas industry, and 100 per cent in the case of coal.

159. Under the mitigation scenario the total investment needed is reduced by USD 59 billion in 2030, 40 per cent reduction in coal, 19 per cent in oil and 15 per cent in natural gas. Under this scenario, the consumption of oil and natural gas would be higher than present level and consumption of coal would be about the same; thus, the lower investment reflects slower growth rather than declining output. Just over half (USD 32 billion) of the reduction in investment flows would occur in non-Annex I Parties.

160. Most of the investment is made by large corporations, either government-owned or private. The mitigation scenario means they need to invest less.

CHANGE IN INVESTMENT AND FINANCIAL FLOWS NEEDED IN POWER SUPPLY

161. Under the reference scenario, investment in power supply is projected to be USD 439 billion in 2030, of which 53 per cent is T&D, 17 per cent is for coal-fired generation, 9 per cent is for renewables, 9 per cent is for gas-fired generation, 8 per cent is for hydropower and 3 per cent is for nuclear energy.

162. Under the mitigation scenario, the total investment in 2030 would be about the same as in the reference scenario (USD 432 billion), but the investment mix would be significantly different. Less investment will be needed for T&D (USD 101 billion) and fossil-fired generation (USD 55 billion, mainly coal). Additional investment will be needed for CCS in power plants (USD 63 billion), renewables (excluding hydropower) (USD 38 billion), nuclear energy (USD 25 billion) and hydropower (USD 22 billion). As noted in paragraph 155, the projected decline in T&D investment warrants further analysis.

163. Due to rapid economic growth, about 57 per cent of the power sector investment is projected to occur in non-Annex I Parties under both scenarios (USD 251 billion for the reference scenario and USD 245 billion for the mitigation scenario). The shift in mix of global investments described above occurs in non-Annex I Parties as well.

164. Most of the investment in electricity generation and T&D is made by government-owned or private, usually regulated, electric utilities. In all regions, the majority of the investment is made domestically, but foreign equity and debt are important additional sources of financing in developed countries and ODA is important in LDCs. Investment in renewables is currently concentrated in a few developed countries and a significant proportion is not financed by electric utilities, although both of these patterns are changing.

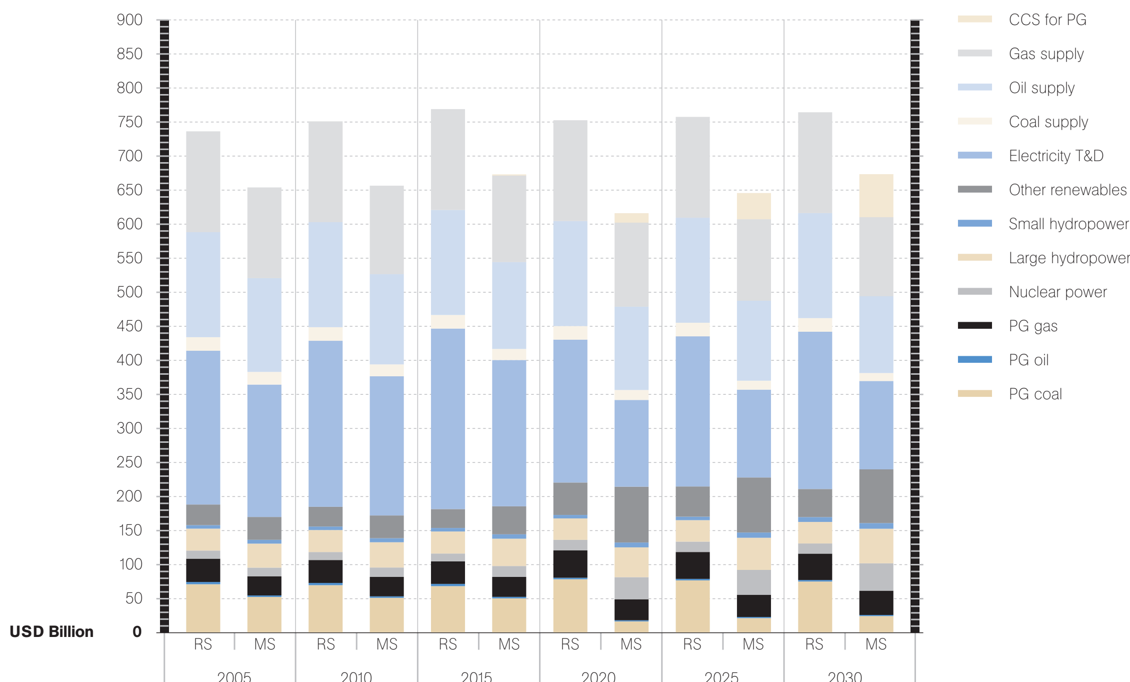
[18] Production of electricity close to where it is used.

Table IV-11. **Investment flows needed for energy supply under the reference and mitigation scenarios in 2030 (billions of United States dollars)**

	Global 2030			Non-Annex I Parties 2030		
Sectors	**Reference scenario**	**Mitigation scenario**	**Additional investment**	**Reference scenario**	**Mitigation scenario**	**Additional investment**
Fossil fuel supply total	322	263	-59	156	124	-32
Coal	20	12	-8	13	8	-5
Oil	154	125	-29	85	69	-16
Natural Gas	148	126	-22	58	47	-11
Power supply total	439	432	-7	251	245	-6
Coal-fired generation	75	24	-51	40	13	-27
Oil-fired plants	2	1.5	-1	1	1	0
Gas-fired plants	39	36	-3	17	13	-4
Nuclear	15	40	25	3	14	11
Hydro	37	59	22	28	46	18
Renewable	41	79	38	12	30	18
CCS Facility coal fired plants	–	40	40	0	21	21
CCS Facility gas fired plants	–	23	23	0	6	6
Transmission and distribution	231	130	-101	149	101	-48

Abbreviations: CCS = carbon dioxide capture and storage

Figure IV-11. **Investment in energy supply needed under the reference and mitigation scenarios, 2005 – 2030**



Abbreviations: CCS = carbon dioxide capture and storage; PG = power generation; MS = mitigation scenario; RS = reference scenario; T&D = transmission and distribution.

165. Changing the mix of technologies in the power sector as projected under the mitigation scenario poses some challenges. Specifically:

- Electric utilities will continue to add fossil-fired plants rather than switch to renewables, nuclear energy and large hydropower unless these options are less costly and their environmental, social and safety concerns are addressed;
- Electric utilities may resist adoption of CCS for fossil-fired plants because of the cost, newness of the technology, legal uncertainties and for other reasons;
- Rapid growth of renewables may be constrained by their relatively high cost, supply bottlenecks, locational constraints and grid management considerations;
- Private investors financing renewable energy projects seek supportive government policies, financial incentives, such as feed-in tariffs and renewable energy credits, and secure markets for the power generated.

166. These are challenges for Parties included in Annex I to the Convention (Annex I Parties) and non-Annex I Parties, since over a half of the projected investment is expected to occur in non-Annex I Parties. Non-Annex I Parties may need financial incentives or assistance with national policies to address these challenges.

CHANGE IN INVESTMENT AND FINANCIAL FLOWS NEEDED IN CARBON DIOXIDE CAPTURE AND STORAGE

167. CCS for power plants, and to a lesser extent for industry, is a significant contributor to the emission reductions achieved under the mitigation scenario. The investment in CCS in 2030 is over USD 75 billion, of which over 80 per cent is for power plants. There is no CCS under the reference scenario.

168. Before large-scale implementation of CCS can occur, technology development is still required, mainly related to CO_2 capture. Though no real technical barriers have yet been identified, it is envisaged that at least two generations of pilot and demonstration plants are required, which could take up to two decades. As demonstration plants often need to operate for a considerable time before large-scale deployment, this will affect the timing of full-scale commercial implementation. A detailed analysis was undertaken by Hendriks (2007).

169. Only a few quantitative estimates of CO_2 storage potential in different regions have been made. These estimates should be treated with care as methodologies for estimating storage capacity are still under development and reliable geological data are lacking, especially for aquifers and coal seams. Storage capacity is also affected by the safety considerations. As safety requirements are still under discussion, capacity estimates are uncertain.

Box IV-1. Summary of investment and financial flows in energy supply and infrastructure

Investment and financial flows needed in 2030

Global investment in energy supply infrastructure under the mitigation scenario is projected to be USD 695 billion in 2030, USD 67 billion (9 per cent) less than under the reference scenario. Power supply requires more than USD 432 billion of investment under the mitigation scenario, USD 7 billion (1.6 per cent) less than the reference scenario. Universal electricity access by 2030 would require an additional annual investment of USD 25 billion. Capital expenditure in fossil fuel supply would require USD 263 billion under the mitigation scenario, 59 billion (18 per cent) less than the reference scenario. More than half of all the energy investment needed worldwide is in developing countries due to their rapid economic growth.

Current investment and financial flows

In all regions, the majority of the investment is domestic, but foreign equity and debt are important in developed countries and ODA is important in LDCs. The sources of financing vary, with mostly private financing in the United States and the United Kingdom, and government funding in much of Europe, transition economies and most developing countries. Much developing country financing, other than in developing Asia, comes through a combination of ODA and loans from the World Bank and regional development banks. Most of the investment in renewable energy and energy efficiency occurs in OECD countries; ODA funding for renewable energy is less than 4 per cent of the total ODA flows. LDCs, such as in sub-Saharan Africa, and smaller developing countries, still attract limited private sector investment and continue to rely on ODA and soft loans from IFIs such as the World Bank.

170. Legal implications and public attitudes are important with respect to CCS as well. Work on resolving the associated legal and regulatory issues may not be proceeding quickly enough for large-scale implementation by 2030, and for implementation of larger-scale demonstration facilities in particular. The public is still quite unaware of CCS as an option.

171. Long-term liability issues of CCS also require resolution. The legal responsibility of entities operating CCS reservoirs must be clearly defined if they are to be able to attract the required investment. The expectation is that the CO_2 will remain in the CCS reservoir for thousands of years but the entity operating a CCS reservoir cannot be held responsible for such long periods of time, and its responsibility must be transferred to the government at some reasonable time after the reservoir is sealed.

Box IV-2. Summary of investment and financial flows in carbon dioxide capture and storage

CCS for power plants, and to a lesser extent for industry, is a significant contributor to the emission reductions achieved under the mitigation scenario. The investment in CCS in 2030 under the mitigation scenario is over USD 75 billion, of which over 80 per cent is for power plants. Technology development, legal implications, public attitudes and long-term liability of CCS are the critical factors for large-scale implementation of CCS.

4.4.1.5. ASSESSMENT OF THE CHANGES NEEDED IN INVESTMENT, FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP UNDER THE MITIGATION SCENARIO

172. The major reductions in emission achieved under the mitigation scenario rely on increased energy efficiency, shifts being made in the energy supply from fossil fuels to renewables, nuclear energy and hydropower and large-scale deployment of CCS (even though there are only a few CCS demonstration projects at the present time). Much of the shift will need to occur in developing countries where energy demand is projected to grow most rapidly.

173. Most of the investment in fossil fuel production, processing and transportation is made by large corporations, either government-owned or private. The mitigation scenario means they need to invest less.

174. Historically, nuclear power and large hydropower plants have been financed by the utilities that also build fossil-fired generation and transmission systems. These utilities would probably be expected to finance the cost of CCS at coal and gas plants under the mitigation scenario. The value of the added investment needed for nuclear energy, large hydropower and CCS is lower than the value of reduced investment in fossil-fired generation. Thus the financing challenge faced by electric utilities is less severe under the mitigation scenario than under the reference scenario, although some private utilities may be reluctant to invest in nuclear plants.

175. Renewable energy projects are presently financed largely by private investors. If this trend continues to, the scale of investment projected will require supportive government policies, financial incentives, such as feed-in tariffs and renewable energy credits, and secure markets for the power generated. It also will be necessary to ensure that the investment flows to the countries and regions that need it most. Africa probably faces the greatest challenge, needing to attract capacity investment of nearly USD 3 billion a year from a base of almost nothing.

4.4.2. INDUSTRY

4.4.2.1. INTRODUCTION

176. Globally, the industry sector[19] is responsible for nearly 27 per cent of world energy consumption, 19 per cent of energy-related CO_2 emissions and 7 per cent of non-CO_2 emissions (US EPA, 2006a). Energy and GHG intensity[20] varies greatly among the different industrial sectors and too therefore does the potential absolute emission reductions. This chapter focuses on the more intense sectors because even a small change in their energy or GHG intensity can significantly alter emissions levels (Nyboer, 2007). That is not to say other manufacturing sectors are not important; growth may be rapid and contributions to emissions significant. The following industrial sectors are covered in this chapter:

- Pulp and paper;
- Cement, lime, and other non-metallic minerals;
- Nonferrous metal smelting and iron and steel smelting;
- Metal and non-metal mining;
- Chemical products;
- Other manufacturing.

177. For energy-related CO_2 emissions, this chapter adopts the same reference and mitigation scenario as the energy supply sector – the IEA's WEO 2006 reference and the BAPS respectively. Non-CO_2 emissions are based on reference projections by the US EPA. The mitigation scenario includes cost-effective emission reductions estimated using marginal abatement cost curves developed by the US EPA. Industrial process CO_2 emissions are assumed to continue to increase under the reference scenario and to diminish under the mitigation scenario based on the WBCSD cement industry report (WBCSD, 2002).

4.4.2.2. ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS

RECENT TRENDS IN ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS

178. In 2000, the industry sector consumed 1,758 Mtoe energy, of which 50 per cent was consumed by OECD countries and 41 per cent by developing countries (see TABLE IV-12).

Table IV-12. **Industrial sector fuel consumption and CO_2 eq emissions in 2000**

	Fuel Consumption (Mtoe)				Emissions (Mt CO_2 eq)			
Country/region	Fossil Fuels	Electricity	Non-Fossil Fuels	Total	Combustion	Non-CO_2	Industrial process CO_2 emission	Total
World	1,139	457	161	1,757	4,366	2,446	826	7,638
OECD	538	277	67	883	1,951	1,080	266	3,296
OECD North America	242	124	45	411	822	628	66	516
OECD Pacific	100	54	5	159	413	127	70	610
OECD Europe	196	100	17	313	715	325	130	1,169.8
Transition Economies	106	41	2	149	414	497	40	951
Developing Countries	494	139	92	725	2,002	870	520	3,391
Developing Asia	332	94	36	462	1,426	527	403	2,355
Latin America	61	24	34	119	219	107	45	372
Africa	31	15	22	68	136	129	36	301
Middle East	70	6	0.2	77	221	106	36	363

Abbreviations: OECD = Organisation for Economic Co-operation and Development.

179. The OECD is responsible for 44 per cent of combustion and non-CO_2 emissions, and developing countries for 29 per cent, with the United States and China both responsible for approximately 17 per cent of global industrial emissions. Fossil fuels account for the majority of energy consumption (65 per cent) and electricity consumption makes up 26 per cent[21]. OECD countries consume 50 per cent of total fuel, slightly more than its share of emissions, while developing countries consume 26 per cent, slightly less than their share of emissions. The United States is responsible for 19 per cent of global fuel consumption, and China is the second largest consumer (15 per cent).

ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS UNDER THE REFERENCE SCENARIO

180. TABLE IV-13 provides an overview of industrial energy consumption and GHGs under the reference scenario. Fuel consumption rises steadily in every region, but particularly in developing countries, where fuel consumption doubles between 2005 and 2030. This growth is driven by rising population levels and continued economic growth in China and other non-industrialized countries (WBCSD, 2006).

[19] Petroleum refining is covered in energy supply.

[20] Emissions per unit of output.

[21] Emissions associated with electricity generation are included in the energy supply sector.

Table IV-13. **Fuel consumption and GHG emissions in 2030 under the reference scenario in the industrial sector**

	Fuel Consumption (Mtoe)				Emissions (Mt CO_2 eq)			
Country/region	Fossil Fuels	Electricity	Non-Fossil Fuels	Total	Combustion	Non-CO_2	Industrial process CO_2 emission	Total
World	2,597	940	395	3,932	8,075	4,691	1871	14,637
OECD	903	351	139	1,393	2,593	1,935	248	4,777
OECD North America	410	140	70	620	1,145	1,212	62	2,419
United States	319	97	57	472	899	799	56	1,754
Canada	56	23	12	91	152	92	6	250
Mexico	35	21	1	56	94	321	–	415
OECD Pacific	189	75	20	283	588	298	49	936
Japan	100	37	8	145	320	97	32	449
Korea	67	26	6	100	208	122	14	345
Australia and New Zealand	22	12	6	39	60	79	3	142
OECD Europe	305	136	50	490	859	426	137	1,422
Transition Economies	212	72	53	337	594	695	80	1,369
Russia	104	43	41	189	280	307	–	587
Other EIT	107	29	12	148	314	388	–	702
Developing Countries	1,483	517	203	2,202	4,888	2,060	1,542	8,491
Developing Asia	1,042	393	116	1,551	3,685	1,150	1,034	5,868
China	657	282	63	1,002	2,471	710	587	3,768
India	155	46	30	231	516	226	211	953
Indonesia	53	9	3	64	155	62	0	217
Other Developing Asia	177	57	21	254	544	151	236	930
Latin America	133	67	53	253	375	279	170	825
Brazil	56	26	43	125	169	71	–	240
Other Latin America	77	41	11	128	206	208	–	415
Africa	63	33	34	130	188	294	239	721
Middle East	244	23	0	268	640	338	98	1,076

Abbreviations: EIT = Economies in transition, OECD = Organisation for Economic Co-operation and Development.

181. The reference scenario includes significant energy efficiency improvements and emission reduction technologies. Energy efficiency increases at 1.5 per cent annually (Vattenfall, 2007c) reducing energy intensity in developing and transition economies to close to current OECD levels by 2030 (IEA, 2006). The major emission reduction measures expected to be adopted under the reference scenario include:

- A shift of Chinese cement production to the pre-heater/precalciner technology;
- Complete switching from the basic oxygen furnace to the electric arc furnace in the steel industry by 2030;
- Commitments by the global aluminium, semiconductor, and magnesium industries o substantially reduce emissions of high global warming potential (GWP) gases.

182. As fuel consumption increases, so do combustion-related emissions. Overall emissions grow moderately in the OECD and transition economies, but grow rapidly in developing countries. Although emissions of some non-CO_2 gases decline, emissions of others grow significantly, leading to an overall increase.

ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS UNDER THE MITIGATION SCENARIO

183. Table IV-14 provides an overview of industrial energy consumption and GHG emissions under the mitigation scenario. Fuel consumption rises slowly in the OECD and transition economies, but by over 60 per cent from 2005 to 2030 in developing countries. Total emissions rise continuously in each region, but global combustion emissions fall after 2020. Reductions in emissions of some non-CO_2 gases are more than offset by increases in the emissions of others. CCS facilities are used to reduce emissions by 0.5 Gt CO_2.

184. Compared with the reference scenario, fossil fuel and electricity demand under the mitigation scenario decline by 17 and 15 per cent respectively, while non-fossil fuel energy consumption rises by 5 per cent. Almost all of the growth in non-fossil fuel use comes from biomass and waste consumption, particularly in Asia, where combined heat and power projects using biomass displace some gas and coal (IEA, 2006). Significant contributors to the reduction in fossil fuel demand are a substitution of natural gas for coal in China and a decline in oil demand in developing countries due to fuel switching and improvements in process heat and boiler efficiencies.

185. Electricity consumption in OECD countries falls by 25 per cent, with motor system efficiency improvements being a prime contributor to the reduction. More than half of global industrial energy savings result from increased efficiency in the iron and steel, chemicals, and non-metallic minerals industries (IEA, 2006).

Table IV-14. **Fuel consumption and GHG emissions in 2030 under the mitigation scenario for the industrial sector**

	Fuel Consumption (Mtoe)				Emissions (Mt CO_2 eq)			
Country/region	Fossil Fuels	Electricity	Non-Fossil Fuels	Total	Combustion	Non-CO_2	Industrial process CO_2 emission	Total
World	2,167	795	415	3,377	6,076	2,931	1,656	10,663
OECD	788	299	138	1,225	2,095	1,334	221	3,651
OECD North America	354	121	66	541	940	870	49	1,858
United States	276	83	54	413	734	590	44	1,368
Canada	47	20	12	79	125	72	5	202
Mexico	31	18	1	50	81	208	–	289
OECD Pacific	167	67	23	257	458	189	47	693
Japan	89	32	9	130	242	74	31	348
Korea	60	24	6	90	171	75	12	259
Australia and New Zealand	19	11	7	36	45	39	3	87
OECD Europe	266	111	50	427	697	276	126	1,099
Transition Economies	173	62	49	284	445	438	77	961
Russia	87	39	38	164	222	197	–	419
Other EIT	86	24	10	120	224	241	–	465
Developing Countries	1,206	433	228	1,868	3,536	1,158	1,358	6,052
Developing Asia	836	328	140	1,304	2,544	537	886	3,966
China	524	234	73	831	1,646	292	509	2,447
India	122	40	33	195	366	115	177	659
Indonesia	45	8	4	57	121	36	–	157
Other Developing Asia	145	47	30	222	410	93	200	704
Latin America	110	55	50	216	300	191	162	653
Brazil	47	21	40	107	133	48	–	181
Other Latin America	63	34	11	108	167	143	–	310
Africa	54	29	38	120	149	190	220	559
Middle East	207	21	0	228	543	241	90	874

Abbreviations: EIT = Economies in transition, OECD = Organisation for Economic Co-operation and Development.

4.4.2.3. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS BY SOURCE OF FINANCING

186. As TABLE IV-15 shows, most investment in the industry sector (72 per cent globally) comes from domestic sources. This is particularly so in developing and transition economies; in OECD Europe and OECD North America, only 63 per cent and 53 per cent respectively of industrial investment is domestic. FDI provides 22 per cent of the global total, but more in OECD Europe (25 per cent of total) and OECD North America (37 per cent). Debt plays a small role, and is concentrated in developed countries, while ODA barely registers as a source of industrial investment.

4.4.2.4. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

INVESTMENT AND FINANCIAL FLOWS NEEDED UNDER THE REFERENCE SCENARIO

187. As summarized in TABLE IV-16, investment in the industry sector increases under the reference scenario along with the pace of economic growth. Significant investment occurs in non-Annex I Parties, accounting for 52 per cent of the global total, 6 per cent more than OECD countries. As is currently the case, a large majority of the investment is expected to come from domestic sources.

188. The additional investment needed in 2030 for further energy efficiency improvement, CCS and destruction of non-CO_2 emissions from industrial processes to meet the mitigation scenario is shown in TABLE IV-17. Of the USD 35.7 billion total, USD 19.5 billion is needed for energy efficiency improvement. Installation of CCS infrastructure accounts for around USD 14 billion; the investment for reducing of N_2O and high GWP GHGs is only USD 0.013 billion.

Table IV-15. **Investment flows in the manufacturing sector in 2000, by source and region (percentage)**

	Total Investment	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	ODA Bilateral total	ODA Multilateral total	Total	Total Investment USD billion
Africa	1.2	89.18	6.36	3.34	1.07	0.05	100	16
Developing Asia	18.66	81.35	18.02	0.56	0.07	0	100	243
Latin America	4.56	80.46	15.53	3.84	0.13	0.04	100	59
Middle East	1.07	75.24	24.75	0	0.01	0	100	14
OECD Europe	24.04	62.92	25.35	11.73	0	0	100	313
OECD North America	31.15	55.01	36.57	8.42	0	0	100	405
OECD Pacific	18	99.25	0.05	0.7	0	0	100	234
Other Europe	0.02	-175.61	0	275.61	0	0	100	0
Transition economies	1.29	85.8	14.03	0.05	0.12	0	100	17
Global Total	**100**	**71.93**	**22.09**	**5.95**	**0.03**	**0**	**100**	**1,301**
NAI Parties	34.03	84.14	15.29	0.46	0.09	0.01	100	443
Least Developed Countries	0.33	75.45	11.61	12.27	0.67	0	100	4

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

Table IV-16. **Investment flows in the industrial sector by region and time period (billions of United States dollars)**

Region	2002	2005	2010	2015	2020	2025	2030
Africa	25	20	28	36	45	56	71
Developing Asia	276	443	668	874	1,066	1,238	1,406
Latin America	88	34	44	53	61	69	79
Middle East	45	14	36	42	55	74	100
OECD Europe	313	243	291	369	417	452	431
OECD North America	323	372	426	481	543	586	628
OECD Pacific	160	251	258	342	363	387	411
Transition Economies	38	21	28	35	41	47	54
World	1,268	1,397	1,779	2,232	2,592	2,911	3,179

Source: OECD ENV-Linkage Model.
Abbreviations: OECD = Organisation for Economic Co-operation and Development.

Table IV-17. **Additional investment flows needed under the mitigation scenario in 2030 in the industrial sector (millions of United States dollars)**

Country/region	Energy-related investment	CH_4 reduction	N_2O reduction	High GWP GHG reduction	CCS	Total
World	19,500	2,028	9	4	14,125	35,665
OECD	11,500	487	5	2	2,052	14,047
OECD North America	5,115	316	2	1	626	6,059
United States	3,899	125	2	1	561	4,587
Canada	750	23	0	0	49	823
Mexico	465	168	0	0	16	649
OECD Pacific	2,340	70	0	1	798	3,209
Japan	1,194	2	0	0	550	1,747
Korea	822	8	0	0	177	1,008
Australia and New Zealand	324	59	0	0	70	453
OECD Europe	4,045	102	3	0	629	4,779
Transition economies	1,061	369	0	0	804	2,234
Russia	596	157	0	0	260	1,013
Other EIT	465	212	0	0	544	1,222
Developing Countries	6,939	1,171	3	2	11,269	19,384
Developing Asia	4,887	691	2	1	10,691	16,273
China	3,157	421	2	1	8,621	12,202
India	727	154	0	0	982	1,863
Indonesia	202	41	0	0	214	457
Other Developing Asia	802	75	0	0	875	1,751
Latin America	798	125	1	0	278	1,202
Brazil	393	21	0	0	199	614
Other Latin America	405	104	0	0	80	588
Africa	410	217	0	0	275	902
Middle East	844	139	0	0	24	1,008

Abbreviations: CCS = carbon dioxide capture and storage, EIT = Economies in transition, GHG = Greenhouse gas, GWP = Global warming potential, OECD = Organisation for Economic Co-operation and Development, CH_4 = methane, N_2O = nitrous oxide.

Box IV-3. **Summary of investment and financial flows for industry**

Investment and financial flows needed in 2030

The additional global investment needed under the mitigation scenario is approximately USD 35.7 billion, of which more than half accounts for energy efficiency improvement. Installation of CCS infrastructure accounts for around USD 14 billion. Approximately 54 per cent of the additional investment will be needed in developing countries, 39 per cent in OECD countries and the rest by transition economies.

Current investment and financial flows

Most investment mostly comes from domestic sources (more than 75 per cent). This is particularly so in developing countries and transition economies; in OECD countries, only approximately 50 – 60 per cent of industrial investment is domestic. FDI provides 22 per cent of the global total, but again is heavily weighted towards OECD countries (25 – 27 per cent). Debt plays a small role and is concentrated in developed countries, while ODA hardly registers as a source of industrial investment.

4.4.2.5. ASSESSMENT OF THE CHANGES NEEDED IN INVESTMENT, FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP UNDER THE MITIGATION SCENARIO

189. In industry, investment in energy efficiency and emission reduction measures is generally self-financed, although external financial incentives are sometimes available. The energy efficiency measures assumed have very short payback periods (less than four years).

190. Achieving the projected emission reductions in the industrial sector will require:

- Aggressive policies to increase energy efficiency and emissions reductions. Such policies could include mandatory energy efficiency standards, emissions regulations, emissions trading systems for industrial sources, and, in non-Annex I Parties, clean development mechanism (CDM) projects;
- Regulations and/or incentives to adopt CCS. The technological challenges, legal aspects, costs and other issues will also need to be addressed.

191. These are challenges for both Annex I and non-Annex I Parties, since almost half of the projected investment is expected to occur in non-Annex I Parties. Non-Annex I Parties may need to financial incentives or assistance with national policies to address these challenges.

192. The feasibility of reducing industrial emissions levels to those under the mitigation scenario is high, as emissions are easy to track, most GHG emitters are large and economically rational, abatement measures do not usually have an impact on consumers' lifestyles, and non-CO_2 gases are limited and easily identifiable (Vattenfall, 2007a). Additionally, most financing for industrial efficiency improvements is internal. However, the majority of the mitigation opportunities exist in China and other developing countries, where the initial financial investment and knowledge and availability of advanced technologies are often lacking. As a result, additional mechanisms will be needed to stimulate industrial investment to reduce emissions in these countries.

193. Internationally, the key regulatory mechanism required is to ensure that CO_2 abatement opportunities are pursued in the industrial sector is a stable financial incentive to invest in low GHG emitting technology, such as a CO_2 price. A global CO_2 price would be best, as regional differences could cause distortions. Financial incentives to reduce the capital cost of more efficient equipment and to provide incentives for small-scale CCS technologies would also be useful (Vattenfall, 2007a; IEA, 2006). To reduce non-CO_2 industrial emissions, a cap and trade system or performance standards are likely to be more efficient than technology standards, as they would spur innovation and stimulate the large number of diverse measures needed for abatement (Vattenfall, 2007a). Clear international incentives will be needed to ensure that China and non-industrialized countries achieve their abatement potential (Vattenfall, 2007a).

194. In developing countries specifically, international collaboration and technology transfer are extremely important for driving higher energy efficiency. Small-scale local industrial operations often use outdated processes and low quality fuel and feedstock, and suffer from weaknesses in transport infrastructure (IEA, 2006). As a result, there is a significant potential for energy efficiency improvement, but specific policies tailored to the industry and location are required (IEA, 2006). All of these activities should be strongly supported by IFIs, development assistance programmes and international carbon markets through the CDM (IEA, 2006).

4.4.3. TRANSPORTATION

4.4.3.1. INTRODUCTION

195. Motorization of transport and rates of automobile ownership are increasing rapidly in developing countries experiencing strong economic growth. Vehicle travel continues to grow steadily in developed and developing economies, and economic globalization is driving increases in international shipping and air transport. Investments made over the next two decades in transport equipment and infrastructure, energy efficient technologies, biofuels and R&D and demonstration will have a major influence on the level of GHG emissions from the transportation sector in 2030, and beyond.

196. Transport, as defined in this paper, includes passenger and freight movements by road vehicles, railways, aircraft, and both inland and maritime vessels. For aircraft and marine transport, both domestic and international energy use and emissions are included.

4.4.3.2. ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS

RECENT TRENDS IN ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS

197. In 2004, transport consumed 1,969 Mtoe of energy, a quarter of the world's final energy consumption. Petroleum dominates energy use by transport, accounting for 94 per cent of total energy consumption in the transport sector and 58 per cent of the world's oil consumption. Biofuels accounted for only 15 Mtoe (0.8 per cent), and all other energy sources (mostly electricity and natural gas) accounted for 93 Mtoe (4.7 per cent) (IEA, 2006).

198. Transport emitted about 14 per cent of global GHGs, 5.8 Gt CO_2 eq in 2004 nearly all of which was CO_2 (Vattenfall, 2007b). It accounts for one fifth of energy-related CO_2 emissions (IEA, 2006).[22] Although the IPCC AR4 WG III indicates that non-CO_2 emissions account for 4 – 12 per cent of total GHG emissions in the transport this analysis focuses on transport's energy-related CO_2 emissions.[23]

199. Road transport, including passenger and freight, is responsible for almost three quarters (73 per cent) of the sector's energy use and CO_2 emissions, followed by air transport (12 per cent), marine transport (10 per cent), rail (4 per cent) and all other modes (1 per cent) (Vattenfall, 2007b). The volume of road transport and its mode distribution varies widely across regions. In 2000, North America and Western Europe had 50 per cent higher miles per vehicle of road travel than the rest of the world combined. This situation is changing rapidly as vehicle ownership increases in developing and transitional economies. Two and three-wheel motor vehicles account for significant share of road traffic in Eastern Europe, Latin America, Japan and South and Southeast Asia. Light trucks account for a large share of road traffic in the America.

ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS UNDER THE REFERENCE SCENARIO

200. Under the reference scenario total energy consumption in the transport sector is projected to be 3,111 Mtoe in 2030. Petroleum remains the dominant source of energy for transportation. Biofuel use increases from 15 to 92 Mtoe, but this still represents only 3 per cent of world transport energy use in 2030. Other energy sources, including electricity and natural gas actually decrease in relative importance. Transport CO_2 emissions increase from just over 5.5 Gt CO_2 in 2005 to 8.7 Gt CO_2 in 2030. Emissions increase in all regions but by far the greatest increases occur in the developing economies.

ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS UNDER THE MITIGATION SCENARIO

201. The mitigation scenario relies on increased use of hybrid electric vehicles and bio-fuels, and further vehicle efficiency improvements. The market share for hybrid vehicles rises from 18 per cent under the reference scenario to 60 per cent under the mitigation scenario, along with a doubling of biofuel use and further improvement on efficiency of internal combustion engine. As a result, the energy consumption in transport sector drops by 447 Mtoe to 2,664 Mtoe in 2030.

202. Although petroleum remains the dominant source of energy for transportation, its share drops to 83 per cent under the mitigation scenario. Biofuel use in transport increases greatly in OECD countries from 9 Mtoe in 2005 to 169 Mtoe in 2030. In developing countries and transition economies, biofuel use grows from 6 to 125 Mtoe. While most of the growth occurs in Brazil, there are also significant increases in India, Indonesia, China, and other developing Asia countries.

[22] As might be expected with such estimates, there are some differences in the data characterizing the transportation sector. To maintain consistency throughout the full document, the IEA estimates have been adopted.

[23] Although various studies give some consideration to N_2O and F-gases from mobile air conditioning, non-CO_2 emissions from transport, especially those from aircraft, are relatively less well understood and could be of increasing concern (IPCC, 2007c, chapter 5, box 5.1).

203. Transport CO_2 emissions increase from their current level, driven by the growth of motorized transport in developing economies, but the 2030 total is 2 Gt lower than it would be under the reference scenario. Most of the reductions are achieved in developing countries, where transport is growing fastest, and in OECD North America, which has the largest stock of vehicles.

4.4.3.3. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS BY SOURCE OF FINANCING

204. TABLE IV-18 provides an estimated total global investment in transport in 2000 to be USD 889 billion, of which 66 per cent was domestic finance, 17 per cent was FDI and 17 per cent was international debt finance. In the five largest developing countries (China, India, Mexico, South Africa and Brazil) domestic finance accounted for more than 90 per cent of transport investment, FDI for approximately 8 per cent and international debt and ODA for less than 1 per cent.

205. In 2000, most of ODA for the transport sector (USD 8.2 billion) went to developing Asia, Latin America and Africa. In Africa excluding South Africa, the ODA amounted to 10 per cent of total transport investment in 2000. Developing Asia received 65 per cent of the total transport ODA. Total transport ODA is approximately half bilateral and half multilateral. The USD 8.2 billion total represented 4 per cent of the USD 211 billion of investment made in developing economies during 2000.

206. A number of projects of the GEF have addressed energy efficiency or alternative fuels in the transport sector. In 2006, a total of 16 energy efficiency projects in the transportation sector had been funded and six more were in the pipeline, with a total funding of USD 147 million. Over the same period, six alternative fuels projects were funded or in the pipeline, with a total funding level of USD 27 million (GEF Secretariat, 2007).

4.4.3.4. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

INVESTMENT AND FINANCIAL FLOWS NEEDED UNDER THE REFERENCE SCENARIO

207. An estimate for total transport sector investment under the reference scenario was obtained from the OECD ENV-Linkages model. The global investment

Table IV-18. **Investment flows in the transportation, storage and communications sector in 2000, by source and region (percentage)**

	Total Investment	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	ODA Bilateral total	ODA Multilateral total	Total	Total Investment USD billion
Africa	1.66	85.87	3.89	3.71	3.26	3.27	100.0	15
Developing Asia	15.06	90.10	2.43	3.43	2.06	1.98	100.0	134
Latin America	6.05	51.24	40.71	6.13	1.63	0.29	100.0	54
Middle East	2.57	98.59	0.50	0.57	0.18	0.16	100.0	23
OECD Europe	25.96	0.00	48.25	51.73	0.02	0.00	100.0	231
OECD North America	29.04	89.64	3.49	6.77	0.00	0.10	100.0	258
OECD Pacific	17.84	97.23	0.47	2.30	0.00	0.00	100.0	159
Other Europe	0.03	-140.42*	0.00	240.42	0.00	0.00	100.0	0
Transition economies	1.79	87.16	11.25	0.00	1.30	0.28	100.0	16
Global Total	**100.00**	**65.53**	**16.73**	**16.83**	**0.50**	**0.41**	**100.0**	**889**
AI Parties	70.94	77.53	0.26	22.20	0.01	0.01	100.0	630
NAI Parties	27.95	86.43	8.85	1.54	1.74	1.44	100.0	248
Least Developed Countries	0.54	68.21	9.10	0.00	11.90	10.80	100.0	5

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

estimated by the OECD for 2002 (USD 1.14 trillion) shown in TABLE IV-19 is approximately 28 per cent greater than the USD 0.89 trillion for 2000 reported in TABLE IV-18. In part this can be attributed to differences in the definitions of transport, but it must be chiefly attributed to different data sources and estimation methods. The vast majority of investment is for "trade & transport", a category that includes infrastructure investments as well as all other transport equipment not considered road vehicles.

208. Under the reference scenario, global investment in motor vehicles would increase from USD 91 billion in 2005 to USD 209 billion in 2030, reflecting the expected growth in world motor vehicle supply and demand. The largest increases are expected in China, Japan, and East Asia; in Europe and North America the rates increase more slowly but the investment is still substantial. Gross investment in transport and trade grows from USD 1.5 trillion to USD 4 trillion over the same period. The greatest increases come in China and India, but there are substantial requirements for increased investment throughout the world.

INVESTMENT AND FINANCIAL FLOWS NEEDED UNDER THE MITIGATION SCENARIO

209. The total additional investment in transport in 2030 under the mitigation scenario is estimated USD 88 billion, of which USD 9.2 billion is for bio-fuel production and the balance mainly for more costly hybrid electric vehicles (see TABLE IV-20).

Table IV-19. **Projected transport-related investments under the reference scenario (billions of United States dollars)**

	2002	2005	2010	2020	2030
Motor vehicles	69	91	113	162	209
Petroleum and coal products	23	17	19	21	24
Trade and transport services	1,138	1,509	2,005	2,955	4,034
Total	1,230	1,617	2,137	3,138	4,267

Source: OECD ENV-Linkage Model.

Table IV-20. **Estimated share of additional investment in the transportation sector under the mitigation scenario in 2030, by region (billions of United States dollars)**

Country/region	Energy efficiency and vehicle	Biofuel
World	78.7	9.2
OECD	**41.9**	**5.2**
OECD North America	25.3	2.4
United States	21.1	2.3
Canada	1.8	0.1
Mexico	2.4	0.0
OECD Pacific	5.2	0.1
Japan	2.5	0.0
Korea	1.5	0.0
Australia and New Zealand	1.2	0.0
OECD Europe	11.3	2.7
Transition Economies	**5.3**	**0.0**
Russia	3.6	0.0
Other EIT	1.7	0.0
Developing Countries	**31.5**	**4.0**
Developing Asia	18.9	1.6
China	10.6	0.8
India	2.0	0.2
Indonesia	1.7	0.2
Other Developing Asia	4.7	0.4
Latin America	4.6	2.0
Brazil	2.2	2.0
Other Latin America	2.5	0.0
Africa	3.6	0.3
Middle East	4.3	0.0

Abbreviations: EIT = Economies in transition, OECD = Organisation for Economic Co-operation and Development.

Box IV-4. **Summary of investment and financial flows for transport**

Investment and financial flows needed in 2030
The worldwide additional investment needed under the mitigation scenario is approximately USD 88 billion, of which USD 79 billion is for hybrid vehicles and efficiency improvements in vehicles and about USD 9 billion for biofuels. Of the total additional investment needed, developing countries and OECD countries account for approximately 40 per cent and 54 per cent respectively.

Current investment and financial flows
About two thirds of the investment is financed domestically, one sixth from FDI and one sixth is financed from international debt. In China, India, Mexico, South Africa and Brazil domestic investment provided more than 90 per cent of transport investment. In 2000, most of the ODA for the transport sector went to developing Asia, Latin America and Africa.

4.4.3.5. ASSESSMENT OF THE CHANGES NEEDED IN INVESTMENT, FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP UNDER THE MITIGATION SCENARIO

210. Nearly all additional transport investment needed under the mitigation scenario is for the purchase of motor vehicles and production of transport fuels; most of this investment will be made by the private sector. There will be no significant change to large transport infrastructure investments between the reference and mitigation scenarios, such as roads, transport systems, airports, and ports, in which governments usually invest in.

211. Increased use of bio-fuels as blends with conventional fuels will need to be driven by policies. Biofuel production and consumption are likely to be co-located, as a general rule.

212. The shift to hybrid vehicles projected under the mitigation scenario will require government policies such as vehicle efficiency standards or other policies to raise the market share of hybrid vehicles. Vehicle buyers are unlikely to voluntarily pay the added cost, about USD 1,000 per vehicle. Given the rapid growth of vehicle ownership in non-Annex I Parties, they will need to adopt such policies as well. Many developing economies will not have domestic capacity for vehicle production but will record increased spending on vehicle purchases under such policies. These countries will also require investment in physical and human capital for repairing and maintaining advanced technology vehicles.

213. International funding sources such as the GEF, ODA and the CDM have thus far had minimal impact on GHG emissions in supporting mitigation in the transport sector. It does not appear likely that the CDM will provide adequate financing for transportation mitigation in developing economies (Dave *et al.*, 2005). Transport CDM projects have been slow to get started and are too few in number to have the necessary impact. These international funding sources would have to be increased by an order of magnitude or more to contribute a meaningful share of the estimated future investment needs for transport mitigation.

214. Although ODA currently constitutes a significant source of fund for transport (USD 10 billion per year), it is directed to a wide range of transportation unconnected to GHG mitigation. By continuing and expanding on efforts to bring climate change strategies into transport sector ODA, the role of ODA in meeting the mitigation scenario for the transport sector might be significant.

215. Most of the investment in transport mitigation in developed and developing economies will, however come from the private sector.

216. Investment flows for transport mitigation will have to be increased greatly if the emission reductions of the mitigation scenario are to be met. This will require appropriate policies in both developed and developing countries. In the developed countries, the investment requirements for mitigation are not large in relation to investment in the transport sector and it seems very likely that funding will be forthcoming, especially given the savings in energy expenditures that can be achieved by more energy efficient transport. In contrast, securing mitigation investment in the developing world will be difficult.

4.4.4. BUILDINGS

4.4.4.1. INTRODUCTION

217. The buildings sector includes residential floor space and all commercial or service activities of the economy. Most fuel use and emissions in the buildings sector result from the combustion of fossil fuels for space and water heating. Much of the increased energy demand in this sector has been for electricity as a result of significant increases in the number of appliances, computers and cooling (HVAC) technologies over the last few decades (the number of appliances per European household has increased tenfold over the past 30 years).

4.4.4.2. ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS

RECENT TRENDS IN ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS

218. Globally, 2,296 Mtoe energy was consumed by the building sectors in 2004 (see TABLE IV-21). Fossil fuel consumption is the source of direct emissions from building sector, of which OECD countries are responsible for 64 per cent and developing countries for 25 per cent. In terms of CO_2 emissions, OECD countries are again the largest emitters, at 62 per cent of emissions, with developing countries producing only 27 per cent.

Table IV-21. **Fuel consumption and GHG emissions of the buildings sector in 2000**

	Fuel Consumption (Mtoe)				Emissions (Mt CO_2)
Country/region	**Fossil fuels**	**Electricity**	**Non-fossil fuels**	**Total**	**(All combustion)**
World	954	561	781	2,296	2,574
OECD	**615**	**415**	**60**	**1,089**	**1,595**
OECD North America	285	230	20	534	709
United States	241	202	12	455	597
Canada	34	23	2	58	86
Mexico	10	5	6	21	26
OECD Pacific	85	63	2	150	234
Japan	58	45	0	103	162
Korea	22	9	0.1	31	60
Australia and New Zealand	5	9	2	16	12
OECD Europe	245	122	38	405	652
Transition Economies	**105**	32	**10**	**147**	**274**
Russia	60	18	2	80	159
Other EIT	45	14	8	68	115
Developing Countries	**234**	114	**712**	**1,060**	**704**
Developing Asia	145	55	506	707	467
China	84	20	213	318	286
India	31	8	179	218	97
Indonesia	13	4	40	56	36
Other Developing Asia	18	23	75	116	49
Latin America	28	27	26	81	73
Brazil	8	14	7	29	21
Other Latin America	20	14	19	52	51
Africa	19	12	179	210	53
Middle East	42	20	0	62	111

Abbreviations: EIT = Economies in transition, OECD = Organisation for Economic Co-operation and Development.

219. The largest contributor to CO_2 emissions is space heating and ventilation (36 per cent of total), followed by lighting (16 per cent), residential appliances (15 per cent), water heating (13 per cent), commercial appliances (9 per cent), and air conditioning (8 per cent) (Vattenfall, 2007c). The commercial sector has a higher CO_2 intensity than the residential sector, due to a larger share of electricity and lower share of renewables in its fuel mix (Vattenfall, 2007c).

ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSION UNDER THE REFERENCE SCENARIO

220. TABLE IV-22 shows the projected fuel consumption and GHG emission of the buildings sector per region in 2030 under the reference scenario. Fuel consumption in the buildings sector is projected to rise by 43 per cent between 2005 and 2030 under the reference scenario. Electricity use rises by 86 per cent, propelled by a 226 per cent increase in developing countries. Energy end-use technologies are assumed to become gradually more efficient (IEA, 2006), but because the lifetime of buildings is several decades or longer, some more efficient technologies are slow to penetrate the market. The residential sector is responsible for approximately three quarters of buildings sector emissions and the commercial sector is responsible for approximately one quarter of emissions, with these proportions staying constant throughout the period (Vattenfall, 2007c).

Table IV-22. **Fuel consumption and GHG emissions of the buildings sector in 2030, under the reference scenario**

	Fuel Consumption (Mtoe)				
Country/region	**Fossil fuels**	**Electricity**	**Non-Fossil fuels**	**Total**	**Emissions (Mt CO_2)**
World	1,500	1,322	1,146	3,968	4,089
OECD	751	691	159	1,601	1,932
OECD North America	337	388	37	762	847
United States	274	337	27	637	687
Canada	46	35	3	84	112
Mexico	17	15	7	40	48
OECD Pacific	109	102	17	228	297
Japan	66	59	6	132	190
Korea	33	26	3	61	82
Australia and New Zealand	10	17	8	35	25
OECD Europe	304	202	105	611	788
Transition Economies	177	57	122	355	459
Russia	89	28	89	206	233
Other EIT	88	29	32	149	226
Developing Countries	573	574	865	2,012	1,697
Developing Asia	354	379	548	1,281	1,078
China	208	197	203	607	638
India	74.0	91	196	361	234
Indonesia	28	21	50	98	81
Other Developing Asia	44	70	100	215	126
Latin America	63	62	30	156	177
Brazil	15	23	13	51	45
Other Latin America	49	38	18	105	133
Africa	54	58	284	396	164
Middle East	101	75	3	179	278

Abbreviations: EIT = Economies in transition, OECD = Organisation for Economic Co-operation and Development.

221. The main drivers of increased buildings sectors emissions are: floor space growth (64 per cent residential growth by 2030) (driven by population and GDP growth, a growing service sector, and the continued rise of the information economy (WBCSD, 2006); increasing demand for electric appliances; and a fuel shift to electricity (such as for water heating in developing countries) (Vattenfall, 2007c and IEA, 2006).

ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSION UNDER THE MITIGATION SCENARIO

222. TABLE IV-23 shows the projected fuel consumption and GHG emission of the buildings sector per region in 2030 under the mitigation scenario. Under the mitigation scenario, electricity use drops by 22 per cent compared with the reference scenario in 2030 and fuel use is reduced by 13 per cent, which cuts emissions during 2030 by 0.5 Gt CO_2 (19 per cent). OECD countries are responsible for 40 per cent of the total emission reductions, with China contributing 20 per cent. The largest proportional decline in emissions occurs in India, where CO_2 emissions fall by 34 per cent in 2030 compared with the reference scenario.

223. The largest contributing factor in the reduction in electricity use is the use of more efficient appliances, both in OECD and non-OECD countries, with improved air conditioning efficiency (primarily in non-OECD countries), better insulation, and improved lighting efficiency (primarily in OECD countries) also significant factors (IEA, 2006).

Table IV-23. **Fuel consumption and greenhouse gas emissions of the buildings sector in 2030, under the mitigation scenario**

	Fuel Consumption (Mtoe)				
Country/region	**Fossil fuels**	**Electricity**	**Non-fossil fuels**	**Total**	**Emissions (Mt CO_2)**
World	1,302	1,034	1,045	3,380	3,535
OECD	663	555	194	1,412	1,711
OECD North America	306	319	41	665	772
United States	247	278	30	555	624
Canada	42	29	3	74	103
Mexico	16	12	7	36	45
OECD Pacific	98	83	22	202	267
Japan	60	48	8	117	173
Korea	28	20	4	52	71
Australia and New Zealand	9	14	10	33	23
OECD Europe	259	154	132	545	672
Transition Economies	150	45	113	308	390
Russia	75	21	83	179	197
Other EIT	75	23	30	129	193
Developing Countries	489	434	738	1,660	1,434
Developing Asia	294	280	454	1,028	880
China	176	148	159	482	531
India	52	73	172	298	160
Indonesia	26	16	45	87	76
Other Developing Asia	40	42	78	160	113
Latin America	56	48	31	135	158
Brazil	14	18	12	43	41
Other Latin America	43	30	19	91	117
Africa	49	47	245	342	149
Middle East	90	59	8	157	247

Abbreviations: EIT = Economies in transition, OECD = Organisation for Economic Co-operation and Development.

224. Efficiency standards allow the efficiency of equipment in non-OECD countries to approach the level of efficiency currently attained in OECD countries (IEA, 2006). Stricter building codes reduce oil and gas demand for space heating in OECD countries and solar power use doubles, primarily for water heating (IEA, 2006).

225. For the residential and the commercial sectors, the largest emission mitigation measures address heating and ventilation, including improvements to the building envelop (façade, roof and floor insulation), efficiency improvement to water heating and air conditioning. Other significant measures are improving lighting efficiency in residential buildings and improving the efficiency of other appliances and reducing standby losses (Vattenfall, 2007c).

4.4.4.3. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS BY SOURCE OF FINANCING

226. As TABLE IV-24 shows, the vast majority of commercial and residential buildings investment (97 per cent globally) are domestic, with the exception of the Middle East, where 46 per cent GFCF comes from debt. ODA to the buildings sector is virtually zero.

Table IV-24. **Investment flows in the construction sector by source and region in 2000 (percentage)**

Region	Total Investment	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	ODA Bilateral total	ODA Multilateral total	Total	Total Investment USD billion
Africa	1.80	99.72	0.28	0.00	0.00	0.00	100.0	8
Developing Asia	26.01	98.46	1.54	0.00	0.00	0.00	100.0	114
Latin America	4.14	98.76	0.97	0.28	0.00	0.00	100.0	18
Middle East	0.42	49.79	3.87	46.34	0.00	0.00	100.0	2
OECD Europe	14.36	87.43	3.25	9.32	0.00	0.00	100.0	63
OECD North America	36.94	99.09	0.17	0.74	0.00	0.00	100.0	162
OECD Pacific	15.16	97.95	0.93	1.12	0.00	0.00	100.0	66
Other Europe	0.02	100.00	0.00	0.00	0.00	0.00	100.0	0
Transition Economies	1.14	97.35	2.65	0.00	0.00	0.00	100.0	5
Global Total	100.00	96.85	1.16	1.99	0.00	0.00	100.0	438
AI Parties	51.31	95.56	1.28	3.16	0.00	0.00	100.0	225
NAI Parties	47.71	98.93	0.75	0.33	0.00	0.00	100.0	209
Least Developed Countries	0.88	98.80	1.20	0.00	0.00	0.00	100.0	4

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

4.4.4.4. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

INVESTMENT AND FINANCIAL FLOWS NEEDED UNDER THE REFERENCE SCENARIO

227. Projected investment by region during 2005 – 2030 in the residential and commercial buildings sector is shown in TABLE IV-25. Investment grows at 5 – 7 per cent per year in developing country regions, reflecting the rapid population and economic growth, urbanization and rising per capita incomes. In OECD regions, the growth rate is less than 3 per cent per year.

228. As in the current situation, almost all investment in the buildings sector is expected to come from domestic sources.

INVESTMENT AND FINANCIAL FLOWS NEEDED UNDER THE MITIGATION SCENARIO

229. As shown in TABLE IV-26, in 2030, USD 51 billion of additional investment will be needed worldwide in the buildings sector to meet the mitigation scenario emission levels, of which USD 14.1 billion (28 per cent) would be needed in non-Annex I Parties.

Table IV-25. **Investment flows in the residential and commercial sector by region and time period (billions of United States dollars)**

Region	2005	2010	2015	2020	2025	2030	Annual growth rate (per cent)
Africa	33	49	67	91	123	167	6.70
Developing Asia	432	770	1,069	1,422	1,861	2,383	7.10
Latin America	88	117	158	201	250	306	5.10
Middle East	42	88	144	200	266	343	8.80
OECD Europe	1,154	1,527	1,850	2,156	2,475	2,340	2.90
OECD North America	1,754	2,135	2,491	2,830	3,252	3,723	3.10
OECD Pacific	898	1,142	1,228	1,423	1,580	1,733	2.70
Transition Economies	38	66	91	121	156	197	6.80
World	**4,438**	**5,894**	**7,097**	**8,444**	**9,962**	**11,191**	**3.80**

Source: OECD ENV-Linkage Model.
Abbreviations: OECD = Organisation for Economic Co-operation and Development.

Table IV-26. **Additional investment needed in the buildings sector under the mitigation scenario in 2030 (billions of United States dollars)**

Country/region	Energy efficiency
World	**50.8**
OECD	**34.2**
OECD North America	16.3
United States	13.6
Canada	1.8
Mexico	0.9
OECD Pacific	4.9
Japan	2.8
Korea	1.3
Australia and New Zealand	0.8
OECD Europe	13.0
Transition Economies	**2.5**
Russia	1.4

Country/region	Energy efficiency
Other EIT	1.0
Developing Countries	**14.1**
Developing Asia	9.0
China	4.3
India	2.5
Indonesia	0.7
Other Developing Asia excluding China, India and Indonesia	1.5
Latin America	1.1
Brazil	0.4
Other Latin America	0.7
Africa	2.8
Middle East	1.3

Box IV-5. **Summary of investment and financial flows for buildings**

Investment and financial flows needed in 2030	**Current investment and financial flows**
The additional global investment needed under the mitigation scenario for energy efficiency improvement is about USD 51 billion of which approximately 28 per cent is needed in developing countries, 67 per cent in OECD countries and rest in transition economies.	The vast majority of commercial and residential buildings investment (97 per cent globally) are domestic, with the exception of theMiddle East, where 46 per cent of investment comes from international debt. ODA to the buildings sector is virtually zero.

230. Most emission reductions in the buildings sector result from increased efficiency of appliances, space and water heating and cooling systems, and lighting. There is also a fuel-shift away from fossil fuels and electricity, and towards biomass and waste. Within this sector, financing for CO_2 eq abatement projects generally comes from the private sector or from consumers themselves (IEA, 2006).

4.4.4.5. ASSESSMENT OF THE CHANGES NEEDED IN INVESTMENT, FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP UNDER THE MITIGATION SCENARIO

231. Most investment in commercial and residential energy efficiency comes from the building owner and is financed domestically. Most of the measures assumed have a very quick payback period (less than four years).

232. Aggressive policies, in particular stringent mandatory efficiency standards for appliances, equipment, and buildings, will be needed to overcome the recognized barriers to the adoption of cost-effective efficiency measures. These policies will be needed in non-Annex I Parties as well. Non-Annex I Parties may need access to financial incentives or assistance to develop and implement such policies.

4.4.5. WASTE

4.4.5.1. INTRODUCTION

233. The waste sector includes both landfills and wastewater. The major GHG emissions from landfills and wastewater treatment is methane (CH_4). Produced by anaerobic degradation of organic matter, the methane is often used to power sewage treatment processes or to co-generate electricity. N_2O is also emitted during wastewater processing. Energy-related emissions of waste are not considered in this sector, since most energy consumption is covered elsewhere. For example, much of the energy used to move waste material is probably recorded in the transportation sector as freight.

4.4.5.2. GREENHOUSE GAS EMISSIONS

RECENT TRENDS IN GREENHOUSE GAS EMISSIONS

234. Global emissions of CH_4 and N_2O from waste in 2000 were 1.18 Gt CO_2 eq and 95 Mt CO_2 eq respectively. Of the total CH_4 emissions, landfills were responsible for 58 per cent while wastewater contributed the remaining 42 per cent (US EPA, 2006b).

235. The vast majority of emissions in developing countries come from untreated wastewater in latrines and open sewers; over 80 per cent of domestic wastewater is uncollected and untreated in large portions of China/centrally planned Asia, south and east Asia and Africa, with the situation worse in rural areas. Septic tanks are the largest contributor of GHG emissions from wastewater in the United States (US EPA, 2006b).

236. Developing countries contribute 53 per cent of global CH_4 emissions, with China responsible for 14 per cent and India for 10 per cent. The United States is the largest global emitter (15 per cent) of emissions. In terms of N_2O emissions, the OECD and developing countries are equal contributors, with the United States emitting 21 per cent and China 20 per cent of the global total.

GREENHOUSE GAS EMISSIONS UNDER THE REFERENCE SCENARIO

237. Emissions in the waste sector are projected to rise by 17 per cent between 2005 and 2030 under the reference scenario. They fall by 1 per cent in OECD countries, but rise by 15 per cent in transition economies and by 30 per cent in developing countries. CH_4 emissions from landfills gradually increase under the reference scenario, driven upwards by population growth and increases in personal incomes and expanding industrialization which lead to increased waste generation, particularly in developing countries.

238. Wastewater CH_4 emissions grow much faster than landfill emissions. By 2020, the share of emissions from wastewater has grown from 42 per cent of the total to 45 per cent of the total (US EPA, 2006b). Wastewater N_2O emissions are projected to decrease in several European Union (EU) countries by 2020, but rise quickly in developing countries – particularly in Africa, where they grow by 86 per cent by 2020.

GREENHOUSE GAS EMISSIONS UNDER THE MITIGATION SCENARIO

239. The major GHG abatement opportunity undertaken in the waste sector under the mitigation scenario is capture of CH_4 from landfills and wastewater, and the use of that CH_4 for fuel or electricity production. Within the landfill

Table IV-27. **Greenhouse gas emissions under the reference and mitigation scenarios and additional investment required for the waste sector in 2030**

	Reference scenario Mt CO_2 eq			Mitigation scenario Mt CO_2 eq			
Country/region	CH_4	N_2O	Total emissions	CH_4	N_2O	Total emissions	Additional Investment USD million
World	1,420	120	1,540	707	90	797	936
OECD	**421**	**54**	**475**	**236**	**40**	**277**	**251**
OECD North America	285	25	310	163.61	19	182	163
United States	176	21	197	102	16	118	102
Canada	44	2	46	31	1	32	17
Mexico	65	2	67	31	2	32	45
OECD Pacific	44	12	55	24	9	33	27
Japan	4	10	14	1	8	9	6
Korea	18	1	19	12	1	12	9
Australia and New Zealand	22	1	23	12	1	12	12
OECD Europe	92	17	110	48	13	61	61
Transition Economies	**123**	**6**	**129**	**58**	**5**	**63**	**84**
Russia	40	3	44	19	2	22	28
Other EIT	83	3	86	39	2	41	56
Developing Countries	**876**	**60**	**936**	**413**	**45**	**458**	**600**
Developing Asia	542	40	582	256	30	286	358
China	194	22	216	91	17	108	138
India	174	3	177	82	3	84	118
Indonesia	44	3	47	21	3	23	31
Other Developing Asia	130	11	142	61	9	70	71
Latin America	125	8	133	59	6	65	88
Brazil	53	5	58	25	4	29	37
Other Latin America	72	3	75	34	3	36	51
Africa	112	7	119	53	5	58	86
Middle East	97	5	14	46	4	7	67

Abbreviations: EIT = Economies in transition, OECD = Organisation for Economic Co-operation and Development.

sector, CH_4 emissions can also be reduced at the source by reducing the amount of degradable material that enters landfills through reduced initial waste production, and through recycling and composting. Wastewater emissions can be reduced by advanced treatment technologies that use aerobic rather than anaerobic digestion and by filtering out degradable waste.

240. The emission reductions estimated for the mitigation scenario are those that can be achieved at a marginal abatement cost of up to USD 30 per t CO_2 eq using cost curves from the US EPA (US EPA, 2006b). This value was selected because the marginal abatement cost curves rise sharply beyond this point. Thus this value captures virtually all of the potential emission reductions.

241. Waste sector emissions are reduced by almost 50 per cent from the reference scenario level and developing country emissions decline by 30 per cent from current levels rather than increasing at all. Most (approximately 65 per cent) of the abatement opportunities are in developing countries, coincident with the emissions.

4.4.5.3. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

242. Data on current investment flows for the waste sector are not available. Projected investment in this sector under the reference scenario is also not available.

243. The additional investment needed under the mitigation scenario is calculated using the capital cost from the US EPA marginal abatement cost curves used to estimate the potential emission reductions. The additional investment needed globally is almost USD 1 billion in 2030 and shown in TABLE IV-27. Most of the additional investment occurs in developing countries, coincident with the distribution of waste emissions and reduction opportunities.

Box IV-6. Summary of investment and financial flows for waste

The global additional investment needed to reduce CH_4 and N_2O emissions in the waste sector is approximately USD 1.0 billion in 2030. About two third of emission reductions and investment occur in developing countries, a quarter in OECD countries and the balance in transition economies.

4.4.5.4. ASSESSMENT OF THE CHANGES NEEDED IN INVESTMENT, FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP UNDER THE MITIGATION SCENARIO

244. Many developed countries are already taking measures to reduce CH_4 emissions from landfills and wastewater treatment, generally because of environmental and public health concerns other than climate change.

245. In many developed countries, actions that reduce methane emissions from landfills and wastewater treatment are likely to be undertaken for environmental and public health concerns. However, most of the abatement opportunities in developing countries still face many barriers to investment access. These include: lack of awareness of and experience in alternative technologies; poor economics at smaller dumps and landfills; limited infrastructure for natural gas use in some regions; lack of even rudimentary disposal systems at many dumps; and difficulties bringing together the many actors involved in energy generation, fertilizer supply and waste management.

246. To overcome these barriers, a combination of several measures is necessary, including institution building and technical assistance policies, voluntary agreements, regulatory measures and financial assistance. Multilateral and bilateral ODA programmes can play an important role in institution building and technical assistance. Voluntary agreements or public-private partnerships can be set up between governments and utilities to overcome information and knowledge barriers and to identify sites with high mitigation potential. Financial assistance can come from ODA, the carbon market or other sources. The carbon markets improve the economics of these projects appreciably. Over 100 projects, representing almost 10 per cent of the projected emission reductions, were in the pipeline at the end of 2006.

247. The carbon market improves the economics of landfill gas emission reduction projects appreciably. Over 100 projects representing approximately 10 per cent of the projected emission reductions were in the pipeline at the end of 2006. However, the emission reductions achieved are substantially lower than initially estimated.

4.4.6. AGRICULTURE

4.4.6.1. INTRODUCTION

248. Agricultural lands, comprising arable land, permanent crops and pasture, cover about 40 per cent of the earth's land surface (United Nations Food and Agriculture Organization, FAOSTAT, 2007), and these lands are expanding. Most of the agricultural land is under pasture (approximately 70 per cent), and only a small per cent (less than 3 per cent) are under permanent crops.

249. There are two sources of GHG emissions from agriculture:

- Non-CO_2 GHGs from management operations;
- Energy-related CO_2 emissions.

250. In addition, the agricultural sector offers significant opportunities for increased removals by sinks mainly through agroforestry and improved grassland management.

251. Agricultural products, such as biomass energy, bio-plastics and bio-fuel, can reduce GHG emissions by replacing fossil fuel based products. Those opportunities are considered in the sectors where the products are used.

4.4.6.2. GREENHOUSE GAS EMISSIONS AND REMOVALS BY SINKS

RECENT TRENDS IN GREENHOUSE GAS EMISSIONS AND REMOVALS BY SINKS

252. Current global emissions from the agriculture sector are 6.8 Gt CO_2 eq, of which 6.2 Gt CO_2 eq are non-CO_2 emissions from agriculture operations and 0.6 Gt CO_2 eq come from energy use in the agriculture sector.

GREENHOUSE GAS EMISSIONS AND REMOVALS BY SINKS UNDER THE REFERENCE SCENARIO

253. No widely accepted reference scenario of agriculture emissions is available, so the reference scenario is specified for each emission reduction and sink enhancement option analysed for the mitigation scenario. A detailed analysis is provided in CHAPTER IV.4.6.4.

GREENHOUSE GAS EMISSIONS AND REMOVALS BY SINKS UNDER THE MITIGATION SCENARIO

254. The mitigation scenario assumes that cost-effective measures to reduce non-CO_2 emissions are implemented. The emission reductions and the associated financial flows are estimated in CHAPTER IV.4.6.4. The potential for increased removals by sinks through agroforestry and the associated investment flows are also estimated in the same chapter. Options for reducing energy-related CO_2 emissions are not analysed because the level of emission reductions are low relative to the other options.

4.4.6.3. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS BY SOURCE OF FINANCING

FINANCIAL FLOWS

255. Global government expenditures in agriculture are increasing in real terms by 2.5 per cent annually. In developed countries, government expenditures are approximately 20 per cent of agricultural GDP; they are less than 10 per cent of agricultural GDP on average in developing countries.

INVESTMENT FLOWS

256. The current sources of investment by region in AFF[24] are shown in TABLE IV-28. The vast majority of the investment comes from domestic sources, such as the farmers themselves from their own savings, funds they borrow or government assistance. In developing countries, most of the remaining investment comes from ODA. Developed countries receive some foreign investment in the form of equity or loans.

4.4.6.4. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

INVESTMENT AND FINANCIAL FLOWS NEEDED IN THE REFERENCE SCENARIO

257. TABLE IV-29 shows current and projected GFCF for the agriculture sector by region. The OECD projections for cropping agriculture show rapid and accelerating growth in Africa and the Middle East, moderate growth in most developed countries, emerging economies and transition economies, and declining investments in Japan. In the livestock sub-sector, projections are for high growth in Africa, India, South and South-East Asia, the Middle East, and Turkey. Similar to the cropping sub-sector, projections are for moderate growth in most developed countries, emerging economies and economies in transition, and declining investments in Japan.

[24] OECD ENV-Linkage model has aggregated agriculture, forest and fisheries current investment data into one category.

Table IV-28. **Investment by source for agriculture, forestry and fisheries in 2000 (percentage)**

	Total Investment	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	ODA Bilateral total	ODA Multilateral total	Total	Total Investment USD billion
Africa	5.51	96.16	0.97	0.00	1.79	1.07	100.0	10
Developing Asia	17.95	96.02	2.53	0.00	0.88	0.56	100.0	31
Latin America	9.02	98.53	1.04	0.00	0.39	0.04	100.0	16
Middle East	3.49	99.95	0.00	0.00	0.05	0.00	100.0	6
OECD Europe	35.18	84.79	0.13	15.08	0.00	0.00	100.0	62
OECD North America	13.67	98.52	1.43	0.05	0.00	0.00	100.0	24
OECD Pacific	12.10	98.58	0.81	0.62	0.00	0.00	100.0	21
Other Europe	0.05	100.00	0.00	0.00	0.00	0.00	100.0	0
Transition Economies	3.02	97.60	0.85	0.00	0.23	1.32	100.0	5
Global Total	100.00	93.14	0.97	5.39	0.30	0.20	100.0	175
NAI Parties	38.65	96.88	1.72	0.19	0.76	0.45	100.0	68
AI Parties	59.64	91.05	0.04	8.91	0.00	0.00	100.0	104
Least Developed Countries	2.42	92.02	2.48	0.00	2.95	2.55	100.0	4

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Note: Only aggregated estimates for agriculture, forest and fisheries are available for current investment.

Table IV-29. **Investment flows in the agriculture sector by region and time period (millions of United States dollars)**

	2005	2010	2015	2020	2025	2030
Africa	14,275	12,601	16,204	19,668	23,605	28,074
Australia/New Zealand	3,153	3,871	3,986	4498	5,009	5,483
Brazil	5,311	8,932	9,973	11,277	12,623	14,125
Canada	1,885	3,156	3,515	3,763	4,002	4,301
China	14,205	16,863	19,834	22,763	25,666	28,302
EU-15	7,548	11,672	13,044	14,215	15,137	15,733
India	9,320	11,800	14,299	16,881	19,640	22,457
Japan	4,513	7,673	7,186	7,471	7,606	7,723
Latin America/Caribbean	15,473	17,328	19,899	22,680	25,654	28,970
Mexico	461	2,352	2,120	2,689	3,010	3,219
Middle East	3,619	3,908	5,402	6,658	7,870	9,209
Russia	1,047	1,036	1,224	1,415	1,559	1,652
South & SE Asia	13,862	17,383	20,879	24,651	28,668	32,777
Republic of Korea	192	378	382	397	435	413
Turkey	1,575	2,766	2,979	3,166	3,350	3,534
United States	12,842	15,313	16,907	17,323	18,041	19,035
Global Total	109,281	137,031	157,833	179,513	201,874	225,006

Source: OECD ENV-Linkage Model.

INVESTMENT AND FINANCIAL FLOWS NEEDED IN THE MITIGATION SCENARIO

INVESTMENT AND FINANCIAL FLOWS NEEDED FOR REDUCTION OF NON-CARBON DIOXIDE GREENHOUSE GAS EMISSIONS

258. The US EPA has published two baseline (reference) scenarios for non-CO_2 emissions. The first was generated from national GHG inventories and provides disaggregated data at the country level (US EPA, 2006a). The second scenario (US EPA, 2006b) was generated from some of the same data, but used process models (daily service of century model (DAYCENT) and denitrification decomposition model (DNDC)) to improve the estimates of N_2O emissions from soils and both N_2O and CH_4 emissions from rice cultivation.

259. Both scenarios are presented in five-year increments from 1990 to 2020. The scenarios were extended to 2030 in the analysis based on a reasonable projection of the time series, usually a linear extension. The global totals for both scenarios are shown in TABLE IV-30. The regional distribution of the second scenario is provided in TABLE 9-ANNEX V.

260. The first scenario is useful for making comparisons among countries and regions because the methods are consistent from country to country. The second scenario is more appropriate for assessing the mitigation scenario and the costs associated with mitigation. It is substantially lower than the emissions reported in the national communications, so it may under estimate the potential reductions.

261. The emissions sources for non-CO_2 gases included in both baselines and their approximate share of global emissions are shown in TABLE IV-31. N_2O from soils accounts for about 45 per cent of the total and CH_4 from enteric fermentation accounts for another 30 per cent of the total.

262. A large number of mitigation options for mitigating GHG emissions from agricultural have been suggested. In many cases, production or cost trade-offs need to be understood before proper incentives for the adoption of these practices can be designed. The US EPA constructed marginal abatement curves for different regions and different sectors through 2020. Costs include capital, operation and maintenance costs. The calculation included a tax rate of 40 per cent and used a 10 per cent discount rate. Benefits include the intrinsic value of CH_4 as a natural gas or as fuel for electricity or heat generation, benefits of abatement unrelated to climate change (e.g. improved nutrient use efficiency), and the value of abating the gas given a GHG price.

263. The curves all become steep or even vertical at around USD 30 per t CO_2 eq. Thus, this analysis assumes the reduction available at USD 30 per t CO_2 eq is the maximum economic level of abatement and calculates these mitigation potentials. To construct aggregate abatement curves for agriculture, the cultivated area and number of animals can be held constant or production can be held constant. Approximately 13 per cent of total emissions could be mitigated given constant area and animal numbers. When production is held constant, approximately 16 per cent of non-CO_2 emissions could be mitigated.

264. The measures that reduce these emissions are operational measures that do not require new equipment. The annual cost of implementing the measures on the scale projected is assumed to be the marginal cost of USD 30 per t CO_2 eq. The estimated emission reductions and associated annual financial flows are presented in TABLE IV-32.

ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDS FOR INCREASED REMOVALS BY SINKS

INVESTMENT AND FINANCIAL FLOWS NEEDS FOR AGROFORESTRY

265. A rigorous analysis of the costs and mitigation potential for increased removals by sinks does not presently exist in the literature. The IPCC (2000) Special Report presented an illustration of the potential of removals by sinks to contribute to climate change mitigation. The IPCC scenario is expanded in this analysis to illustrate the potential of increased removals by sinks through agroforestry and the associated investment.

266. Activities that increase CO_2 sinks in tropical agricultural landscapes offer a cost effective means to achieve mitigation objectives. The IPCC scenario suggests that the land area available for agroforestry is 630 million ha and that 40 per cent of this area could be in agroforestry by 2040, at a rate about 19 million ha per year after the first decade. Expanding agroforestry by 19 million ha per year would require an annual investment of approximately USD 15 billion (USD 780 per ha) and operating costs of about USD 8 billion (USD 440 per ha).

Table IV-30. **Reference scenarios for non-carbon dioxide greenhouse gas emissions (Mt CO_2 eq) by source through 2030**

	1990	1995	2000	2005	2010	2015	2020	2025	2030
Global total, First scenario	5,343	5,528	5,928	6,291	6,713	7,158	7,648	8,071	8,493
Global total, second scenario	–	–	4,563	4,490	4,417	4,619	4,822	5,025	5,227

Table IV-31. **Approximate shares of non-carbon dioxide greenhouse gas from management operations**

Emissions source	Share of total emissions (percentage)
N_2O from soil	45.5
N_2O from manure management	3.5
CH_4 from enteric fermentation	30.5
CH_4 from manure management	3.5
CH_4 from rice cultivation	10.5
CH_4 from other sources (Savanna burning, burning of agricultural residues, burning from forest clearing, and agricultural soils (CH_4))	6.5

Source: Calculation based on Verchot (2007).

Table IV-32. **Potential total reductions in emissions (Mt CO_2 eq) from agriculture for selected countries and regions with carbon prices at USD 0 and USD 30 per t CO_2 eq, with constant herd size**

Regional distribution	Potential reductions (Mt CO_2 eq) from croplands		Total Cost in USD million	Potential reductions (Mt CO_2 eq) from rice cultivation		Total Cost in USD million	Potential reductions (Mt CO_2 eq) from livestock management		Total Cost in USD million
	2030			2030			2030		
Country/Region	USD 0	USD 30		USD 0	USD 30		USD 0	USD 30	
Africa	4.2	5.4	183	–	–	–	2.3	11.9	403
Brazil	1.4	3.7	125	–	–	–	9.6	16.2	549
Mexico	4.2	9.3	315	–	–	–	2.1	2.1	71
Non-OECD Annex I	35.0	39.6	1,342	–	–	–	4.1	4.1	139
OECD	69.4	89.8	3,044	1.9	10.8	366	36.1	77.7	2,634
Russia	35.0	39.6	1,342	–	–	–	2.5	2.5	85
S&SE Asia	2.5	3.3	112	73.2	115.6	3,919	11.2	19.2	651
Global total	**139.6**	**179.7**	**6,092**	**116.2**	**243.3**	**8,248**	**92.4**	**175.2**	**5,939**
Annex I	109.4	135.0	4,577	0.4	6.3	214	38.1	80.1	2,715
Australia/New Zealand	3.7	4.4	149	–	–	–	4.0	6.8	231
China	6.4	8.1	275	39.7	81.8	2,773	11.0	20.3	688
Eastern	5.8	8.9	302	–	–	0	1.7	1.7	58
EU-15	11.8	12.4	420	–	–	0	12.9	24.5	831
India	4.5	8.9	302	–	34.4	1,166	3.7	7.8	264
Japan	–	–	0	0.4	6.3	214	0.9	0.9	31
United States	44.9	58.6	1,987	–	–	–	10.6	33.5	1,136

Source: Table adapted from US EPA (2006b).

267. In most cases agroforestry systems are more profitable than subsistence agriculture. But resource-poor farmers cannot shift to agroforestry because of the initial costs are not recovered for three to five years. Many farmers lack knowledge about the income potential of agroforestry systems and how to grow the trees. In addition, agroforestry systems are more labour intensive than cropping systems, so labor shortages during peak seasons may inhibit their adoption.

INVESTMENT AND FINANCIAL FLOWS NEEDS FOR GRASSLAND MANAGEMENT

268. IPCC scenario suggested that the land area available for improved grassland management is 3,400 million ha and that it would be possible, with considerable international effort, to have 20 per cent of this area under improved pasture management by 2040, at a rate of about 68 million ha per year after the first decade. No estimate is available for the cost of grassland management measures to increase removals of CO_2 under the scenario.

SUMMARY OF INVESTMENT AND FINANCIAL FLOWS NEEDS

269. Table IV-33 summarizes the additional investment and financial flows under the mitigation scenario in 2030 for the measures analysed for the agriculture sector. The additional investment and financial flows needed for the mitigation scenario total about USD 35 billion per year. For livestock and crops 50 – 70 per cent of the additional financial flow is needed in developing countries. A regional split for agroforestry is not available.

Table IV-33. Summary of investment flows for the reference and mitigation scenarios in 2030 (billions of United States dollars)

Region	Non-CO_2 crops[a]	Non-CO_2 livestock[a]	Removal by sinks agroforestry[b]	Mitigation scenario
World	14.3	5.9	15	35.2
Annex I	4.8	2.7	N.A.	–
Non-Annex I	9.6	3.2	N.A.	–

Note:

[a] financial flow,
[b] investment flow.

Box IV-7. Summary of investment and financial flows for agriculture

Investment and financial flows needed in 2030
In the agriculture sector the global additional investment and financial flows needed under the mitigation scenario total approximately USD 35 billion of which USD 20 billion (financial flow) is non-CO_2 emissions reductions (rice cultivation, cropland practices and livestock management) and USD 15 billion (investment) is for removal by sinks through agroforestry. About 65 per cent of the financial flows for reducing non-CO_2 emissions occur in developing countries.

Current investment and financial flows
In the agriculture sector most of the investment, by far, comes from domestic sources, such as the farmers themselves from their own savings, funds they borrow or government assistance. In developing countries, most of the rest of the investment comes from ODA.

4.4.6.5. ASSESSMENT OF THE CHANGES NEEDED IN INVESTMENT, FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP UNDER THE MITIGATION SCENARIO

270. Most of the costs of farm operation are borne by the farmer but financial incentives may be needed to encourage adoption of N_2O and CH_4 emission reduction measures in developing countries.

271. Projects to reduce CH_4 emissions from livestock manure are being implemented under the CDM. Projects to collect and use agricultural waste, such as bagasse and rice husks, are also being implemented under the CDM. The CDM can contribute to reducing the non-CO_2 emissions but it cannot address the full mitigation in agriculture sector because some measures are not eligible and projects need to exceed a minimum size to be economical.

272. In principle, transition from pure agriculture to agroforestry system by planting trees is eligible as a CDM project. But that does not address the initial capital cost barrier of planting trees, or the knowledge and labour supply barriers. Since agroforestry system is more profitable than cropping system, there is a role for mechanisms that provide the initial capital and knowledge and receive a return from a share of the new crops and CDM credits.

4.4.7. FORESTRY

4.4.7.1. INTRODUCTION

273. This chapter focuses on the land in forests at each point in time. It does not include agroforestry, which is addressed in the agriculture sector, bio-energy, which is addressed in the transport and energy supply sectors, or management of wood products. Mitigation options for the forestry sector are reduction of deforestation, better management of productive forest (forest management) and afforestation and reforestation to increase the forest area.

4.4.7.2. GREENHOUSE GAS EMISSIONS AND REMOVALS BY SINKS

RECENT TRENDS IN GREENHOUSE GAS REMOVALS BY SINKS IN THE FORESTRY SECTOR

274. TABLE 10-ANNEX V compares the principal data sets for CO_2 fluxes and forest area losses. Due to differences in methods and scope, values from different data sets are not directly comparable, therefore, the table presents samples of reported results only. The main sources of information for fluxes are those reviewed by IPCC AR4 Working Group III (IPCC, 2007c)[25]. Flux estimates from the Climate Analysis Indicators Tool (CAIT) database[26] of the World Resources Institute (WRI) are also reported. Data on forest area and forest area lost between 2000 and 2005 are from the Food and Agriculture Organisation of the United Nations (FAO) Global Forest Resources Assessment (FRA) 2005 (FAO, 2006). Other estimates of forest area lost and degraded from different sources are also reported.

GREENHOUSE GAS REMOVALS BY SINKS IN THE REFERENCE SCENARIO

275. The forestry section of the IPCC WG III contribution to the Fourth Assessment Report (AR4) found there had been little new effort to develop global baseline scenarios for land-use change and the associated carbon balance against which mitigation options could be examined. Since no suitable scenario for baseline emission for the forestry sector are available, the reference scenario assumes that GHG emissions from the forestry sector in 2030 are the same as in 2004, as estimated at section 11 of the IPCC WG III contribution to the AR4 estimated at 5.8 Gt CO_2 eq. This estimate excludes peat and other bog fires (see TABLE 11-ANNEX V).

GREENHOUSE GAS REMOVALS BY SINKS IN THE MITIGATION SCENARIO

276. The potential of reducing greenhouse gas emissions or enhancing removals by sinks in the forestry sector is estimated as mitigation potential for different mitigation options. A detailed analysis is provided in CHAPTER IV.4.7.4.

[25] According to FAO (2005) equalling 4,000 Mt CO_2 year-1 FAO, 2005: Forest Finance: sources of funding to support sustainable forest management (SFM). Rome: FAO.

[26] The CAIT of the WRI in Washington uses data from: Carbon Dioxide Information Analysis Center (CDIAC), Dutch National Institute of Public Health and the Environment (RIVM), EarthTrends (WRI), Mr. Richard Houghton (Woods Hole Research Center), IPCC, IEA, The World Bank, World Health Organization (WHO).

4.4.7.3. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS BY SOURCE OF FINANCING

277. Data on the sources of current investment in forestry are aggregated with agriculture and fisheries and are shown in TABLE IV-28 (see CHAPTER IV.4.6 on agriculture). Most of the investment comes from domestic sources. In non-Annex I Parties, most of the rest of the investment comes from ODA.

278. OECD ENV-Linkages model estimates for forestry alone put the total new investment at about USD 23 billion for 2005. Other estimates indicate that FDI into the forestry sector of developing countries has been increasing, while the share of ODA going into forestry has seen a steady decline to about USD 1.75 billion per year (Noble, 2006). Estimates vary, but all agree that FDI considerably exceeds ODA.

279. TABLE IV-34 contains information on selected funding and investment flows in the forestry sector from various sources, without claiming to be comprehensive or complete.

280. Reconciling the available data is a challenge:

- Total investment in AFF in 2000 was about USD 175 billion. OECD model estimates for forestry alone put the total new investment at about USD 23 billion for 2005. The Tomaselli (2006) estimate of USD 63 billion is three times this amount. The Tomaselli figure could include investments to purchase existing assets, such as forest land, and investments in wood products industries;
- Total ODA in 2000 for forestry was about USD 370 million, of which USD 124 million was capital investment. Some of the spending under the IFC and ITTO programmes could be included in the ODA total. The ITTO spending includes very little capital investment;
- The GEF figure of USD 1,250 million since 1997 (about USD 150 million per year) is the total spending, not just capital investment, under six operational programmes. Some contributions to GEF and some spending by implementing agencies funded by GEF could be included in the ODA total (see TABLE 12-ANNEX V).

281. Most of the current investment and financial flows into the forestry sector are not related to climate change. The vast majority of investment and financial flows into the forestry sector, including sustainable forest management (SFM) are from the private sector. According to Savcor Indufor (2006) over 90 per cent of the private sector investments are domestic and less than 25 per cent is invested in developing countries and transition economies.

282. According to PROFOR (2004), current levels of investment in the forestry sector, both domestic and foreign, fall far short of the level necessary to realize the potential of well-managed forest resources to contribute to poverty alleviation, the protection of vital environmental services, and sustainable economic growth in developing and transition countries.

Table IV-34. **Information on funding and investment flows in the forestry sector**

Funding source	Volume	Comments
Direct private investments	USD 63 billion per year, USD 15 billion per year to developing countries	USD 63 billion per year in total (all countries). USD 15 billion per year to developing countries and EITs. Mainly domestic direct investments (over 90 per cent)[a]
ODA	USD 328 million total in 2000, of which USD 110 million is capital investment	Source: Creditor Reporting System (CRS), 2006, OECD Statistics.
IFC	USD 65 to 75 million per year	Source: Program on Forests (PROFOR), 2004
ITTO	USD 11.5 million in 2006	Conservation and sustainable management, use and trade of tropical forest resources[b]
GEF	USD 1.25 billion since 1997	236 projects through six operational programmes. Leveraged co-financing USD 3.45 billion[c].
National Forest Programme (NFP) Facility, FAO	USD 17.3 million over five years (2002 to 2007), of which 12.5 is committed	The Facility has programmes in approximately 50 countries, each of which receives 300,000 USD over 3 years. Committed: USD 1.7 million in 2005, over USD 2 million in 2006. In 2006, 44 per cent of the funding went to Africa, 7.5 per cent to Central Asia, 13 per cent to Asia and the Pacific and 35 per cent to Latin America and the Caribbean[d].
PROFOR	USD 8.2 million between 2002 and 2006	34 different activities. Themes include: livelihoods, governance, financing, cross-sectoral cooperation, and knowledge management. USD 8.2 million over the period 2002 to 2006, 58 per cent was spent on global activities, 6 per cent in regions and 36 per cent in countries. It has leveraged USD 1.3 million in co-financing[e]
World Bank Global Forest Alliance	USD 1.5 – 2 million per year	It expects to raise about USD 100 million for technical and catalytic functions, about USD 300 million for piloting avoided deforestation schemes in selected pilot countries and about USD 75 million for carbon finance reforestation projects with poverty reduction objective[f]
Other funds	USD 53.8 million	Biocarbon fund[g]
New South Wales GHG Abatement Scheme		USD 6.7 million to date based on prices of AUD 11.50 per t CO_2 eq for forestation and a traded volume 0.7 M t CO_2 eq[h]

Abbreviations: IFC = International Finance Corporation; ITTO = International Tropical Timber Organization; NFP = National forest programmes; USD = United States dollar.

[a] Tomaselli 2006 cited in Savco Indufor 2006.
[b] www.itto.or.jp.
[c] GEF/C.27/14, 12 October 2005 and information directly from the GEF secretariat.
[d] 2006 Progress Report. Courtesy of NFP Facility.
[e] Savcor Indufor 2006.
[f] World Bank, 2007.
[g] www.carbonfinance.org.
[h] Modified after Savcor Indufor 2006.

4.4.7.4. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

283. The reference scenario assumes that GHG emissions from the forestry sector remain constant from 2004 through 2030 at 5.8 Gt CO_2 eq, excluding peat and other bog fires. This involves no additional investment or financial flows.

INVESTMENT AND FINANCIAL FLOWS NEEDED UNDER THE MITIGATION SCENARIO

284. The mitigation options for the forestry sector are:

- Reduced deforestation[27];
- Better management of productive forest (forest management);
- Forestation to increase the forest area (afforestation and reforestation).

285. Forestry mitigation projections are regionally unique, but linked across time and space by changes in global physical and economic forces. Boreal primary forests could be sources or sinks, depending on the net effect of enhancement of growth due to climate change versus a loss of organic matter from soil and emissions from increased fires. The temperate forests in United States, Europe, China and Oceania, will probably continue to be net carbon sinks, partly because of enhanced forest growth due to climate change. Tropical forests are expected to continue to be sinks because of human induced land-use changes. Enhanced growth of large areas of primary forests, secondary regrowth, and increasing plantation areas will also increase the sink.

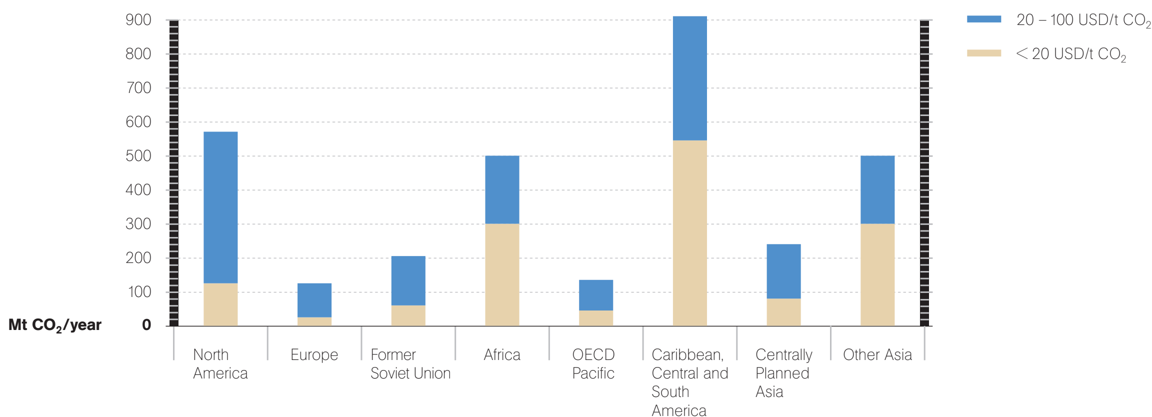
286. IPCC WGIII AR4 presents estimates of the mitigation potential for different costs per tonne for 2030, but no indication is given as to what area is required to achieve those potentials. Figure IV-12 shows the annual economic mitigation potential in the forestry sector by world region and cost class in 2030. The IPCC WGIII AR4 estimate that forestry mitigation options have the economic potential (at carbon prices up to USD 100 per t CO_2) to contribute between 1,270 and 4,230 Mt CO_2 in 2030 (medium confidence, medium agreement). About 50 per cent of the medium estimate can be achieved at a cost under USD 20 per t CO_2 (1,550 Mt CO_2 per year). Over two thirds of the total mitigation potential, and over 80 per cent of the low cost potential, is located in developing countries.

COSTS OF REDUCED DEFORESTATION

287. Estimates for costs of reduced deforestation include reducing emissions from both deforestation and degradation. The biggest mitigation potential in the forestry sector is to reduce deforestation and degradation in the tropics, where almost all of the emissions from deforestation and degradation originate. Available studies

[27] Reducing emission from deforestation in developing countries as defined in Subsidiary Body for Scientific and Technological Advice (SBSTA).

Figure IV-12. **Estimated economic mitigation potential in the forestry sector by region and cost class**



Source: adapted from IPCC, 2007c.
Note: The regions mentioned in the figure above are as per the Fourth Assessment Report of the IPCC.

differ widely in basic assumptions regarding carbon stocks, costs, land areas, and other major parameters. A thorough comparative analysis is therefore very difficult.

288. The financial flow needed to reduce deforestation/degradation is estimated as the opportunity cost of converting forest to other land uses.

289. The three major direct drivers of deforestation/degradation as follows:

- Commercial agricultur (national and international markets)
  - Commercial crops
  - Cattle ranging (large-scale)
- Subsistence farming
  - Small-scale agriculture/shifting cultivation/slash and burn agriculture
  - Fuelwood and NTFP gathering for local use, mostly family based
- Wood extraction
  - Commercial (legal and illegal) for national and international markets
  - Traded fuelwood (commercial at sub national and national level).

290. The driver for converting forest to one of these other land uses determines the opportunity cost of maintaining the forest; preventing the deforestation/forest degradation. Estimates of the opportunity costs by driver are based on ITTO (2006); Forner *et al.* (2006); Kaimowitz and Angelsen (2001); Moutinho and Schwartzman (2005); Chomitz and Kumari (1998); Chomitz, K. (2006) and Geist and Lambin (2002) and expert judgement.

291. The total net loss for countries with a negative change in forest area was 13.1 million ha per year for 1990 – 2000 and 12.9 million ha per year for the period 2000 – 2005 (FRA, 2005). Consequently, the forest loss through deforestation/degradation by main direct driver has been assumed to be 12.9 million ha per year in the absence of mitigation measures.

292. The direct drivers for deforestation/degradation differ in each country where it occurs. The share of total forest area lost to each direct driver was estimated based on the area lost by country and the direct drivers for the country.

293. Applying the opportunity cost for drivers relevant to each region to the area lost to deforestation/degradation each year in the region yields an estimated annual cost of USD 12.2 billion to reduce deforestation/forest degradation of 12.9 million ha per year as shown in TABLE IV-35. Reducing deforestation/forest degradation completely would reduce emissions by 5.8 Gt CO_2 in 2030.

Table IV-35. **Cost for reducing deforestation**

Main direct drivers	Rate of Deforestation/ Degradation (percentage)	Area of Deforestation/ Degradation (million ha per year)	Opportunity cost of forest conversion (USD per ha)	Financial flow required to compensate the opportunity costs (USD million per year)
Commercial agriculture				
Commercial crops	20	2.6	2,247	5,774.18
Cattle ranching (large-scale)	12	1.6	498	801.35
Subsistence farming				
Small scale agriculture/ shifting cultivation	42	5.5	392	2,148.13
Fuel-wood and NTFP gathering	6	0.75	263	196.95
Wood extraction				
Commercial (legal and illegal)	14	1.8	1,751	3,187.4
Fuel-wood/charcoal (traded)	5	0.7	123	85.96
Total	100	12.9	–	12,193.97

Note: Various studies have estimated cost for reducing deforestation ranging from 0.4 billion to as high as 200 billion per year. However these estimates vary greatly in assumption and opportunity cost for the deforestation drivers and the area of reduced deforestation Sathaye *et al.* (2006), IIED (2006), Stern (2006) and Trines (2007).

294. Opportunity costs vary significantly by location and over time. The underlying drivers for deforestation (e.g. structural changes in land tenure or in agricultural or forest policies) also affect the opportunity costs. The opportunity costs do not include investment or maintenance costs of alternative land-use. They also do not include administrative and transaction costs for reducing emissions from deforestation and/or forest degradation. The estimates presented above therefore must be considered as indicative only.

295. Another estimate of cost of reducing deforestation (Trines, 2007) assumes that the area of primary forest lost as reported in FRA 2005 is deforestation. The annual rate of primary forest loss between 2000 and 2005 is assumed to continue through 2030. The analysis uses primary forest loss data for 40 countries that were responsible for over 66 per cent of the CO_2 emissions in 2000 (WRI CAIT). The CO_2 emitted due to deforestation is estimated using carbon content values presented in the FRA 2005. This approach yields an estimate of approximately 148 million ha of deforestation by 2030 with total emissions of about 60,000 Mt CO_2 or annual emissions of about 2,300 Mt CO_2.

296. The highest marginal cost to completely stop deforestation – the "choke price" – is applied to the projected deforestation to estimate the cost of reduced deforestation. Choke prices estimated by Sathaye *et al.* (2006) vary between USD 11 to 77 per t CO_2, excluding transaction costs. Applying those prices to the projected emissions due to the loss of primary forest in each region yields a cost of USD 25 to 185 billion per year to stop deforestation.

297. However for this report, the mitigation potential and cost of reducing deforestation have been estimated using the opportunity costs of the direct drivers of deforestation and forest degradation.

COSTS OF FOREST MANAGEMENT

298. Forest management, in particular SFM has received ample attention over the past decade, and is promoted by the private sector, and aid agencies, but in a non-climate context. Public forests in Annex I Parties are already managed to relatively high standards, which limits possibilities for increasing removals by sinks through changed management practices (for example, by changing species mix, lengthening rotations, reducing harvest damage and or accelerating replanting rates). There may be possibilities to increase carbon storage by reducing harvest rates and/or harvest damage.

299. This analysis assumes that forest management can reduce emissions from production forests in developing countries. The production forests in each country is assumed to remain constant at the 2005 area of 602 million ha (FRA, 2005).

300. The ITTO Expert panel report estimated the costs to achieve SFM at USD 6.25 per ha for all tropical production forests in ITTO member countries (about 350 million ha) (ITTO, 1995). Adjusting for inflation and the larger area of production forest, the cost is estimated at USD 12 per ha.

301. For non-Annex I Parties in tropical and subtropical areas, the cost of achieving (sustainable) forest management on 602 million ha of production forests would be about USD 7.2 billion per year leading to increased annual removals of 5.4 Gt CO_2 (see TABLE IV-36). Non-Annex I Parties with temperate and boreal forests have the potential to increase carbon stocks through SFM at a cost of USD 20 per ha (Whiteman, 2006) for an annual cost of USD 1 billion and increased annual removals of 1.1 Gt CO_2. Thus the annual potential for increased removals through forest management in non-Annex I Parties is estimated at 6.5 Gt CO_2 at an annual cost of USD 8.2 billion in 2030.

COSTS OF FORESTATION

302. So far, afforestation and reforestation (here is referred to as 'forestation') initiatives have been driven mainly by the private sector, for 'no regret' options, such as commercial plantation forestry, or governments. Owing to the lack of liquidity of the investment, the high capital cost of establishment and long period before realizing a financial return, many plantation estates have relied upon government support, at least in the initial stages. Incentives for plantation establishment take the form of forestation grants, investment in transportation and roads, energy subsidies, tax exemptions for forestry investments, and tariffs on competing imports.

303. The drivers that influence forestation vary by region and often even within a country, and originate predominantly from outside the forestry sector. Hence, modelling the area likely to be planted as part of a forestation initiative is complicated.

304. Sathaye *et al.* (2006) present the benefits of land area planted and removals by sinks across a number of scenarios relative to a reference case to 2100. For 2050 the range of land area planted is 52 – 192 million ha whereas the carbon benefits range from 18 – 94 Mt CO_2.

305. Establishment costs for forests range from USD 654 per ha on good sites to USD 1580 per ha on difficult sites (ORNL, 1995). Using this range, the initial investment required to mitigation 18 – 94 Mt CO_2 through afforestation/reforestation on 52 – 192 million ha land is USD 34 – 303 billion.

306. The IPCC WGIII AR4 estimate of the mitigation potential of afforestation by 2030, 1,618 to 4,045 Mt CO_2 year^{-1}, is substantially lower than the estimate of Sathaye *et al.* Using a similar ratio between carbon sequestered and hectares planted, the WGIII AR4 estimates would require 4.6 – 8.2 million ha. At establish ment costs of USD 654 – 1580 per ha establishment costs that would be USD 3 – 12.9 billion or USD 0.1 – 0.5 billion per year over 25 years. Conservative estimates from IPCC have been taken for this analysis.

307. The estimated investment and financial flows for the mitigation options analysed are summarized in TABLE IV-37.

Table IV-36. **Potential removal by sinks through forest management**

Regions	Area of production forest x 1000 ha	Cost estimate for SFM USD million	Global estimate of carbon in biomass t CO_2 per ha	Forest managed area at a 25-years rotation basis ('000 ha) 2005 – 2030	Additional annual growth potential through SFM m³ per ha and year	Increased carbon removal potential per ha through SFM t CO_2	Additional carbon removals potential in the year 2030 Mt CO_2
Total Eastern and Southern Africa	43,948	527	233.045	1.758	2.8	5.138	227.54
Total Northern Africa	46,129	554	95.42	1.845	0.5	0.9175	44.04
Total Western and Central Africa	123,912	1,487	568.85	4.956	5.8	10.643	1,317.53
Total East Asia	125,369	1,505	136.891	5.015	3.5	6.422	803.73
Total South and Southeast Asia	120,046	1,440	282.6	4.802	7	12.845	1,541.4
Total Caribbean, Central America & Mexico	46,645	560	438.198	1.866	6	11.01	513.8
Total South America	96,459	1,158	403.7	3.858	5.5	10.0925	972.55
Tropics	602,185	7,231	308.28	24.1	4.4	8.074	5,420.59

Source: FAO FRA, 2006.

Table IV-37. **Investment and financial flows needed for mitigation options in the forestry sector**

Country/Region	Afforestation/Reforestation: Emission offset potential ($Mt CO_2$) in 2030		Cost in USD billion in 2030		Forest management: Emission avoided Mt CO_2	Cost in USD billion in 2030	Reduced deforestation: Emission reduced in 2030 Mt CO_2	Cost in USD billion in 2030
	Lower	Higher	Lower	Higher				
Annex I	18.79	46.96	0.03	0.15	–	–	–	–
Non-Annex I	43.51	108.74	0.07	0.35	6,522	8.2	5,790	12.3
Global	**64.7**	**161.9**	**0.1**	**0.5**	**6,522**	**8.2**	**5,790**	**12.3**

Box IV-8. **Summary of investment and financial flows for forestry**

Investment and financial flows needed in 2030

In the Forestry sector the additional global investment and financial flows needed under the mitigation scenario total about USD 21 billion, of which financial flows for emission reductions through reduced deforestation account for USD 12 billion and for forest management account for USD 8 billion. Afforestation and reforestation accounts for USD 0.12 – 0.5 billion in 2030. Almost all forestry sector related investment and financial flows occur in developing countries.

Current Investment and Financial Flows

The majority of investments in forestry sector come from the private sector, mainly in plantation development and forestry concessions. Over 90 per cent of these are domestic. In non-Annex I Parties, most of the rest of investments come from ODA.

4.4.7.5. ASSESSMENT OF THE CHANGES NEEDED IN INVESTMENT, FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP UNDER THE MITIGATION SCENARIO

308. How much funding is currently being diverted to avoided deforestation, forest management or forestation is not known as financial flows are hardly ever pertinent to single activity.

FORESTATION

309. Forestation projects in developing countries can earn credits under the CDM for the carbon sequestered. The project activity extension of the CDM to forestation projects is relatively recent and not many projects have been developed yet. Thus it is too early to know whether the CDM will be able to stimulate a significant amount of forestation activity.

310. The BioCarbon Fund, which buys emission reductions, now has total capital of USD 80 million, mostly for reforestation, but also some for avoided deforestation and carbon management of the soil. More than half of BioCarbon Fund's capital is from the private sector. Forestation projects in New South Wales (NSW) and the Australian Capital Territory (ACT) can earn credits for sale in the NSW-ACT GHG Abatement Scheme.

311. Annual investment of USD 0.1 – 0.5 billion in forestation projects in 2030 could be supported by the CDM.

REDUCED DEFORESTATION

312. At COP 11, Papua New Guinea and Costa Rica, supported by several developing countries, tabled a proposal to include emissions from avoided deforestation in any kind of compensation scheme under the UNFCCC[28]. It leaves open whether that should happen under a separate forest protocol or as a part of an overall post-2012 protocol. Since then several proposals for supporting reduced deforestation have been submitted. The main features of the different proposals for voluntary approaches to reduced deforestation and degradation are presented in TABLE IV-38.

[28] Report on the second workshop on reducing emissions from deforestation in developing countries, FCCC/SBSTA/2007/3.

Table IV-38. Proposal for policy approaches and positive incentives to reduce emissions from deforestation in developing countries

Country (or group of countries)	Brief description of proposal
Tuvalu[29]	Proposal for a policy approach called the Forest Retention Incentive Scheme (FRIS) based on projects implemented by local communities. There are three key elements under the FRIS: the establishment of a Community Forest Retention Trust Account that retains funds for the projects; the issuance of forest retention certificates (FRCs) as a result of emissions reductions from the projects; and the establishment of an International Forest Retention Fund under the UNFCCC for the redemption of the FRCs.
India[30]	Proposal based on the concept of Compensated Conservation as a policy approach to reducing deforestation. It is based on providing compensation to countries for maintaining and increasing their forests, and consequently their carbon stocks, as a result of effective forest conservation policies and measures. Such an approach would have to be supported by a verifiable monitoring system. For the operationalisation of this approach, a new financial mechanism, linked to verifiable carbon stock increments and separate from the CDM, would have to be set up.
Congo Basin countries[31]	Establishment of a reducing emission from deforestation in developing countries (REDD) mechanism, which would provide positive incentives to support voluntary policy approaches to reducing emissions from deforestation and degradation. Establishment of a Stabilization Fund to support developing countries that have low rates of deforestation and want to maintain their existing forests. In addition, use of an Enabling Fund for developing national capacities to participate in the REDD mechanism and/or to stabilize forest stocks, as well as for pilot activities.
Brazil[32]	Provision of positive financial incentives for developing countries that voluntarily reduce their GHG emissions from deforestation. The arrangement would not generate future obligations or count towards emissions reduction commitments of Annex I Parties. Positive financial incentives would be given relative to a reference emission rate (calculated based on a pre-defined reference deforestation rate and an agreed carbon content). Parties included in Annex II to the Convention would voluntarily provide funds for this arrangement, taking into account their ODA commitments. The funds would then be divided among participating developing countries in the same ratio as the emission reductions they have achieved.
Group of Latin American countries[33]	Any mechanism to reduce emissions from deforestation should be based on a basket of incentives and any financial mechanism supporting this should include both non-market and market instruments. Call for "credit for early action" and suggested that any emission reductions generated by participating developing countries should be creditable post-2012. Setting up of an Avoided Deforestation Carbon Fund to cover specific activities that directly reduce emissions from deforestation and maintain forest cover in countries that have low rates of deforestation. Establishment of an Enabling Fund that would provide for capacity-building and pilot activities.
Coalition for Rainforest Nations[34]	Proposal based on a basket of instruments that include provision of sustainable financial resources (for which market instruments will be necessary); expanding existing efforts by building capacities and undertaking national pilot projects; and allowing credits for early action. Establishment of an REDD mechanism and two funds, the Enabling Fund and the Stabilization Fund. Under the REDD mechanism, credits generated must be fully fungible and measured against a national reference scenario.

Note: Information in the table below is based on the proposals presented by Parties at the two UNFCCC workshops on reducing emissions from deforestation in developing countries (30 August to 1 September 2006, Rome, Italy; and 7–9 March 2007, Cairns, Australia) as contained in the reports of these workshops (see documents FCCC/SBSTA/2006/10 and FCCC/SBSTA/2007/3). Additional information can be found in the latest submissions from Parties (see FCCC/SBSTA/2007/MISC.2 and Add.1). The order is the same as they appear in document

[29] See also paper no. 3 in FCCC/SBSTA/2007/MISC.2/Add.1.

[30] See also paper no. 11 in FCCC/SBSTA/2007/MISC.2.

[31] See also paper no. 9 in FCCC/SBSTA/2007/MISC.2; and FCCC/SBSTA/2006/10, paragraph 36. The countries of the Congo Basin supporting this proposal include Cameroon, the Central African Republic, the Republic of the Congo, the Democratic Republic of the Congo, Equatorial Guinea and Gabon.

[32] See also paper no. 4 in FCCC/SBSTA/2007/MISC.2; and FCCC/SBSTA/2006/10, paragraph 48.

[33] See also paper no. 7 in FCCC/SBSTA/2007/MISC.2. This submission was supported by Costa Rica, the Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Panama, Paraguay and Peru.

[34] See also paper no. 3 in FCCC/SBSTA/2007/MISC.2. This submission was supported by Bolivia, the Central African Republic, Costa Rica, the Democratic Republic of the Congo, the Dominican Republic, Fiji, Ghana, Guatemala, Honduras, Kenya, Madagascar, Nicaragua, Panama, Papua New Guinea, Samoa, Solomon Islands and Vanuatu.

313. The World Bank has established the Global Forest Alliance, which focuses on forests and poverty reduction, forest management, and new financing mechanisms. Its targeted capital is about USD 100 million. It will build capacity and fund research rather then buy carbon.

314. The World Bank also has established the Forest Carbon Partnership Facility, as requested by the G8. This facility is designed to help reduce emissions from deforestation and degradation. The Bank envisions that this new facility will reach a funding level of USD 250 million over five years, of which one forth to one third would be for capacity building, and the rest for carbon finance transactions. Most, but not all, of the funding is expected to come from ODA sources.

315. Sustainable Forestry Management and Credit Suisse have recently announced a new facility of USD 200 million for reforestation and avoided deforestation.

316. Together the Global Forest Alliance and Forest Carbon Partnership Facility may provide annual funding of about USD 100 million for reduced deforestation. While this is significant funding for a pilot phase, it is negligible relative to the projected annual need of USD 12 billion in 2030. Implementing reduced deforestation on such a scale will require access to a market so that it can be funded privately. The alternative is to have national governments implement policies to reduce deforestation.

FOREST MANAGEMENT

317. Forest management is estimated to need annual funding of USD 8 billion in 2030. At present, only the ITTO provides funding for forest management. Currently, funding for such projects averages about USD 10 million per year. Funding USD 8 billion per year would require another source of funds.

4.5. TECHNOLOGY RESEARCH AND DEVELOPMENT

4.5.1. INTRODUCTION

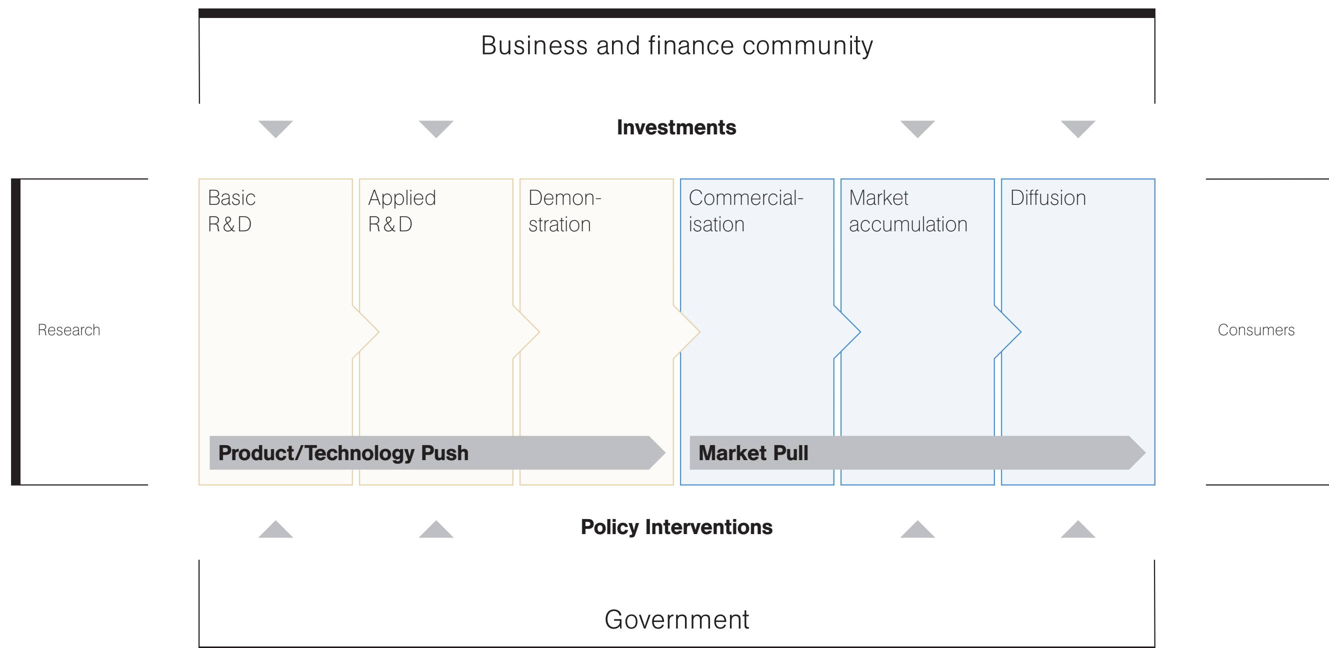
318. GHG mitigation requires mechanisms that can help both push and pull low GHG emitting technologies onto the market. This chapter discusses research and development of those technologies.

319. No single technology – say nuclear power or solar power – can deliver the emission reductions needed to stabilize atmospheric concentrations of GHG. A range of technologies is already available, but most have higher costs than existing fossil fuel based options. Others are yet to be developed. The success of efforts to move these low GHG emitting technologies through the innovation cycle will be an important determinant of whether low emission paths can be achieved.

320. Innovation is typically a cumulative process that builds on existing progress, generating competitive advantages in the process. Grubb (2004) identifies the ‘stages’ of innovation as shown in FIGURE IV-13. Although as with most models, this fails to capture many complexities of the innovation process, it is useful for characterizing stages of innovation. Transition between stages is not automatic (many products fail at each stage of development) and there are also linkages between them, as further progress in basic and applied R&D affects products already in the market, while subsequent learning also has an R&D impact.

321. The graph refers to both push policies – where government supports innovation through grants and ubsidies – as well as pull policies – where markets provide the incentives required to drive the innovation.

Figure IV-13. **The innovation cycle**



Source: Grubb, 2004.

4.5.2. CURRENT SITUATION ON TECHNOLOGY RESEARCH AND DEVELOPMENT

322. Worldwide, nearly USD 600 billion was expended on R&D in all sectors in 2000. Nearly 85 per cent of that amount was spent in only seven countries[35] (IPCC, 2007c). Over the last 20 years, the government share of R&D funding has generally declined while the industry share has increased in these countries. Innovation varies dramatically across sectors. The information technology and pharmaceuticals sectors have high rates of innovation with private sector financing equal to 10 – 20 per cent sector revenue (Neuhoff, 2005). In the power sector private R&D has fallen sharply with privatization to around 0.4 per cent of revenue (Margolis and Kammen, 1999).

323. Between 1970 and 1998, R&D spending for agriculture rose from USD 3.3 – 4.9 billion. Since the mid 1980s, private sector research spending has exceeded and grown faster than the public component. By 2030 total investment in agricultural research is projected to reach USD 12 billion, with 60 per cent of this amount coming from the private sector. About 75 per cent of the USD 2.5 billion annual increase in research spending between 2005 and 2030 is expected to be funded by the private sector. No information is available on the difference in research spending between the reference and mitigation scenarios in agriculture sector.

324. The significant increase in energy prices after the 1970s oil crisis led to an expansion of R&D spending as shown in FIGURE IV-14. The subsequent collapse in prices in the 1980s led to a decline of R&D initiatives and support. Recent energy price increases have so far not translated into an expansion of R&D funding.

325. Government spending on energy R&D worldwide has stagnated, while private sector spending has fallen. Total government expenditures of IEA member countries on energy R&D decreased from some USD 9.6 billion in 1992 to USD 8.6 billion in 1998, with a recovery to USD 9.5 billion in 2005. Over this period, two countries – Japan (34 per cent) and the United States (29 per cent) – accounted for more than 60 per cent of the total IEA government R&D spending. In the United States, federal funding for energy research has been falling steadily since 1980. Only Japan has maintained energy R&D spending relative to GDP. The historical trend in energy R&D spending contrasts with overall research spending in the OECD, which grew by nearly 50 per cent between 1988 and 2004 (Stern, 2006).

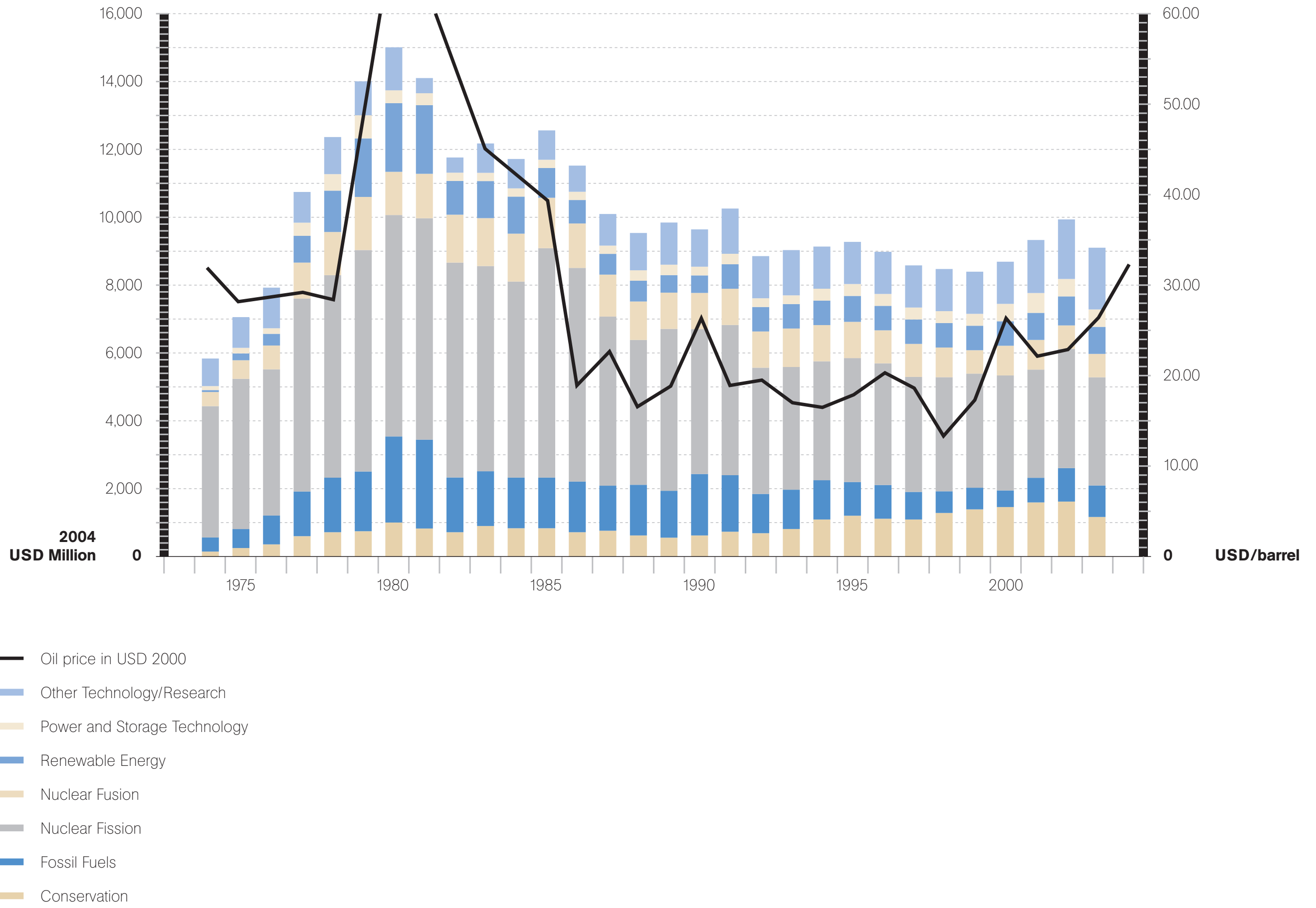
326. Spending on fossil fuels fell steadily during the second half of the 1990s, but rebounded at the start of the current decade (see FIGURE IV-14). The share of nuclear fission and fusion in total spending has dropped since the early 1990s, but still accounts for about 40 per cent of the total. Spending on energy efficiency rose significantly in the 1990s and then fell back sharply after 2002. Research on renewables and power technologies – including hydrogen – has continued to grow steadily. Energy efficiency and renewables still receive only 12 per cent of government R&D spending on energy.

327. Insufficient resources have been allocated to energy R&D to meet medium- and long-term energy policy objectives, including global climate change mitigation. IEA consultative bodies have been suggesting that member governments should find a more balanced R&D budget mix that focuses on the longer-term policy objective of sustainable development.

328. Private R&D spending for energy is discouraged by energy subsidies, since they make commercialization of new technologies more difficult. In OECD countries, where most of the energy R&D occurs, fossil fuels are subsidized to the extent of USD 20 – 30 billion per year, double or triple the total government spending on energy R&D.

[35] Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

Figure IV-14. **Government R&D expenditure in IEA countries and oil price from 1974 to 2004**



Source: OECD, 2006.

4.5.3. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

329. A portfolio of existing or well advanced low carbon technologies is assumed to be deployed under the mitigation scenario. Figure IV-15 shows the projected emission reductions under the mitigation scenario in 2030 by technology. The key technologies are end-use efficiency, CCS, renewables, nuclear energy, large hydropower and biofuels.

330. Figure IV-16 shows the annual investment by technology by region in 2030. For each of the technologies, a substantial share will be invested in developing countries. This suggests that developing country participation in R&D and deployment of these technologies could facilitate the projected investments.

331. The IEA's Energy Technology Perspectives looks at the impact of policies to increase the rate of technological development. It assumes USD 720 billion of investment in deployment support occurs over the next two to three decades, an average of USD 24 – 36 billion per year. This estimate is on top of an assumed carbon price (whether through tax, trading or implicitly in regulation) of USD 25 per t CO_2. The TECH Plus scenario is closest to the mitigation scenario. It assumes faster rates of progress for renewable and nuclear electricity generation technologies, for advanced biofuels, and for hydrogen fuel cells, leading to global energy-related CO_2 emissions about 16 per cent below current levels in 2050.

332. The Stern review estimated existing deployment support for renewables, biofuels and nuclear energy at 33 billion each year. If the IEA figure is assumed to be additional to the existing effort, it suggests an increase of deployment incentives of between 73 and 109 per cent, depending on whether this increase is spread over two or three decades. The Stern Review also suggested that global public energy R&D funding should double, to around USD 20 billion.

Box IV-9. **Summary of investment and financial flows for technology R&D**

Investment and financial flows needed in 2030

Government energy R&D budgets should double to USD 20 billion per year and government support for deployment of renewables, biofuels and nuclear energy should double to USD 60 billion per year.

Current investment and financial flows

Government spending on energy R&D has stagnated, while private sector spending has fallen. Most of the government funding comes from Japan and the United States. Japan has maintained energy R&D spending relative to GDP while federal funding for energy research has fallen steadily falling since 1980 in the United States.

Figure IV-15. **Emission reductions by technology under the mitigation scenario in 2030, in Gt CO_2 eq.**

Nuclear **1.6 Gt**
Clean fossil fuel generation **1.6 Gt**
Advanced biofuel **0.7 Gt**
CCS (power and industry) **2.5 Gt**
End use efficiency **6.0 Gt**
Renewables **1.6 Gt**

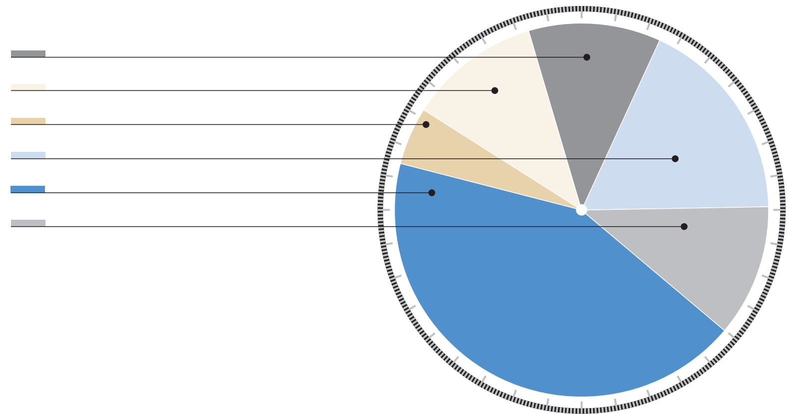
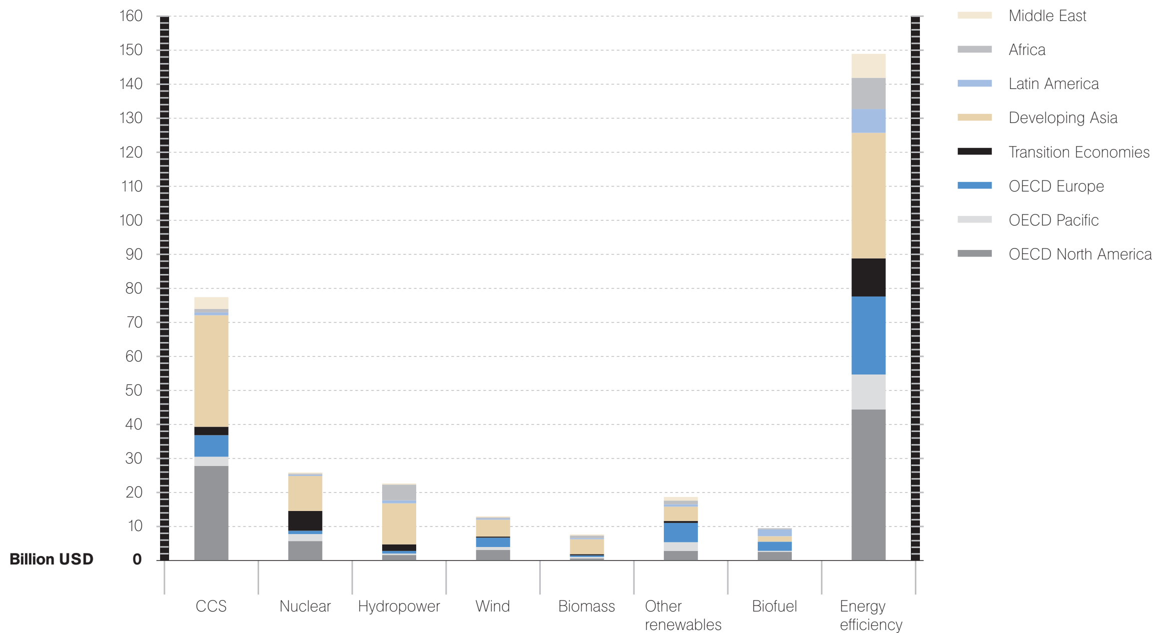


Figure IV-16. **Annual additional investment by technology and by region under the mitigation scenario in 2030**



4.5.4. ASSESSMENT OF THE CHANGES NEEDED IN INVESTMENT, FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP UNDER THE MITIGATION SCENARIO

333. An ambitious and sustained increase in the global energy R&D effort is required if the technologies reflected under the mitigation scenario are to be delivered within the time required. However, government funding for energy R&D has only recently recovered to the level of the early 1990s, while private funding has declined.

334. The available estimates suggest that government energy R&D budgets need to double from roughly USD 10 – 20 billion per year, and that support for deployment of renewables, biofuels and nuclear energy needs to double from roughly USD 30 – 60 billion annually.

335. Private R&D spending for energy in OECD countries is discouraged by subsidies to fossil fuels, which are double or triple the total government spending on energy R&D, since they make commercialization of new technologies more difficult.

336. The scale of some low GHG emitting technologies is too large for countries to implement individually. International cooperation is essential in accelerating efficient and cost-effective progress towards a low carbon energy future. A number of international cooperation initiatives for R&D were undertaken and showing successful results in sharing information and development costs. Further enhanced international cooperation and collaboration would be key to promote technology R&D. This would need to also include participation of emerging and developing economies countries.

4.6. CONCLUSIONS

337. The global additional investment and financial flows of USD 200 – 210 billion will be necessary in 2030 to return global GHG emissions to current levels (26 Gt CO_2), see TABLE 6-ANNEX V. In particular:

- *For energy supply,* investment and financial flows of about USD 67 billion would be reduced owing to investment in energy efficiency and biofuel of about USD 158 billion. About USD 148 billion out of USD 432 billion of projected annual investment in power sector would need to be shifted to renewables, CCS, nuclear energy and hydropower. Investment in fossil fuel supply is expected to continue to grow, but at a reduced rate;
- *For industry,* additional investment and financial flows are estimated at about USD 36 billion. More than half of the additional investment is for energy efficiency, one third for installation of CCS and the rest for reduction of non-CO_2 gases, such as N_2O and other high GWP GHGs;
- *For buildings,* additional investment and financial flows amount to about USD 51 billion. Currently commercial and residential energy efficiency investment comes from building owners and is financed domestically;
- *For transportation,* additional investment and financial flows amount to about USD 88 billion. Efficiency improvements for vehicles and increased use of biofuels are likely to require government policies, but the investment would come mostly from the private sector;
- *For waste,* additional investment and financial flows are estimated at about USD 1 billion. Capture and use of methane from landfills and wastewater treatment could reduce emissions by about 50 per cent in 2030 mainly in non-Annex I Parties;
- *For agriculture,* additional investment and financial flows are estimated at about USD 35 billion. Non-CO_2 emissions from agriculture production could be reduced by about 10 per cent at cost of USD 20 billion in 2030. With a concerted international effort and an annual investment of about USD 15 billion agroforestry could be expanded at a rate of about 19 million ha per year by 2030;
- *For forestry,* additional investment and financial flows are estimated at about USD 21 billion. An indicative estimate of the cost of reducing deforestation and forest degradation in non-Annex I Parties to zero in 2030 is USD 12 billion. The estimated investment and financial flows in 2030 to increased GHG removals by sinks through SFM is USD 8 billion and the estimated investment and financial flows needed for afforestation and reforestation is USD 020 – 0.5 billion;
- *For technology R&D and deployment,* additional investment and financial flows are estimated at about USD 35 – 45 billion. Government spending on energy R&D worldwide has stagnated, while private sector spending has fallen. Government budgets for energy R&D and support for technology deployment need to double, increased expenditures in 2030 are expected at USD 10 – 30 billion respectively.

338. In many sectors the lifetime of capital stock can be thirty years or more. The fact that total investment in new physical assets is projected to triple between 2000 and

2030 provides a window of opportunity to direct the investment and financial flows into new facilities that are more climate friendly and resilient. The investment decisions taken today will affect the world's emission profile in the future.

339. Almost half of the additional global investment and financial flows need would occur in developing countries due to rapid economic and population growth. Mitigation actions are expected to be less expensive in non-Annex I Parties. Table IV-39 shows that 68 per cent of the projected global emission reductions occur in non-Annex I Parties while only 46 per cent of the additional investment and financial flows are needed in non-Annex I Parties. This reflects mitigation opportunities associated with the rapid economic growth projected for large developing countries, the relatively inefficient energy use, and the prevalence of low cost mitigation opportunities in the forestry sector. The data in table IV-39 should not be used to compare the cost per t CO_2 eq reduced by sector. The investment and financial flows for reducing electricity use in buildings and industry are reported in those sectors, while the emission reductions are counted in the power supply sector.

340. The estimated investment and financial flows for energy assume that the major reductions in emissions between the reference and mitigation scenarios rely on increased energy efficiency and shifts in the energy supply from fossil fuels to renewables, nuclear energy and hydropower and large-scale deployment of CCS, although there are only a few CCS demonstration projects at the present time.

Table IV-39. Additional investment and financial flows and greenhouse gas emission reductions

	Global		Non-Annex I Parties			
Sectors	**Emission Reduction Gt CO_2 eq**	**Investment and financial flows in 2030 USD billion**	**Emission Reduction Gt CO_2 eq**	**Investment and financial flows in 2030 USD billion**	**Per cent of global emission reduction**	**Per cent of global investment and financial flows**
Power generation[a]	9.4	148.5	5.0	73.4	53	49
Industry[b]	3.8	35.6	2.3	19.1	60	54
Transport	2.1	87.9	0.9	35.5	42	40
Building[b]	0.6	50.8	0.3	14.0	48	28
Waste	0.7	0.9	0.5	0.6	64	64
Agriculture	2.7	35.0	0.4	13.0	14	37
Forestry	12.5	20.7	12.4	20.6	100	99
Total	31.7	379.5	21.7	176.2	68	46

[a] Total investment for power supply in 2030 declines from USD 439 billion in the Reference scenario to USD 432 billion in the Mitigation scenario (see table IV-11). The USD 148 billion reported in this table is the additional investment that would be needed for renewables, CCS, nuclear power and hydropower. Investment for coal-, oil- and gas-fired generation and transmission and distribution would be reduced by USD 155 billion.
[b] The emission reductions reported for the Industry and Building sectors reflect only the direct emission reductions for those sectors. The investment in electricity efficiency measures is included in the investment flows for the Industry and Building sectors, but the emission reductions due to those measures are reflected in lower emissions for the power sector.

341. Currently most of the investment in mitigation measures is domestic; however, ODA plays an important role in Africa and the LDCs. With appropriate policies and/or incentives, a substantial part of the additional investment and financial flows needed could be covered by the currently available sources. However, there will be a need for new and additional external sources of funds dedicated to mitigation.

342. Renewable energy projects are financed largely by private investors at present. The scale of projected investment will require supportive government policies, financial incentives, such as feed-in tariffs and renewable energy credits, and secure markets for the power generated. It also will be necessary to ensure that the investment flows to the countries/regions that need it most. Africa probably faces the greatest challenge, needing to attract capacity investment of nearly USD 3 billion a year from a base of almost zero.

343. Currently most of the energy sector investment is made by government-owned or private, usually regulated utilities, and is made domestically in most regions.

344. More of the capital needed for energy projects in developing countries will have to come from private and foreign sources than in the past. Financing projects in developing countries, particularly in the poorer countries, is a key challenge. The investment gaps are likely to remain in the poor developing countries, deferring the time scale for widespread access to electricity.

345. Domestic savings — the single most important source of capital for investment in infrastructure projects — exceed by a large margin all other sources in total energy-financing requirements. But in some regions, energy-capital needs are very large relative to total savings (For e.g., in Africa and LDC). And energy investment has to compete for funds which might equally well be devoted to other social development sectors.

346. The entities that make the investment decisions are different in each sector, and the policy and/or financial incentives needed will vary accordingly. For example:

- Increased energy efficiency is best achieved through appropriate policies or regulations (the investments are internal and often incremental, and have short payback periods, but adoption is hampered by recognized barriers);
- Shifting investments in efficient motor vehicles need incentives to:
  - Introduce hybrid vehicles such as vehicle purchase subsidies, regulatory standards and higher taxes on the least efficient vehicles;
  - Expand the use of biofuels with measures such as larger R&D programmes and minimum requirements for biofuels in conventional fuel blends;
- Shifting investment in the power sector to CCS and low GHG emitting generation technologies will need both policies and, financial incentives that make these technologies economically more attractive than high GHG emitting technologies. This requires large R&D programmes, incentives for large-scale demonstration plants, national or international policy frameworks, such as carbon markets, renewable portfolio standards or higher feed-in tariffs, loan guarantees to reduce the cost of capital, financial penalties on carbon emissions;
- Financial incentives will be needed to achieve significant reductions in emissions through agroforestry, agriculture waste, deforestation and forest management.

347. Policies are needed in Annex I and non-Annex I Parties. International coordination of policies by Parties in an appropriate forum will often be most effective. Areas where international coordination would be beneficial include:

- Technology R&D and deployment;
- Energy efficiency standards for internationally traded appliances, equipment.

348. Some mitigation measures, especially reduced deforestation and forest management, are likely to need significant external funding for large-scale implementation. Some countries may need assistance for the development and implementation of national policies.

349. As this paper provides only an overview of investment and financial flows based on existing data and models, it could be improved by further analytical work ensuring scenarios are more adequately developed for the purposes of estimating investment and financial flows. For example:

- *Energy efficiency* is the most promising means to reduce GHG emissions in short term. Specific analysis to promote investments for energy efficiency improvements, particularly the implication for improvements of the financial mechanism under the Convention and/or project based mechanisms under the Kyoto Protocol (CDM and JI) could be carried out at the regional and sectoral levels;

- There is need for better understanding of different national circumstances, specific analysis should focus on *different groups of countries* such as LDCs, rapid growth developing countries and economics in transition countries;
- The *removal of energy subsidies and economically efficient pricing and taxation policies* could play an important role in promoting renewable energy and energy efficiency and reducing GHG emissions. However, the role of energy subsidies and non-technical losses need further assessment in terms of their impact on GHG emissions and deterrence of investment in mitigation measures. Little data on this is currently available;
- More research is needed on the *role of different sources of funding* for specific sectors, current data cover investment flows for aggregated sectors. For example, investment data is reported for electricity, gas and water together, and it is often difficult to split the analyse for each of the sub sectors;
- The existing estimates of costs relating to mitigation options for *forestry* and for potential removals by sinks from agriculture are preliminary. There is also a lack of common understanding on assumptions to consider costs and a resulting high range of differences in estimate. More analytical and empirical work is needed;
- *CCS* is projected under the BAPS to play a key role to mitigate climate change in a medium or long term. There are, however, only a few CCS demonstration projects at the present time. Further analysis is needed on how investment from different sources such as private, public and multilateral development banks (MDBs) could collaborate to bring CCS into reality.

V. AN OVERVIEW OF INVESTMENT AND FINANCIAL FLOWS NEEDED FOR ADAPTATION

5.1. INTRODUCTION

350. Raising the standard of living of the poorest peoples in the world to meet the Millennium Development Goals will be challenging, particularly as populations in the developing world continue to increase. Climate change will make this task more challenging by increasing risks to human health, inundating low-lying areas, changing extreme weather events, altering water supplies, changing crop yields and ecosystems, and through many other impacts. The investment and financial flows needed for development in the midst of population growth and climate change will be substantial. It is important to be aware of how adaptation to climate change will affect the needs for investment and financial flows.

351. This analysis does not aim to provide a precise estimate of the total cost of adaptation, but assesses the order of magnitude of additional investment and financial flows that could be required in 2030 to adapt to the impacts of climate change. Although the intimate link between economic growth, population growth, human development and adaptation is acknowledged, this analysis focuses on the additional need for adaptation over and above the investment and financial flows required to address needs related to expected economic and population growth.

352. The investment and financial flows needed for adaptation to climate change have been estimated for five sectors identified by the Working Group II contribution to the Fourth Assessment Report of the IPCC:

- Agriculture, forestry and fisheries;
- Water supply;
- Human health;
- Coastal zones;
- Infrastructure.

353. Adaptation of natural ecosystems (terrestrial and marine) was also analysed. There is, however, very limited literature on adaptation in this sector, and it was not possible to estimate the investment needs associated with adaptation to climate change. Instead, the need for investments to protect ecosystems from all current threats was analysed.

354. This report first presents the scenarios used to undertake the analysis and addresses limitations in estimating adaptation costs. For each sector included in this study, the report briefly reviews climate change impacts, the methods used for the analyses, current level of investment and financial flows in the sector, estimated future investment and financial flows needed in 2030 and a brief analysis of the adequacy of current investment and financial flows to meet the additional needs. Finally, an analysis of damages that can be avoided with mitigation measures is then presented.

5.2. SCENARIOS

355. The analysis of investment and financial flows needed for adaptation to climate change was based on emissions scenarios for which climate change impacts could be inferred and responses to the climate impacts could be projected, so that the associated investment and financial flows could be estimated. The scenarios were selected based on their suitability for the analysis, the detail they provide on estimated investment and financial flows, and how representative they are of the literature. The following scenarios have been used for different sectors:

- IPCC SRES A1B and B1 scenarios are used for the water supply and coastal zones sectors (Nakicenovic N. and Swart R. (eds). 2000);
- For the human health sector, the scenarios used were variation from the IPCC IS92a: a scenario resulting in stabilization at 750 ppmv CO_2 equivalent by 2210 (s750), and a scenario resulting in stabilization at 550 ppmv CO_2 equivalent by 2170 (s550) (Leggett et al., 1992). These scenarios were used in the context of a WHO study on the global and regional burden of disease (GBD) (McMichael AJ *et al.*, 2004);
- Projected investment in physical assets for 2030 from the OECD ENV-Linkage model were used as the basis for estimating additional investment and financial flows needed in the AFF and infrastructure sectors.[36] The projected investment in physical assets

for 2030 based on the OECD ENV-Linkage model corresponds to the projection of the IEA WEO reference scenario.

356. Higher GHG emission levels than projected under these scenarios are possible.

357. The impacts on needs for investment and financial flows for adaptation have not been modelled based on the reference and mitigation scenarios used for the mitigation analyses. Given the lack of data, this work could not be undertaken in the context of this study, so different scenarios had to be used for the adaptation analyses.

358. In 2030, the year for which needs for investment and financial flows are estimated in this study, the CO_2 concentrations and projected changes in temperature and thus the associated differences in the adverse impact of climate change between any scenarios can be expected to be quite small.[37] For some sectors, it was assumed that adaptation would only be to the realized impact of climate change in 2030 so there would be little difference across scenarios in investment and financial flows needed by then. However, in the water supply and coastal zones sectors, adaptation to climate change anticipates some change in climate for, respectively, another 20 and 50 years. In those sectors, it is assumed that those adapting have perfect information on changes in global and regional climate in 2050 and 2080. In those cases differences in greenhouse gas emissions across scenarios would be significant.

5.3. LIMITATIONS IN ESTIMATING ADAPTATION COSTS

359. There are many difficulties and limitations in estimating the costs of adapting under various scenarios as well as the ability of countries to self-finance adaptation. These include (1) differences in adaptive capacity; (2) the fact that most adaptations will not be solely for the purpose of adapting to climate change; (3) the uncertainties associated with any readily available methods to estimate adaptation costs and (4) the existence of an adaptation deficit.

5.3.1. ADAPTIVE CAPACITY

360. One of the key limitations in estimating the costs of adaptation is the uncertainty about adaptive capacity. Adaptive capacity is essentially the ability to adapt to stresses such as climate change. It does not predict what adaptations will happen, but gives an indication of the differing capacities of societies to adapt *on their own* to climate change or other stresses. Smit *et al.* (2001) identified six determinants of adaptive capacity:

- Economic resources;
- Technology;
- Information and skills;
- Infrastructure;
- Institutions;
- Equity.

361. Unfortunately, all the scenarios used in this study leave many key aspects of adaptive capacity undefined. Although, in some cases, economic resources are specified and the level of technology is defined to some extent, the other four determinants of adaptive capacity are not defined. For example, institutions, which to some extent are a proxy for governance, a key factor in adaptive capacity, are not defined. It is not clear how this and other factors might differ across the scenarios.

362. A further limitation of the scenarios is that the socio-economic variables are defined at best, only at highly aggregated scales. Development paths are not projected for individual countries. Within any scenario, it is reasonable to expect that the development paths of individual countries will differ. Some may have economic or population rates of growth that are faster or slower than the regional averages. Thus, it is not possible to determine how adaptive capacity will change at the country level based on the selected scenario.

[36] OECD. ENV-Linkages Model calibrated to the IEA WEO 2006 Reference scenario. Personal communication with Philip Bagnoli at OECD.

[37] For example, in the SRES A1B and B1 scenarios by 2050, the CO_2 concentrations are almost 540 ppmv and 490 ppmv respectively. The global mean temperature increase differs only slightly between the two scenarios, about 1.6° C for the A1B scenario and 1.4° C for the B1 scenario. By 2100, the A1B scenario results in CO_2 concentrations of more than 700 ppmv, while the B1 scenario results in concentrations of about 550 ppmv. This yields a global mean temperature increase in 2100 of 2.8° C (with a range of 1.7 to 4.4° C) for the A1B scenario and 1.8° C (with a range of 1.1 to 2.9° C) for the B1 scenario (IPCC, 2007a).

5.3.2. ADAPTATIONS ARE TYPICALLY NOT SOLELY CLIMATE CHANGE RELATED

363. A second key limitation is that most adaptations to climate change will most likely not be made solely to adapt to climate change. Most activities that need to be undertaken to adapt to climate change will have benefits even if the climate does not change. For example, improvements in the management of ecosystems to reduce stresses on them or water conservation measures can typically be justified without considering climate change. Climate change provides an additional reason for making such changes because benefits of the adaptations are larger when climate change is considered. Indeed, the need for these adaptations may not depend on specific greenhouse gas concentration levels and thus climate change associated with scenarios. It may well be justified to introduce water use efficiency or reduce harm to coral reefs no matter what scenario is assumed.

364. However, some adaptations would happen solely on account of climate change considerations. Such adaptations are typically marginal adjustments to infrastructure or land use decisions. For example, flood protection infrastructure could be enlarged to account for additional risks from sea level rise or more intense precipitation (or both). Land use decisions such as defining flood plains, regulating and guiding land use or setbacks from the coast could be adjusted to account for future risks from climate change.

5.3.3. METHODS FOR ESTIMATING ADAPTATION COSTS

365. At least four methods for estimating global and regional adaptation costs could be used; these are briefly reviewed here. The latter three have been used in this study or in other studies. A discussion of the four methods and their limitations follows.

366. The first method is a complete bottom-up approach. It involves estimating the costs of specific adaptations across the world. Currently, partial information can be obtained from national adaptation programmes of action (NAPAs) and national communications. Where costs have been estimated, they can be used; where they are not estimated in the NAPAs or national communications, they can be derived. This approach has the advantage of building on adaptations identified by countries. Moreover, it is likely that different costing methods would be applied by different countries (or even within countries). The existing information on bottom-up adaptation needs is far from being comprehensive and complete. Therefore, it is impossible to assess needs entirely from the bottom within any reasonable time and resources constraints.

367. A second method is an extrapolation of the bottom-up method. Oxfam America (Raworth, 2007) extrapolates from estimated adaptation costs in NAPAs to the rest of the developing world using three factors: population, income and land. It estimates that adaptation costs will be more than USD 50 billion per year. This method has the advantage of using official estimates of adaptation costs as the basis for the extrapolation. However, as the report notes, only 13 NAPAs have been written. It is not known if these 13 NAPAs are representative of adaptation needs across the developing world or if the identification of adaptations is comprehensive. The NAPAs target only 49 LDC Parties to the UNFCCC and may not reflect needs in more developed countries. It is also important to note that the NAPAs focus on “urgent” needs, not all adaptation needs.

368. A third method, used for the AFF, natural ecosystems, and infrastructure sectoral analyses in this study, is to use current global expenditures in the sectors and apply a rule of thumb to estimate additional costs for meeting development needs and climate change adaptation. For example, the World Bank (2006) assumed that development costs will increase by USD 10 billion to USD 40 billion per year by assuming that climate-sensitive portions of the Bank’s investment portfolio will need an additional 5 to 20 per cent in resources to adapt to climate change. This approach is akin to a sensitivity analysis and can help give an order of magnitude of adaptation costs. A key uncertainty is related to the need to use assumptions about additional costs. The assumptions could be based on experience or a wide and representative sample of studies of specific adaptations; or it could be an educated guess and may not reflect actual conditions or variance of adaptation needs. Because such assumptions may be applied to a large base (the current total level of investment), even small percentage changes can yield large differences in estimates of investment and financial needs.

369. The fourth approach is a top-down quantitative analysis and is used in the water resources, coastal resources, and human health analyses in this study. Models can be applied to estimate biophysical impacts and needs for adaptation such as infrastructure for water supply or coastal defences. Uniform cost rules (perhaps adjusted for different per capita income levels) can be applied to estimate costs. The advantage of the uniform approach is that differences across countries can reflect different conditions and needs. This approach can give a

rough estimate of total costs, but typically will not capture site-specific differences. Actual investment and financial flows needed could vary quite substantially from the uniform rules. Furthermore, top-down approaches may not be comprehensive. For example, the model used to come up with estimates of needs for the water resources sector only includes water supply, not water quality, flood protection or the systems to distribute or treat the water. Models can be very expensive and time consuming. Finally, the use of different assumptions can result in quite different estimates of magnitudes. The water supply and coastal resources analysis consider the need for investment and financial flows associated with economic and population growth, while the health analysis does not consider these two factors.

5.3.4. THE EXISTENCE OF AN ADAPTATION DEFICIT

370. Before examining how development and climate change will affect needs for investment and financial flows, it is important to note that for all of the sectors examined herein, there is a substantial deficit in investment and financial flows. In many places property and activities are insufficiently adapted to current climate, including its variability and extremes. This has been labelled as the "adaptation deficit" (Burton, 2004).

371. Evidence for the existence and size of the adaptation deficit can be seen in the mounting losses from extreme weather events such as floods, droughts, tropical cyclones, and other storms. These losses have been mounting at a very rapid rate over the last 50 years. This increase is likely to be mostly due to the expansion of human populations, socio-economic activities, real property, and infrastructure of all kinds into zones of high risk. Moreover, much of this property is built at a substandard level and does not conform even to minimal building codes and standards. This widespread failure to build enough weather resistance into existing and expanding human settlements is the main reason for the existence of an adaptation deficit. Real property and socio-economic activities are just not as climate-proof as they could and arguably should be. The evidence suggests strongly that the adaptation deficit continues to increase because losses from extreme events continue to increase. In other words, societies are becoming less well adapted to current climate. Such a process of development has been called "maladaptation".

5.4. ANALYSIS OF INVESTMENT AND FINANCIAL FLOWS TO ADDRESS ADAPTATION NEEDS

5.4.1. AGRICULTURE, FORESTRY AND FISHERIES

5.4.1.1. INTRODUCTION

POTENTIAL IMPACTS OF CLIMATE CHANGE ON AGRICULTURE, FORESTRY AND FISHERIES

372. The effects of climate change on agriculture are different across regions and over time. Yields are projected to decline in low latitudes with any increase in temperature. In high latitudes, yields can increase with up to about 3° C of warming of local temperatures,[38] then start to decrease. For the first several degrees of increase in global mean temperature over 1990, global agricultural production could increase, driven by the increased yields in mid- and high latitudes. But, this will happen while yields in low-latitude areas decrease; thus, the potential for malnutrition in developing countries can rise. Malnutrition is projected to decline as a result of development, but the declines could be partially offset by climate change. Beyond several degrees of warming, global agricultural production is projected to decline (Easterling *et al.*, 2007). That would involve widespread adverse economic impacts and greater levels of malnutrition.

373. There are many important caveats in these findings. Changes in extreme events could disrupt agricultural production with even just a few degrees of warming. Adaptative capacities will play a key role in determining vulnerability. The IPCC concluded that a 3° C regional warming would exceed the capacity of developing countries to adapt to climate change impacts on crop yields (Easterling *et al.*, 2007). The potential for technological adaptations such as crop breeding to increase tolerance for heat and drought or taking better advantage of elevated atmospheric CO_2 concentrations has not been studied. Thus uncertainties about estimated impacts of climate change on agriculture mean that actual impacts could be more negative or more benign than projected. Whatever the climate change and its impacts, global agriculture will need to adapt by changing location and types of cropping systems. For example, increased agricultural output will require changes in locations of crops and expansion of agriculture into high-latitude areas. Such adaptations will require capital investment to be realized.

[38] Note that temperature increases in mid- and high-latitude land areas will be higher than increases in global mean temperature (IPCC, 2007a).

374. Meanwhile, Easterling *et al.* (2007) projected that global forestry would be affected modestly by climate, but that regional impacts could be more substantial. Generally, production of forests would shift from low-latitude to high-latitude areas. There could be significant changes in distribution and productivity of fisheries, with fish species in many locations becoming extinct, but fish productivity increasing for some species in some locations. Higher temperatures could adversely affect aquaculture, as could increased extreme weather, presence of new diseases and other factors (Easterling *et al.*, 2007).

ADAPTATION

375. Many actors, varying from individual farmers, ranchers, herders, and fisherpeople to national governments, international research organizations and multinational corporations will be involved in adaptingto climate change and in responding to the growing need for investment and financial flows in the agriculture, forestry, and fisheries sectors. Some of the fundamental forms of adaptation are as follows:

- *Change in mix of crop, forage, and tree species/ varieties.* The mix of crop, forage grasses, or trees species employed, for example, growing crops, grasses, or trees can be changed toward varieties and species that are more heat, drought, or moisture tolerant. More generally, this involves replacing some proportion of the crop, forage, and tree species with alternative species better adapted to new climate regimes;
- *Change in mix of livestock and fish species/breeds.* This involves replacing some proportion of current species or breeds with alternative species or breeds that are more suitable for the altered climatic regime. For fisheries, this may mean harvesting species that have potentially migrated into the fishing grounds. In aquaculture and domestic animal raising this involves adopting livestock and fish species from areas that have had comparable climates;
- *Change in management of crops, forests, and fisheries.* Crops can be planted or harvested earlier to adjust to altered soil warm-up rates, soil moisture conditions, earlier maturity dates, and altered water availability regimes. Livestock and fish management changes can include altering aquaculture facility characteristics, changing stocking rates, altering degree of confinement, among many other possibilities. Adaptation in wild fish management may involve using species that migrate to fishing grounds or travelling farther to catch the same species being harvested now;
- *Moisture management/irrigation.* Climate change can increase crop water needs, decrease water availability, decrease soil moisture holding capacity, and increase flooding and water logging. Adaptation may involve using irrigation, which may require investing in irrigation facilities or equipment, changing drainage management regimes, altering tillage practices to conserve water, altering time of planting/harvesting to better match water availability, changing species to more drought tolerant plants/trees;
- *Pest and disease management.* Climate change is likely to exacerbate pest, disease and weed management problems. Adaptation could involve wider use of integrated pest and pathogen management or preventative veterinary care, development and use of varieties and species resistant to pests and diseases, maintaining or improving quarantine capabilities, outbreak monitoring programmes, prescribed burning, and adjusting harvesting schedules;
- *Management of natural areas.* Some AFF production such as livestock management relies on passively managed, natural ecosystems that may require more active management under climate change to introduce new, better adapted species or to deal with climate change enhanced pest, disease, or fire risks;
- *Fire management.* Forests, grasslands, and to some extent crop lands are vulnerable to climate change induced increases in fire risk. Such risks may stimulate adaptive actions like salvaging dead timber, landscape planning to minimize fire damage, and adjusting fire management systems;
- *Land use or enterprise choice change.* Climate change may make current land uses, such as cropping unsustainable, and it may be desirable to adapt by changing the land use from crops to pasture or trees, or from trees to grazing land. For fisheries, it may be desirable to abandon aquaculture or discontinue pursuing certain fish species in some regions. In some cases, loss of productivity in agriculture, forestry, or fisheries may lead to migration of people to areas such as cities or other countries that may offer better employment opportunities.

376. Governments, international organizations and NGOs have important roles to play in adaptation. The types of adaptation actions that can be pursued are as follows:

- *Research.* Public resources can be placed into research to provide adaptation strategies that could be adopted by the AFF producers, as discussed previously. These resources will be funding domestic government research organizations, international research organizations such as the Consultative Group for International Research, universities, or research oriented NGOs;
- *Extension and training.* Traditionally, substantial funding has gone into extension services and training to disseminate information to farmers, foresters, and fisherpeople on practices and technologies. Funding would need to go into rural training and extension programmes to disseminate adaptation options, by providing information and training on practices that could be adopted by AFF producers. Extension services may need to be enhanced to cope with the demands of development and climate change;
- *Transitional assistance.* Climate change may stimulate location changes and migration. There may be scope for identifying resources for creating job opportunities, supporting incomes, developing new infrastructure/institutions, relocating industry, providing temporary food aid, improving market functions and developing insurance;
- *Trade policy.* Governments may need to revise trade policies to adapt to new climate change conditions to allow imports and exports to mitigate lost AFF production or to sell or dispose of surpluses;
- *Infrastructure development.* Public investment may be needed to adapt to climate change conditions, including development of new transport and municipal infrastructure, development of new lands, protection or improvements of existing lands, construction of irrigation and water control structures, protection of coastal resources, and incubation of new industries, among other possibilities.

METHOD USED TO ESTIMATE NEED FOR INVESTMENT AND FINANCIAL FLOWS

377. Although extensive literature exists on the impacts of climate change on agriculture production, it tends to focus on the net effects on production, not on the costs of adaptation. Indeed, many of the studies related to AFF do not specify needed adaptation measures, not to mention costing them. In the face of these realities the approach used here relies on subjective statements about the current degree to which research expenditures are directed at climate related issues and a broad assumption about how capital formation might be affected.

378. The AFF sector estimated the additional investment and financial flows needed in the primary sector (e.g. the growing of crops, the farming of animals, logging and fish farms) and the secondary sector (e.g. food, wood product and pulp and paper manufacturing industries) to cope with expected economic and population growth and the impacts of climate change.

379. In order to assess investment and financial flows needed to cope with expected economic and population growth in 2030 based on the relevant literature, it is expected that the level of resources spent on research will continue to grow at about 2 per cent per year in both developed and developing countries. Total resources spent on extension are assumed to rise by 20 per cent in developing countries due to their current and emerging food issues and the current level of resources spent on extension in developed countries are assumed to be adequate and remain constant. The projected level of investment in physical assets needed in 2030 is based on the OECD ENV-Linkage model and corresponds to the projection of the IEA WEO reference scenario.

380. In order to meet climate change adaptation needs, the following was assumed:

- Based on a study of the implications of future agricultural research needs and subjective estimates of the amount research expenditures in the Consultative Group on International Agricultural Research (CGIAR) system related to climate, it is estimated that expenditures in research and extension to cope with expected economic growth in 2030 would need to increase by 10 per cent;
- It was assumed that there will be new capital needed to, for example, irrigate areas, adopt new practices, move fish timber processing facilities, etc. However, in 2030 the need for additional investment will be

limited by the fact that most agricultural and fisheries capital tends to have a short life (10 – 20 years) and would be replaced and adapted as climate change proceeds. As a consequence, a low 2 per cent estimate was used to reflect the additional level of investment needed in new facilities for the development of new and larger land areas to cope with regionally diminished production plus expanded irrigation and other inputs, relocation of food, wood industry, and pulp and paper manufacturing facilities. Based on this, the additional investment in gross fixed capital formation between 2005 and 2030, as estimated by the OECD ENV-Linkage model, will need to increase by 2 per cent.[39]

5.4.1.2. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS BY SOURCE OF FINANCING

381. Current expenditures on AFF are presented in TABLE V-40. Public expenditures on research are about two thirds of the total, but are more than 90 per cent of the expenditures in developing countries and less than half of the expenditures in developed countries.

382. TABLE 33-ANNEX V presents the total GFCF for the 3 AFF sub sectors (agriculture, forestry and fisheries) in 2005 and for 2030, as projected by the OECD ENV-Linkage model. About three fifths of the investment is for agriculture, one third is forestry, and the remaining 2 per cent is for fisheries. GFCF is projected to almost double in 25 years, but the shares devoted to the sub sectors are expected to remain about the same. TABLE 35.1- and 35.3-ANNEX V presents the source of funding for the investments in GFCF in the AFF sector in 2000. TABLE 35.1-ANNEX V presents the source of financing for the investment related to AFF activities in the primary sector, growing of crops, farming of animals, logging and operation of fish hatcheries and fish farms, while TABLE 35.3-ANNEX V presents the source of financing for the investment related AFF activities in the secondary sector, the food, wood product and pulp and paper manufacturing industries.[40] Domestic investment represents 97 per cent of the investment in the former sector and 84 per cent in the later, while ODA represents 1.2 per cent in the former and 0.1 per cent in the latter. In both cases, FDI is likely to play a more significant role than ODA, however FDI role is likely to be significantly greater in activities related to the manufacturing industries than in the primary sector.

383. The trend in ODA to AFF by region is displayed in TABLE 14-ANNEX V. Total ODA to AFF reached USD 6.4 billion in 2005. Total ODA in AFF rose by 8 per cent from 2000 to 2005, but expenditures in extension increased by 38 per cent and expenditures in research increased by almost 80 per cent during the same period.

5.4.1.3. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

384. TABLE V-41 presents estimates of additional investment and financial flows needed to address expected economic growth and population growth. TABLE V-41 also presents the additional investment and financial flows needed to adapt to climate change.

385. Overall, a substantial increase in investment and financial flows will be needed to meet the growing demand due to expected economic and population growth in 2030. It is estimated that investment and financial flows into R&D, extension activities and physical assets will need to nearly double (an increase of about USD 575 billion) between 2005 and 2030. Adaptation to the adverse impacts of climate change is estimated to add about 2 per cent to this amount or about USD 14 billion in 2030. About 75 per cent of this latter amount will be required for investment in physical assets (capital formation related investment) and 25 per cent will be required in the form of financial flows for research and extension activities. Slightly more than half of this amount will be needed in developing countries.

[39] Actual investment needs could be somewhat lower (one can imagine costs being half as much) or substantially higher (one can also imagine costs being two to three times or more higher).

[40] TABLE ANNEX V-35.3 includes all manufacturing sectors. The source of financing for the food, wood product and pulp and paper manufacturing industries might thus differ to some extent.

Table V-40. **Expenditures in agriculture, forestry and fisheries (millions of United States dollars)**

Type of expenditures	Amount
Research in developing countries[a]	15,422
Research in high income countries[a]	25,111
Extension in developing countries[a]	3,083
Extension in high income countries[a]	4,161
Capital formation in developing countries[b]	190,102
Capital formation in high income countries[b]	354,017
Total developing countries	208,608
Total high income countries	383,288
Total	591,896

[a] Estimated for 2000
[b] Estimated for 2005

Table V-41. **Investment and financial flows needed in 2030 for economic and population growth and for adaptation to the adverse impacts of climate change (millions of United States dollars)**

Type of expenditures	Additional investment and financial flows needed due to economic and population growth	Additional investment and financial flows needed for adaptation to the adverse impacts of climate change
Research in developing countries	13,526	1,353
Research in high income countries	20,374	2,037
Extension in developing countries	617	62
Extension in high income countries	0	0
Capital formation in developing countries	291,093	5,822
Capital formation in high income countries	248,001	4,960
Total developing countries	305,236	7,237
Total high income countries	268,375	6,997
Total	573,611	14,234

5.4.1.4. ASSESSMENT OF NEEDED CHANGES IN INVESTMENT, FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP IN INVESTMENT AND FINANCIAL FLOWS

386. The additional investment and financial flows needed in 2030 to cope with the adverse impacts of climate change in the AFF sector is about USD 14 billion. Slightly more than half of this amount will be needed for developing countries alone. It is estimated that approximately USD 11 billion will be needed to purchase new capital; for example to irrigate areas, adopt new practices and to move processing facilities. The additional financial flows needed in the AFF sector for research and extension activities to facilitate adaptation would be about USD 3 billion.

387. Most of the additional investment in physical assets needed in the AFF sector is for assets that are currently financed by domestic private agents. ODA currently accounts for less than one per cent of the resources channelled to this sector in non-Annex I Parties and for about 3 per cent in LDC Parties. FDI is likely to play a more significant role than ODA, however its role is likely to be significantly greater in activities related to the manufacturing industries than in the primary sector. Consequently, it can be expected that the majority of the additional investment needed would come from private sources, such as domestic AFF producers and processing firms and multinational seed companies, chemical companies and companies in the manufacturing industries. It can be expected that additional public resources will be needed to provide the private sector with the necessary information and incentives for it to make the required additional investment to better adapt to climate change. The design of adequate and coherent national policies could play a key role and targeted support will be needed for this to happen. Substantial external public resources are already channelled into agricultural and forestry policies in developing countries, in particular in Africa and Latin America. A higher fraction of these resources might need to support the integration of be needed for this, depending on the region.

388. Public sources account for two thirds of the current funding for AFF research worldwide but for as much as 90 per cent of AFF research funding in developing countries. Thus, for the additional USD 3 billion needed in investment and financial flows in 2030 for research and extension in developing countries, most of the additional funding would need to come from public sources unless adequate incentives are provided to the private sector. Assuming that public spending continues to increase by slightly more than 2 per cent per year in developing countries, an additional USD 1.4 billion would need to come from new sources of external public financing in 2030 to cope with the adverse impacts of climate change.

Box V-10. **Agriculture, Forestry and Fisheries**

Investment and financial flows needed in 2030

To address climate change impacts in this sector, an additional USD 14 billion in investment and financial flows would be needed. About half of this amount is estimated to be needed in developing countries. It is estimated that approximately USD 11 billion will be needed to purchase new capital; for example to irrigate areas, adopt new practices and to move processing facilities. The additional USD 3 billion will be needed for research and extension activities to facilitate adaptation.

Current investment and financial flows

Total current expenditure on AFF for capital formation, research and extension is estimated to be in the order of USD 591 billion. A large proportion of the investment in the AFF sector is made in privately own physical assets by AFF producers and processing firms and multinational seed companies, chemical companies and companies in the manufacturing industries. Public expenditures on research are about two-thirds of the total, but are more than 90 per cent of the expenditures in developing countries and less than half of the expenditures in developed countries. A relatively substantial level (2.9 USD billion in 2000) of external public resources are channeled into agricultural and forestry sector policies in developing countries as compared to other sectors, in particular in Africa and Latin America.

5.4.2. WATER SUPPLY

5.4.2.1. INTRODUCTION

POTENTIAL IMPACTS OF CLIMATE CHANGE ON WATER RESOURCES

389. The IPCC reports that water resources around the world will be highly sensitive to climate change. Higher temperatures, increased melting of glaciers, salinization from rising oceans, an increased speed of the hydrological cycle and changes in precipitation patterns will affect the supply, quality and demand for water resources around the world (Kundzewicz *et al.*, 2007). One likely outcome from an increased hydrological cycle is precipitation falling in fewer but more intense events, thus increasing the likelihood of flooding in many regions and more days without precipitation, thus also increasing likelihood of drought (Tebaldi *et al.*, 2006; IPCC, 2007a). One recently finding from the literature is the likelihood of certain regional patterns of precipitation. For example, most climate models project that the Mediterranean Basin, Southern Africa, many parts of northern Brazil and southwestern North America are likely to see a reduction in precipitation (Kundzewicz *et al.*, 2007; Milly *et al.*, 2005).

ADAPTATION

390. The IPCC also notes that there are many options for adaptation related to water resources and that many water bodies in municipalities (particularly, but not exclusively, in developed countries) are already beginning to take steps to prepare for climate change. TABLE V-42, from Kundzewicz *et al.*, (2007), summarizes some options or adaptation. The IPCC identified reservoir construction and decommissioning, increased waste water reuse and desalinization, more efficient waste water treatment, and application of water saving technologies as other options for adaptation.

METHOD USED TO ESTIMATE NEED FOR INVESTMENT AND FINANCIAL FLOWS

391. Given the need to use readily available data for this analysis, estimates presented are only for changes in water supply and demand. The investment resources needed for water quality and flood control are not estimated. The supply costs also do not include estimates of needs for distribution systems. Consequently, the estimates in this study might be underestimating the cost of adaptation in the water resources sector.

392. Modelling was used to estimate changes in demand by each country for water supply for two scenarios: the SRES A1B and B1 scenarios. The estimates consider the needs of increasing populations and growing economies. Change in 2030 assumed planning for the next 20 years and perfect knowledge about climate change impacts in 2050. Estimates of demand for water supplies and estimates of change in supply (as affected by climate change) used by Kirshen (2007) were used. Uniform assumptions were used about how much water in basins could be used to meet off-stream uses such as domestic consumption and irrigation. Some use of desalinated water in coastal cities and some use of reclaimed water for irrigation in countries facing particular water shortages were assumed. The cost of unmet irrigation demands have not been considered in the analysis.

Table V-42. Adaptation measures in the water resource sector

Supply side	Demand side
Prospecting and extraction of groundwater	Improvement of water-use efficiency by recycling water
Increasing storage capacity by building reservoirs and dams	Reduction in water demand for irrigation by changing the cropping calendar, crop mix, irrigation method, and area planted
Desalination of sea water	Reduction in water demand for irrigation by importing agricultural products, i.e., virtual water
Expansion of rain water storage	Promotion of indigenous practices for sustainable water use
Removal of invasive non-native vegetation from riparian areas	Expanded use of water markets to reallocate water to highly valued uses
Water transfer	Expanded use of economic incentives, including metering and pricing to encourage water conservation

Source: Kundzewicz *et al.*, 2007.

393. Applying uniform rules of thumb is a practical method for generating estimates of financial costs. However, it implies that country by country variance in costs and approaches cannot be considered. In the context of this study, uniform assumptions were applied for costs for extracting groundwater, building additional surface water storage capacity, installing desalinization plants, and reclaiming water. However, the cost estimates considered differences in costs in developed and developing countries. Results for regions, and particularly countries, should be treated as preliminary.

394. The cost estimates for 2030 are the total costs associated with the construction of additional infrastructure (reservoirs, wells, desalination, re-use facilities) needed to meet the projected demand for water supplies because of projected population and economic growth and expected climate change under the two scenarios.

5.4.2.2. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS BY SOURCE OF FINANCING

395. Briscoe (1999) estimates current annual expenditures for water-related infrastructure in developing countries to be USD 15 billion for hydropower, USD 25 billion for water supply and sanitation, and USD 25 billion for irrigation and drainage, for a total of USD 65 billion. GFCF for water is estimated at USD 38.4 billion in 2005. Winpenny (2003) and Briscoe (1999) both state that the majority of present financing for all aspects of water resources use comes from public sources, with Briscoe presenting estimates that 90 per cent is from mainly public sources and 10 per cent is from external sources. TABLE 15-ANNEX V gives levels of ODA to water infrastructures in 2000 and 2005. In 2000, total ODA in the water sector infrastructure (USD 4.2 billion) accounted for about 6 per cent of the total annual expenditures estimated by Briscoe (1999).

396. As shown in TABLE 15-ANNEX V, from 2000 to 2005, real ODA directed towards water infrastructure increased by approximately 40 per cent (from USD 4.2 billion in 2000 to USD 5.9 billion in 2005). The regional distribution changed markedly, with Latin America and the Caribbean receiving in 2005 only 32 per cent of the amount it received in 2000. Contributions to Asia, Africa and the Middle East increased significantly from 2000 to 2005.

5.4.2.3. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

397. Much has been written about the challenges of financing Target 10 of the MDGs for halving "by 2015 the number of people without sustainable access to safe drinking water and basic sanitation" (e.g., Toubkiss, 2006, Winpenny, 2003). Eleven different estimates ranged from USD 9 billion to USD 100 billion per year. A commonly accepted estimate is that meeting the most basic domestic water and sanitation goals would require an annual expenditure of USD 10 billion through 2015 (Winpenny, 2003). It appears that none of the reports included climate change impacts on water supply or demand. This is reasonable, as domestic water demands are only a small portion of global water demands. The estimates presented below do not include the costs of meeting Target 10 of the MDGs, rather they complement it.

Table V-43. **Investment and financial flows needed in 2030 for economic and population growth and for adaptation to the adverse impacts of climate change for the SRES A1B and B1 scenarios (billions of United States dollars)**

Region	SRES A1B	SRES B1
Africa	233	223
Developing Asia	303	230
Latin America	23	23
Middle East	151	148
OECD Europe	87	25
OECD North America	41	16
OECD Pacific	3	1
Transition economies	57	54
World total	898	720
NAI Parties	720	628
Least Developed Countries	57	45

398. The estimated investment needs for the SRES A1B and B1 scenarios by region are summarized in TABLE V-43. The estimates of investment and financial flows needed represents the total flows needed for the construction of additional infrastructure required to meet the projected demand for water supply caused by population and economic growth and expected climate change by 2030.

399. The investment cost for meeting the A1B scenario, assuming climate change to 2050 is anticipated, is estimated to be USD 797 billion; the cost of meeting the B1 scenario is estimated to be USD 639 billion, some 20 per cent less. This 20 per cent reduction is mainly due to differences in socio-economic conditions between the two scenarios; there is significantly more economic growth in the A1B scenario.

400. The fraction of the change in investment needs attributable to climate change alone is estimated to be 25 per cent under both the SRES A1B and B1 scenarios. Thus climate change is estimated to increase total investment needs by 2030 by USD 225 billion under the A1B scenario and USD 180 billion under the B1 scenario.

401. Assuming that funding is provided through grants for a 20-year period, the additional investment and financial flows needed for adaptation would be about USD 9 – 11 billion in 2030. About 85 per cent of the investment (USD 8 – 9 billion) is estimated to be needed in non-Annex I Parties. Interestingly, this is of the same order of magnitude as the additional investment and financial flows needed to meet the MDG related to sustainable access to safe drinking water and basic sanitation.

5.4.2.4. ASSESSMENT OF NEEDED CHANGES IN FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP IN INVESTMENT AND FINANCIAL FLOWS

402. For adaptation alone, the additional investment and financial flows needed would be about USD 9 – 11 billion in 2030. Winpenny (2003) describes three types of obstacles to increasing the financing for water-related infrastructure and then presents many recommendations to overcome them. The major classes of obstacles include: governance; particular funding risks of the water sector such as its low rate of return, capital intensity with long payback period; and the large number of projects that cannot obtain financing from any source because of project size or the credit risk of the borrower (called the "exposed segment"). Briscoe (1999) estimates that 90 per cent of funding for all aspects of water resources use is from domestic sources and 10 per cent is from external sources. Both sources might be inadequate to meet future challenges associated with climate change. If the increase in investment needs solely related to climate change in non-Annex I Parties (USD 8 – 9 billion) is to come entirely from ODA, which is currently USD 5.9 billion per year, then ODA would need to rise by about 50 per cent to meet the additional requirements. Despite the important recent increases in ODA allocated to the water and sanitation sector, it is unlikely that this is indicative of the expected change from the present to 2030. New domestic and external public resources will be needed.

Box V-11. **Water supply**

Investment and financial flows needed in 2030
The total cost associated with the construction of additional infrastructure needed to meet the projected demand for water supply is estimated to increase investment needs in 2030 by USD 11 billion. About 85 per cent of the investment is estimated to be needed in non-Annex I Parties.

Current investment and financial flows
In 1999, expenditures for water-related infrastructure in developing countries were estimated at USD 65 billion. Total investment in physical assets only in this sector was estimated at USD 38.4 billion in 2005. Most of this investment is undertaken by governments. About 90 per cent of the cost for all aspects of water resource use is currently covered by domestic funding sources and 10 per cent by external funding sources. From 2000 – 2005, ODA directed towards water infrastructure increased by approximately 40 per cent (from USD 4.2 billion in 2000 to USD 5.9 billion in 2005).

5.4.3. HUMAN HEALTH

5.4.3.1. INTRODUCTION

POTENTIAL IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH

403. Climate change is likely to have widespread, diverse, and on the whole negative impacts on human health across the world. The impacts include changes in the location and incidence of infectious and diarrhoeal diseases, increases in air and water pollution in many locations, increase in risk of heat stress, increases in intensity and frequency of many extreme events, and increased risks of malnutrition and other consequences of poor food quality. In addition, disruption of natural ecosystems could enable the further spread of infectious diseases, and climate change induced human migration can be injurious to mental and physical health. On the positive side, there could be reductions in some cold-related health outcomes. On the whole, the Human Health chapter of the IPCC AR4 concluded that climate change has begun to negatively affect human health, and that projected climate change will increase the risks of climate-sensitive health outcomes (Confalonieri *et al.*, 2007).

ADAPTATION

404. The fundamental adaptation requirement for the health sector in relation to climate change is to improve the capacity of the public health system. There is tremendous disparity in health risks between the developing and developed world. The main reason is that, on average, the public health systems in the developed world function at much higher levels than do the systems in the developing world. Improving the delivery of health care in the developing world would go a long way toward helping developing countries develop and could substantially reduce vulnerability to climate change. Without substantial improvement in the public health systems, human health in developing countries will be highly vulnerable to climate change. However, even with significant improvements in health care, climate change is projected to increase the burden of climate-sensitive health determinants and outcomes.

405. Beyond this, there are many specific measures that can be taken to reduce vulnerability to climate change. These include, for example, improved monitoring systems to detect the arrival or presence of infectious diseases and heat-watch warning systems to warn urban populations about heat waves.

METHOD USED TO ESTIMATE NEED FOR INVESTMENT AND FINANCIAL FLOWS

406. The Global Burden of Disease (GBD) study conducted by the WHO (McMichael *et al.*, 2004) was used to estimate the total increase in health cases in 2030. The GBD study is the most comprehensive study of the total impacts of climate change on global human health that has been conducted to date. The study used internally consistent estimates of incidence, health state prevalence, severity and duration, and mortality for more than 130 major health outcomes, and estimated change in disability adjusted life years (DALYs) lost compared with the base period 1961 to 1990. Twenty-six risk factors were assessed, including major environmental, occupational, behavioural and lifestyle risk factors. The analysis for this adaptation study focuses on three human health outcomes: diarrhoeal disease, malnutrition and malaria. Models were used to estimate risks for each outcome. The model output is reported as a mid-range estimate. As with the study of water investment needs, the advantage of this approach is that a consistent and comprehensive framework is applied across the globe.

407. The limitations of this approach are similar to the limitations of the water assessment. What is essentially top-down modelling typically does not account for many varying local and regional factors that affect results at these scales. Such top-down approaches, however, are useful for providing a consistent and approximate estimate of impacts.

408. The GBD study uses two scenarios. The first scenario is the 750 ppmv stabilization scenario from the GBD analysis; this results in CO_2 concentrations in the atmosphere slightly higher than the SRES A1B scenario. The second scenario is the 550 ppmv stabilization scenario from the GBD analysis. This CO_2 concentration is similar to that from the SRES B1 scenario. The GBD relied on climate change estimates from one general circulation model, the HADCM2 model (Johns *et al.*, 2001).

409. A further limitation is the estimated costs for treating health outcomes. The cost estimates are low because they consider only the cost of treating one case of each health outcome, thus assuming that there is sufficient public health infrastructure to administer the treatment. The estimates do not include the costs of setting up new infrastructure (such as the ability to distribute bed nets) when a health outcome increases its geographic range. In addition, some estimated costs are low. For example, the average cost of intervention per child to combat

malnutrition is estimated to be about USD 20, whereas more recently published studies estimated costs of one order of magnitude higher.

410. Other human health impacts such as increased heat stress, exposure to air and water pollution, exposure to many other diseases such as dengue fever, and exposure to increased intensity of many extreme weather events are not examined. So the total estimated number of cases caused and the costs associated with climate change are not complete.

411. Based on Rosenzweig and Parry (1994), malnutrition is projected to increase. Despite its vintage, it is perhaps the most comprehensive study of climate change impacts on agriculture done to date. The study assumed global population growing to USD 10.8 billion by the middle of the century, whereas the SRES A1B and B1 scenarios assumed global population peaks at about 8 billion. The agriculture estimates do not account for the effect of potential increases in extreme weather on agricultural production or distribution of food. Further, the estimates are of crop yields, not food security. Micronutrient deficiencies are a major source of ill health, even in regions with sufficient crop yields. On the other hand, the study did not account for adaptations such as the development of more heat and drought-tolerant crops or crops that can take better advantage of higher atmospheric CO_2 levels. Finally, for malnutrition, stunting and wasting were analysed, but not all the health impacts. Stunting and wasting are a small percentage of the impacts of climate change, so this can represent a significant underestimate.

5.4.3.2. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS BY SOURCE OF FINANCING

412. Health expenditures come from both the public and private sectors. In many countries, government spending is the majority of total expenditures on health, whereas in many other countries, government spending is less than half of total expenditures. External expenditures on health are typically a small share of total expenditures. However, for very poor countries, external expenditures are a large share of total expenditures and even up to 30 to 50 per cent in a few cases. Table V-44 provides regional details on the above.

Table V-44. **Selected indicators of health expenditure ratios for the year 2000**

Region	Total expenditure on health (millions of United States dollars)	Government expenditure on health as a percentage of total expenditure on health (percentage)	Private expenditure on health as a percentage of total expenditure on health (percentage)	External resources for health as of total expenditure on health (percentage)	Out-of-pocket expenditure as percentage of private expenditure on health (percentage)
Africa	34,813	43	57	5	63
Developing Asia	122,935	36	64	1	93
Latin America	119,458	50	50	1	66
Middle East	37,252	63	37	2	79
OECD Europe	862,604	75	25	0	63
OECD North America	1,572,296	45	55	0	29
OECD Pacific	477,591	78	22	0	86
Other Europe	257	70	30	0	82
Transition Economies	33,526	60	40	1	79
World Total	**3,260,733**	**58**	**42**	**0**	**45**
NAI Parties	355,384	46	54	2	81
Least developed countries	8,330	37	63	17	85

Source: WHO 2006

413. TABLE 16-ANNEX V gives details on ODA by region for the health sector in 2000 and 2005. Total real ODA rose by two thirds from 2000 to 2005, with bilateral aid doubling. Total ODA for health reached USD 5.5 billion in 2005. Africa received the largest share of aid in both years, with South Asia second. Hecht and Shah (2003) estimated development assistance for health for the Disease Control Priorities in Developing Countries project (TABLE V-45). Although aid in the health sector is still dominated by multilateral and bilateral sources, NGOs such as the Bill and Melinda Gates Foundation are becoming a relatively more important source of funding and research.

5.4.3.3. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

414. The increased health risks for the middle scenario from the 750 ppmv and 550 ppmv stabilization scenarios relative to 1990 are presented in TABLE V-46. Regions are based on WHO classification. The groupings are not based on income level but rather on child and adult mortality rate (see ANNEX III for details on WHO regional groupings).

415. Based on model output, under the 750 ppmv stabilization scenario, there would be about 132 million additional cases of diarrhoeal disease, 5 million additional cases of malnutrition, and 22 million additional cases of malaria for these three health outcomes alone. Although virtually all of the malnutrition and malaria cases would be in developing countries, 1–5 per cent of the diarrhoeal disease cases would be in developed countries.

Table V-45. **Development assistance for health, selected years (millions of United States dollars)**

Source	Annual average 1997 to 1999	2002
Bilateral agencies	2,560	2,875
Multilateral agencies	3,402	4,649
European Commission	304	244
Global Fund to fight AIDS, Tuberculosis, and Malaria	0	962
Bill and Melinda Gates Foundation	458	600
Total	6,724	9,330

Source: Michaud (2003) and OECD (2004)

Table V-46. **Projected excess incident cases (in thousands) in 2030 of diarrhoeal diseases, malnutrition, and malaria for the 750 ppmv and 550 ppmv stabilization scenarios (middle estimates)**

	Diarrhoeal diseases		Malnutrition		Malaria	
Region	750 ppmv scenario	550 ppmv scenario	750 ppmv scenario	550 ppmv scenario	750 ppmv scenario	550 ppmv scenario
Africa	50,343	41,952	437	328	17,703	14,170
Americas-A	0	0	0	0	0	0
Americas-B	1,465	1,465	200	86	323	258
Eastern Mediterranean	5,779	5,779	533	335	3,211	2,535
Europe	785	785	0	0	0	0
Southeast Asia-A	0	0	225	113	0	0
Southeast Asia-B	73,608	63,092	3,067	2,165	70	0
Western Pacific-A	0	0	0	0	2	1.5
Western Pacific-B	0	0	211	70	478	404
Total	131,980	113,073	4,673	3,097	21,787	17,369

416. The number of additional cases in the 550 ppmv stabilization scenario is lower than in the 750 ppmv stabilization scenario. For example, additional cases of diarrhoeal disease would drop from 132 million per year to 113 million. Incidences of malnutrition would drop from 4.7 million additional cases to 3.1 million additional cases per year.

417. The estimated total global financial flows needed to cover the cost of the additional number of cases of diseases are reported in TABLE V-47.

418. The annual financial flows needed under the two scenarios to cover the cost of these three health outcomes arising from the adverse impacts of climate change would be USD 4 – 5 billion. Although the additional financial flows needed could not be allocated to different region in a meaningful way, it is assumed to be all in developing countries.

419. The 550 ppmv stabilization scenario results in fewer cases and lower financial flows needed than the 750 ppmv stabilization scenario. The needs are about USD 1 billion lower, from USD 5 billion down to USD 4 billion.

420. Although an estimate of the increased financial flows needed resulting from the socio-economic changes has not being developed for this study, an estimate of current financial needs can be derived by comparing the increase in health cases from climate change with the current number of cases. This can give an indication of the magnitude of financial flows that may be needed. TABLE V-48 presents the current number of cases of the three health outcomes, the projected number of cases under the two scenarios used, and the percentage increase.

421. Assuming the cost per case remains unchanged, under the reference scenario, the total financial flow would need to increase by 3 per cent to treat diarrheal disease, by 10 per cent to treat malnutrition, and by 5 per cent to treat malaria.

422. Although this study did not estimate the costs of improving health to meet the development needs associated with the 750 ppmv and 550 ppmv stabilization scenarios, Stenberg *et al.* (2007) estimated the costs to scale up essential child health interventions to reduce child mortality by two thirds under the four MDGs aimed at children's health by 2015 in 75 countries; the countries chosen accounted for 94 per cent of death among children less than five years of age. The interventions focused on malnutrition, pneumonia, diarrhoea, malaria and key causes of death of newborns. Costs included programme-specific investment and financial flows needed at national and district levels. The authors estimated that an additional USD 52.4 billion would be required for the period 2006 – 2015. This averages about

Table V-47. **Estimated additional financial flows needed in 2030 to cover the cost of additional cases of diarrhoeal diseases, malnutrition, and malaria due the adverse impacts of climate change (millions of United States dollars)**

	Diarrhoeal diseases		Malnutrition		Malaria		Total	
	750 ppmv scenario	550 ppmv scenario	750 ppmv scenario	550 ppmv scenario	750 ppmv scenario	550 ppmv scenario	750 ppmv scenario	550 ppmv scenario
Financial flows needed	2,235	1,923	92 – 122	61 – 81	2,173 – 3,033	1,773 – 2,418	4,500 – 5,390	3,757 – 4,422

Table V-48. **Comparison of current diarrhoeal disease, malnutrition, and malaria cases with estimated climate change impacts in 2030 for the 750 ppmv and 550 ppmv stabilization scenarios (thousands of cases)**

Scenario		Diarrhoeal diseases	Malnutrition	Malaria
Current		4,513,981	46,352	408,227
750 ppmv scenario	Climate change impacts	131,980	4,673	21,787
	Percentage increase	3	10	5
550 ppmv scenario	Climate change impacts	131,073	3,097	17,369
	Percentage increase	2.5	7	4

USD 5 billion per year. It is interesting to note that this is of the same order of magnitude as the estimated additional level of resources needed to treat additional cases of diarrhoea, malnutrition and malaria due to climate change in 2030. Projected costs in 2015 were equivalent to increasing the average total health expenditures from all financial resources in the 75 countries by 8 per cent and raising general government health expenditure by 26 per cent over 2002.

5.4.3.4. ASSESSMENT OF NEEDED CHANGES IN FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP IN INVESTMENT AND FINANCIAL FLOWS

423. The estimated additional financial flows needed for the health sector to treat the additional number of cases of diarrhoea, malnutrition and malaria due to climate change in developing countries are about USD 4 – 5 billion, the same order of magnitude as current ODA. Based on current financing trends of health care, this amount is likely to be paid for mainly by the families of those affected, with some domestic public funds paying for the operation of health care facilities. Whether the resources available will be adequate to meet the additional needs will vary a lot from one country to another, depending on the burden the additional needs represent compared with the availability of public and private resources. In countries where private individuals cannot cope with the additional cost of treatment, new and additional public financing will be necessary. Not being able to treat these diseases will increase morbidity and mortality. Countries that are already currently highly reliant on external sources for health care, such as LDCs, may need new and additional external support to cope with climate change.

Box V-12. **Human health**

Investment and financial flows needed in 2030

The financial flows needed in 2030 to cover the cost of treating the additional number of cases of diarrhoeal disease, malnutrition and malaria due to climate change is estimated to be USD 4 – 5 billion. By assumption, all of this amount will be needed in developing countries.

Current investment and financial flows

Total expenditures on health were in the order of USD 3.3 trillion in 2000. Government expenditure on health as a percentage of total expenditures on health varies from 36 per cent in developing Asia to 75 per cent in Europe. In several countries still, the cost of treating a particular health condition is paid for mainly by the families of those affected, with some domestic public funds covering the costs of operating health care facilities. Least developed countries are particularly reliant on external funding sources for health care. Aid in the health sector is still dominated by multilateral and bilateral sources (total real ODA rose by two thirds from 2000 to 2005 and reached USD 5.5 billion in 2005), NGOs are becoming a relatively more important source of funding and research.

5.4.4. NATURAL ECOSYSTEMS (TERRESTRIAL AND MARINE)

5.4.4.1. INTRODUCTION

POTENTIAL IMPACTS OF CLIMATE CHANGE ON NATURAL ECOSYSTEMS

424. Climate change has already been linked to impacts on species across the world (e.g., Parmesan and Yohe, 2003; Root *et al.*, 2005; Cassassa *et al.*, 2007). Migration patterns, productivity, location, and other changes are being observed. In one dramatic example, the Fish and Wildlife Service of the United States of America proposed listing polar bears as a threatened species because of declining Arctic ice cover (United States Fish and Wildlife Service, 2007).

425. The future impacts of climate change on ecosystems are likely to be profound and dramatic. The IPCC notes that the resilience of many ecosystems is likely to be overcome by the combination of climate change and other socio-economic influences (in particular land-use change and overexploitation). A 1.5 – 2.5° C warming over 1990 could cause the extinction of approximately 20 per cent to 30 per cent of plant and animal species (Thomas *et al.* 2004). A 3° C warming would transform about one fifth of the world's ecosystems (Fischlin *et al.*, 2007). There also are likely to be substantial impacts on marine ecosystems with a 3° C warming.

ADAPTATION

426. The term "adaptation" needs be applied in a relative sense to natural ecosystems. In the so-called managed sectors such as coastal and water resources, agriculture and health, adaptation has the potential to substantially maintain most of the services currently provided in these sectors, particularly in the developed countries. It is not clear, however, that human intervention can substantially offset the impacts of climate change and other socio-economic drivers on natural ecosystems. At best, based on what we know now, adaptation could reduce some of the harmful impacts of climate change.

427. The IPCC concluded that human intervention to assist ecosystem adaptation should consist of actions to reduce the impacts of other threats to ecosystems, such as habitat degradation, pollution and introduction of alien species. For example, diminished or lost ecosystems could be enhanced or replaced (e.g., ecosystem re-creation, rapid dispersal by humans, pollinator reintroduction and use of pesticides for pest outbreaks). In addition, captive breeding and reintroduction and translocation or provenance trials in forestry could be used.

428. Adaptation for natural ecosystems can be put into the following categories:

- Reduce and manage stresses from other sources and activities, such as pollution; over harvesting, habitat conversion, and species invasions;
- Restore habitats;
- Increase size and/or number of reserves;
- Increase habitat heterogeneity within reserves, for example, by including gradients of latitude, altitude, and soil moisture and by including different successional states;
- Maintain ecosystem structure and function as a means to ensure healthy and genetically diverse populations able to adapt to climate change;
- Increase landscape connectivity using corridors and stepping stones to link areas of habitat or reserves;
- Increase landscape permeability through reduction of unfavourable management practices and increasing area for biodiversity;
- Translocate and reintroduce species, especially those having essential functions such as pollination;
- Conserve threatened and endangered species ex situ, for example, using seed banks or collecting germplasm and zoos, including captive breeding for release into the wild.

METHOD USED TO ESTIMATE NEEDS FOR INVESTMENT AND FINANCIAL FLOWS

429. There is very limited literature on adaptation of natural ecosystems to the adverse impacts of climate change. The existing literature emphasizes ideas about ways to reduce vulnerability of natural ecosystems to climate change. There is virtually no information on the effectiveness of these adaptations in reducing the damage to ecosystems from climate change, or on the costs of adaptation to climate change.

430. As a consequence, information on current investments and financial flows going to natural ecosystem protection and how much might be needed to protect ecosystems from current threats was used as the basis for analysis. James *et al.* (2001) estimated the additional costs needed to protect biodiversity. The results of the analysis are discussed.

431. Although the method used by James *et al.* (2001) may be the best method to estimate adaptation costs for protecting natural ecosystems, the approach is quite approximate and indirect. The James *et al.* study is an attempt to estimate the investment and financial flows needed to protect natural ecosystems from current threats. But, as is discussed below, the authors use educated

guesses as to how much additional land needs to be set aside as biodiversity protection areas. This study is not able to rely on bottom-up or top-down (e.g., modelling) estimates of natural ecosystem protection needs.

432. Furthermore, the James *et al.* study does not estimate the additional protection needs that climate change might require. Given the potential for massive disruption of habitats and ecosystems, the need for many species to migrate hundreds of kilometres and the limited options for adaptation for many species, it is possible that the additional costs for addressing adaptation to climate change would be quite substantial. There is insufficient information to hazard even an educated guess as to the magnitude of the additional resources, not to mention their effectiveness in protecting natural ecosystems and biodiversity.

5.4.4.2. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS BY SOURCE OF FINANCING

433. Between 1991 and 2000, the GEF provided about USD 1.1 billion in grants and leveraged an additional USD 2.5 billion in co-financing for biodiversity-related projects. Most of these grants were channelled through developing-country governments and NGOs and used to support more than 1,000 protected sites covering 226 million hectares in 86 countries. OECD data show only USD 198 million in biodiversity projects from the World Bank system (including the GEF) in 2000 and USD 267 million in 2005.

434. James *et al.* report that in the mid-1990s an average of USD 6.8 billion per year was spent on global protected areas, with about 89 per cent of that amount spent in developed countries.

435. The private sector resources allocated to biodiversity protection have been relatively limited and focused in areas such as ecotourism, agroforestry and conservation of medicinal and herbal plants.

5.4.4.3. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

436. James *et al.* examined what they called a relatively modest goal by the World Conservation Union (IUCN) to increase protected areas by 10 per cent (but noting that some scientists call for increasing protected areas by 50 per cent). They examined two options for such an expansion, one more ambitious than the other. James *et al.* estimate that improving protection, expanding the network in line with IUCN guidelines, and meeting the opportunity costs of local communities could all be achieved with an annual increase in expenditures of USD 12–22 billion. The range is based on different options for redressing the current lack of resources going to conservation. Note that this estimate does not consider the level of resources needed to reduce other threats to natural ecosystems, such as pollution. It also does not consider any additional requirements for protecting natural ecosystems from climate change. Such requirements could include developing migration corridors for species to migrate as climate zones shift.

437. It does not appear possible to estimate how resources needed for the protection of natural ecosystems would increase as a result of the reference or mitigation scenarios. However, it is clear that the larger the magnitude of climate change, the greater the harm to natural ecosystems. Therefore, the resources needed for protecting natural ecosystems will in all likelihood be higher for the reference scenario than for the mitigation scenario.

5.4.4.4. ASSESSMENT OF NEEDED CHANGES IN FINANCIAL AND POLICY ARRANGEMENTS TO PROTECT ECOSYSTEMS FROM CURRENT THREATS

438. The James *et al.* analysis indicates that just to meet current natural ecosystem protection needs, current levels of investment and financial flows would have to increase by a factor of three to four. This would require increasing public sources of funds and leveraging private sector funding as well.

439. However, so far, attempts at leveraging private sector financing for ecosystem protection have had limited success. Demonstrating that there is a business case for ecosystem protection is a difficult endeavour. ODA for ecosystem protection is currently two orders of magnitude below the identified level of investment and financial flows needed. Clearly, a substantial increase in public domestic and external funding will be needed to address not just the current lack of resources going to ecosystem protection but also the additional needs of climate change.

Box V-13. **Natural ecosystems**

Investment and financial flows needed in 2030	**Current investment and financial flows**
Estimates in the literature indicate that improving protection, expanding the network of protected areas and compensating local communities that currently depend on resources from fragile ecosystems could be achieved for an increase in annual expenditure of USD 12 – 22 billion.	Current annual spending to ensure natural ecosystem protection is of the order of USD 7 billion from public domestic and external funding.

5.4.5. COASTAL ZONES

5.4.5.1. INTRODUCTION

440. The IPCC (Nicholls *et al.*, 2007) reports that hazards relating to human development of coastal areas are quite high. About 120 million people are exposed to hazards from tropical cyclones each year, and on average these events kill more than 12,000 people a year. Climate change will result in higher sea levels, increased intensity of coastal storms and the destruction of many coral reefs and coastal wetlands. The combination of this and continued expansion of human settlements in coastal areas is likely to lead to an increasing need for protection from coastal hazards.

ADAPTATION

441. Nicholls *et al.* note that, in general, the costs of adaptation to sea level rise (e.g., through protection of threatened areas) are far less than the losses associated with not protecting coastal areas. It is not clear if it is feasible to adapt to more than a few metres of sea level rise. Protection of natural ecosystems such as wetlands and coral reefs can increase their resilience to climate change. The three basic options for adaptation are:

- Protect – to reduce the risk of the event by decreasing the probability of its occurrence;
- Accommodate – to increase society's ability to cope with the effects of the event;
- Retreat – to reduce the risk of the event by limiting its potential effects.

442. Table V-49 summarizes major adaptation options for coastal resources.

443. The benefits of mitigation of GHG emissions could be quite substantial over the very long term. The IPCC found that a sustained warming of 1–4° C above 1999–2000 levels could result in the deglaciation of Greenland. This would lead to many metres of sea level rise over many centuries. Such an amount of sea level rise appears to be beyond the capacity of societies to adapt through coastal protection. Abandonment of coastal areas would be necessary in response to such an outcome. The costs of abandoning coastal development around the world would be a few orders of magnitude above protection costs for a metre or two of sea level rise and entail major implications for human migration and cultural heritage.

METHOD USED TO ESTIMATE THE NEED FOR INVESTMENT AND FINANCIAL FLOWS

444. The dynamic interactive vulnerability analysis (DIVA) tool was used for this analysis. DIVA is a very detailed model of the world's coasts. It divides the world's coasts into more than 12,000 segments and can account for the effect of different adaptation options. The study examined protection only from coastal flooding through the building of dykes or the use of beach nourishment. A benefit-cost test was applied to estimate whether the costs of coastal protection were less than the value of lost economic output should no protection measures be used. Although use of benefit-cost analysis could favour protection of wealthier coastal areas, coastal lands in many developing areas apparently had a high enough value to justify use of protection measures. The results are provided globally, for the IPCC regions, and at a finer resolution.

445. DIVA analyses a limited set of adaptations in a uniform manner. This has the advantage of applying a uniform method that can account for local and regional differences in conditions such as value of threatened areas. However, it has the disadvantage of not accounting for unique local circumstances or varying decision criteria that may be applied around the world. Such a top-down approach was also used in the water supply analysis and has similar limitations.

446. Socio-economic conditions for all scenarios were assumed to be the conditions in the SRES A1B scenario (Nakićenović and Swart, 2000). The estimated additional investment and financial flows associated with the SRES A1B and B1 scenarios presented in this analysis are exclusively to cover the cost of adaptation measures to address sea level rise itself, not socio-economic development. However, the value of protected economic output is based on the A1B scenario. The A1B scenario assumes the highest GDP growth of all of the SRES scenarios.

447. DIVA estimates investment needs without a sea level rise. This considers the costs of adapting to subsidence and flooding. The SRES scenarios incorporate sea level rise. The difference between the SRES scenarios and no sea level rise is the effect of climate change alone.

448. DIVA estimates a number of impacts from sea level rise including beach nourishment costs, land loss costs, number of people flooded, costs of building dykes, and losses from flooding. Of these, only the costs of beach nourishment and the costs of building dykes will be counted as adaptation costs. The other categories are damages. In reality, adaptation costs would likely be involved in responding to the damages.

449. Investment needs in 2030 were analysed assuming that decision makers can project future rates of sea level rise and plan for a 50- to 100-year time frame. This study assumes that decision makers plan for sea level rise out to 2080. Planning for a shorter time frame is likely to result in lower adaptation costs in 2030, whereas planning for a longer time frame (such as for expected sea level rise in 2130) would result in higher costs in 2030. Planning for 100 years rather than 50 is estimated to increase costs by about two thirds.

450. Table V-50 gives sea level rise projections to 2130. These projections were taken from the IPCC Third Assessment Report (Houghton *et al.*, 2001). There is virtually no difference between SRES emissions scenarios in 2030 A1B and B1. However, by 2080, there is a substantial difference between the two scenarios.

Table V-49. **Major physical impacts and potential adaptation responses to sea level rise**

Physical impacts		Examples of adaptation responses (P – Protection; A – Accommodation; R – Retreat)
1. Inundation, flood and storm damage	a. Surge (sea)	Dykes/surge barriers (P) Building codes/buildings (A)
	b. Backwater effect (river)	Land use planning/hazard delineation (A/R)
2. Wetland loss (and change)		Land use planning (A/R) Managed realignment/forbid hard defenses (R) Nourishment/sediment management (P)
3. Erosion (direct and indirect change)		Coast defenses (P) Nourishment (P) Building setbacks (R)
4. Saltwater Intrusion	a. Surface waters	Saltwater intrusion barriers (P) Change water abstraction (A)
	b. Groundwater	Freshwater injection (P) Change water abstraction (A)
5. Rising water tables and impeded drainage		Upgrade drainage systems (P) Polders (P) Change land use (A) Land use planning/hazard delineation (A/R)

Table V-50. **The range in sea level rise by 2030 (relative to 1990) expected for each SRES scenario (cm)**

	SRES emissions scenario	
	A1B	B1
Minimum rise	3	3
Mean rise	9	9
Maximum rise (2030)	15	15
Maximum rise (2080)	53	44
Maximum rise (2100)	69	57
Maximum rise (2130)	96	75

5.4.5.2. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS BY SOURCE OF FINANCING

451. While there is significant interest in elaborating coastal adaptation measures and understanding their costs (e.g., Klein *et al.*, 2001; Bosello *et al.*, 2007), the level of investment in coastal adaptation is difficult to assess as there is never a single agency with published accounts in any country. However, there is some information on the level of investment and actions to protect vulnerable coastal areas in some countries and regions:

- *European Union.* The Eurosion (2004) review reported that the total annual cost of coastal adaptation for erosion and flooding across the European Union was an estimated EUR 3.2 billion (in 2001 EUR; using current exchange rates this would be about USD 4 billion). These measures mainly involved protection;
- *United Kingdom.* The Flood and Coastal Management budget increased substantially since 2000/2001 from approximately GBP 300 million to more than GBP 500 million per year in 2005/2006 (about USD 443 million to USD 910 million using current exchange rates). However, coastal investment is not directly defined and is only an element of this budget;
- *Netherlands.* This is the archetypal country threatened by sea level rise, and it invests large sums in erosion and flood management. They amount to 0.1 to 0.2 per cent of GDP at present;
- *Bangladesh.* Bangladesh has experienced the highest death toll from coastal flooding of any country on earth (Nicholls, 2006), and is a good example of a vulnerable deltaic country. Following the 1970 and 1991 cyclones, when at least 400,000 people died, an accommodation strategy was implemented via a system of flood warnings and the construction of more than 2,500 elevated storm surge shelters. Despite recent severe storms, the death toll for people (and their animals via associated raised shelters) has fallen markedly;
- *The Maldives.* These islands are a good example ofa vulnerable atoll nation where sea level rise could literally extinguish the nation over the coming century without adaptation. However, significant adaptation is occurring on the island. After a significant Southern Ocean swell event that flooded much of the capital Male in the 1980s, a large wall was built around the city with aid from Japan (Pernetta, 1991). However, the costs are not known. More recently, after the Indian Ocean tsunami of 2004, there has been interest in developing tsunami shelters, which may also have a function against climate change.

5.4.5.3. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

452. The estimated investment needs for the SRES A1B and B1 scenarios are displayed in TABLE V-51. Beach nourishment, land loss and flooding costs are estimated for 2030. There is no anticipation of future climate change impacts in these categories. The estimated investment required for dykes in 2030 assumes that the coastal infrastructure built in that year is sufficient to adapt to the maximum amount of sea level rise anticipated in 2080. The cost of dykes is very sensitive to the length of the planning horizon. For instance, under the A1B scenario, if the dykes were built only for the sea level observed in 2030, the costs would be USD 11.7 billion. If, however, the dykes are built to adapt to projected sea level rise 100 year hence (to 2130), the annual cost in 2030 would be USD 16.8 billion. Since the cost of dykes represents more than half of the total costs, the selection of a planning horizon is a critical assumption affecting total costs.

453. Total costs including investment costs (beach nourishment and sea dykes) and losses (inundation and flooding) are estimated to be USD 21–22 billion in 2030.

454. TABLE V-52 examines the increase in investment needed by region. About half of the required investment will be in non-Annex I Parties.

455. The estimated investment needs for the A1B and B-1 scenarios differ by USD 1 billion per year, or about 10 per cent.

Table V-51. **Investment and financial flows needed in 2030 for adaptation to sea level rise assuming anticipation to 2080 for the SRES A1B and B1 scenarios (millions of United States dollars)**

		A1B scenario		B1 scenario	
Impact category	Investment and financial flows needed with no sea level rise	Investment and financial flows needed with sea level rise	Difference in investment and financial flows needed with sea level rise	Investment and financial flows needed with sea level rise	Difference in investment and financial flows needed with sea level rise
Beach nourishment costs	573	3,042	2,469	2,888	2,316
Sea dyke costs	5,601	13,803	8,202	12,815	7,214
Total investment costs	6,174	16,845	10,681	15,703	9,529
Land loss costs	0	6	6	6	5
Sea flood costs	6,385	8,119	1,734	7,853	1,467
Total loss costs	6,385	8,125	1,740	7,859	1,472
Total cost (investment and losses)	12,559	24,971	12,422	23,562	11,002

Table V-52. **Estimated additional investment needed in coastal infrastructure for the SRES A1B and B1 scenarios in 2030 by region (millions of United States dollars)**

	A1B scenario		B1 scenario	
Region	Mean 2030	Maximum in 2080	Mean 2030	Maximum in 2080
Africa	612	1,319	528	1,197
Developing Asia	951	2,181	801	1,928
Latin America	680	1,597	573	1,414
Middle East	72	171	60	153
OECD Europe	737	1,785	624	1,587
OECD North America	1,002	2,022	882	1,838
OECD Pacific	460	1,080	388	958
Transition Economies	189	479	158	421
Total	4,702	10,634	4,014	9,496

5.4.5.4. ASSESSMENT OF NEEDED CHANGES IN FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP IN INVESTMENT AND FINANCIAL FLOWS

456. Additional investment in worldwide coastal infrastructure of about USD 10 – 11 billion will be required in 2030 for adaptation to sea level rise. Adaptation of coastal resources to climate change is highly dependent on public sources of funding. Although much coastal infrastructure may be private (e.g., buildings and homes), efforts to protect coastal areas from coastal storms and sea level rise are typically undertaken by governments. In the developed world and in parts of the developing world, the necessary financial resources are likely to be available to adapt coastal resources to climate change. However, certain settings and regions present particular challenges, as identified in the recent IPCC AR4 assessment of coastal areas (Nicholls *et al.*, in preparation). Deltaic regions, particularly the large coastal deltas in Asia and in Africa and small island states may have significant problems responding to sea level rise and climate change. In these countries, additional sources of external public financing will be needed.

457. Development and integration of coastal zone management institutions and processes, while in itself not demanding large amount of resources, could increase the efficiency of adaptation to climate change and sea level rise. GEF-funded initiatives such as the Caribbean Planning for Adaptation to Climate Change project, the Mainstreaming Adaptation to Global Change in the Caribbean project and the Pacific Islands Climate Change Assistance Programme are contributing to build the capacity in this area.

Box V-14. Coastal Zones

Investment and financial flows needed in 2030
With sea level rise, the investment needed is estimated to represent an additional USD 11 billion in 2030. This estimate assumes that decision makers take into account the expected sea level rise in 2080. About half of the required investment will be needed in non-Annex I Parties.

Current investment and financial flows
Although much of the infrastructure in coastal areas may be private (e.g. buildings and homes), efforts to protect coastal areas from coastal storms and sea level rise are typically undertaken by governments.

5.4.6. INFRASTRUCTURE

5.4.6.1. INTRODUCTION

458. Climate change is likely to have substantial consequences for the integrity, performance, lifetime and design criteria for much of the world's infrastructure. Infrastructure for water supply, sanitation, flood control, hydropower, and coastal development and defences could be substantially affected by climate change. Changes in average climate, but also changes in extreme events, will affect infrastructure. For example, sea level rise threatens to inundate coastal infrastructure. In addition, the potential for more intensive tropical cyclones would put more coastal infrastructure at risk. Changes in runoff patterns and water supplies will affect water supply, flood control, water supply and sanitation. Changes in intense precipitation, flooding and droughts will affect and most likely have major implications for construction of water supply infrastructure. Even changes in peak high and low temperatures may require adjustments to buildings and their heating and cooling systems.

ADAPTATION

459. In general, there are two types of climate change adaptation in infrastructure. The first involves making modifications to or changes in operations of infrastructure that would be directly affected by climate change. This applies to infrastructure used to manage natural resources such as water or coastal resources infrastructure. For example, coastal defences may be raised or otherwise strengthened to adapt to higher sea levels and the potential for more intense coastal storms. Infrastructure for water resource management applications such as flood protection, water supply, water quality treatment, hydropower production, and other uses may be modified to adapt to changing runoff-patterns and water quality conditions. For example, the size of reservoirs could be increased to provide more storage for water supply or flood protection. These changes will also apply to infrastructure such as heating and cooling systems directly affected by climate change.

460. The second type of adaptation affects infrastructure needed to support activities that cope with climate-affected sectors or resources. Provisions of public health services, agriculture extension, research and many other applications require supporting infrastructure. Hospitals, clinics, disease monitoring systems, buildings for extension services, laboratories, and so on may need to be built to enhance the capability to adapt to climate change.

METHOD USED TO ESTIMATE THE NEED FOR INVESTMENT AND FINANCIAL FLOWS

461. The analysis of climate change impacts on infrastructure estimates the share of infrastructure investment that is currently vulnerable to climate variability and then estimates the additional investment in infrastructure that may be necessary to adapt to climate change. It addresses only the first type of adaptation mentioned above.

462. The share of infrastructure vulnerable to the impacts of climate change is estimated based on losses due to extreme weather events.

463. Munich Re provided a data set of "Great Weather Disasters" from 1951 to 2005, from which annual regional losses were estimated. The value of overall losses for each major event from 1951 through 2005 by region and/or country is included in the database. These were summed and averaged over the 55-year record of the database to obtain average annual losses by region. Since the Munich Re data set is only for large catastrophes and does not include damage from smaller climate events, it might underestimate total losses from weather extremes. Furthermore, the analysis in this study does not consider other infrastructure costs such as damage from inundation, erosion, melting of permafrost and other causes. On the other hand, although the vast majority of the "Great Weather Disasters" are likely to be made more intense by climate change (e.g., cyclones, droughts and floods), some, but not all, cold weather events could be less severe with climate change. The Munich Re data were used to obtain an estimate of the minimum additional investment needed to adapt infrastructure to climate change. The Munich Re data were scaled up to cover all weather related losses and accounts to get an estimate of the potential upper bound on the level of additional investment needed. The adjustment used is 4.3, and corresponds to the ratio of the Association of British Insurance (ABI) data on total weather related losses for the period 2000–2006 to the Munich Re losses for the same period. The average annual loss is thus estimated at between USD 21.1 billion and USD 87.7 billion.

464. To estimate the share of infrastructure vulnerable to the impacts of climate change, the annual infrastructure investment in the middle of the period 1951–2005, that is for 1978, was used. Global GFCF data are not available for that year. The GFCF for 1980 is estimated by assuming that the growth rate projected for the period 2005–2030 by OECD (3.65 per cent per year) can be applied to period 1978–2005. That yields a global GFCF for 1978 of about USD 3,025 billion. Based on the average annual loss

estimated above, the average annual loss is estimated to be between 0.7 per cent (based on Munich Re data) and 2.9 per cent (based on ABI data) of the estimated 1978 GFCF. Note that the World Bank estimates that 2 to 10 per cent of gross domestic investment could be sensitive to climate change, although it uses a much lower figure for the annual investment.

465. To estimate the potential additional costs of adapting vulnerable infrastructure to the impacts of climate change, the World Bank estimate of a 5 to 20 per cent (as cited by Noble, 2007) increase in investment was used. The infrastructure analysis implicitly assumes that the incremental cost of 5 to 20 per cent covers the cost of adapting to all climate change impacts over the life of each facility. The upper end was not adjusted, although some studies (e.g. Kirshen *et al.*, 2006; Smith *et al.*, 2006) indicate that some infrastructure investment needs might be 30 per cent higher.

466. The projected level of investment in physical assets needed in 2030 is based on the OECD ENV-Linkage model and corresponds to the projection in the IEA WEO reference scenario.

5.4.6.2. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS BY SOURCE OF FINANCING

467. As can be seen in TABLE 35.11-ANNEX V, total GFCF was USD 7.8 trillion in 2000. It is unclear what is the fraction of private and public infrastructure that is vulnerable to climate change. Total ODA for infrastructure is estimated at more than 15 billion in 2005; this represents a 36 per cent increase in real terms from 2000 (TABLE 17-ANNEX V). Multilateral assistance increased by almost 60 per cent in the same period. South Asia was the largest recipient on ODA in this sector in 2005 and Africa was close behind.

5.4.6.3. ESTIMATED INVESTMENT AND FINANCIAL FLOWS NEEDED

468. In 2030, projected total GFCF is USD 22.3 trillion. When this number is multiplied by the estimated share of infrastructure vulnerable to the impacts of climate change (0.7 and 2.9 per cent) this yields a value of between USD 153 billion and USD 650 billion of infrastructure investment vulnerable to climate change.

469. Assuming adaptation to the impacts of climate change requires a 5 to 20 per cent increase in capital costs, the adaptation costs would be USD 8–31 billion per year in 2030 based on the Munich Re data and USD 33–130 billion per year in 2030 based on the ABI data. Although the share of infrastructure vulnerable to climate change is higher in some developing country regions, total infrastructure investment is higher in developed countries, hence most of these adaptation costs are in developed countries. TABLE V-53 presents the investment needed to adapt infrastructure to the adverse impact of climate change by region in 2030. About two thirds (68 per cent) of the investment would be in OECD countries.

470. The World Bank (2006)/Stern Review (Stern *et al.*, 2006) estimated the added costs necessary to adapt investments to climate change risks at 2000 USD 40 billion, with a range of USD 10–100 billion. The range estimated in this study above is very much in line with this estimate.

471. The costs of adapting infrastructure to cope with climate change are estimated to range from about USD 8–130 billion, depending on the climate change scenario and assumption of sensitivity. As noted above, the additional investment needed to adapt infrastructure to climate change could be larger than the upper-end estimate used here. Two-thirds of the investment is expected to be in developed countries.

5.4.6.4. ASSESSMENT OF NEEDED CHANGES IN INVESTMENT, FINANCIAL AND POLICY ARRANGEMENTS TO FILL THE GAP IN INVESTMENT AND FINANCIAL FLOWS

472. The investment needed to adapt new infrastructure to climate change is estimated to be USD 8–130 billion. This corresponds to less than 0.6 per cent of total GFCF in 2030. About a third of the investment needed will be in non-Annex I Parties of which more than 80 per cent are in developing Asia. The potential sources of financing depends on the nature of the new infrastructures that are vulnerable to climate change and whether they are typically financed by the private or the public sector and whether they are financed with domestic or external resources. Although it is unclear what fraction of private and public infrastructure is vulnerable to climate change, the amount is likely to be financed by all types of sources: domestic and external, public and private. The additional investment is assumed to be on average a small fraction of the total cost of each new infrastructure vulnerable to climate change. Therefore the additional investment is likely to be financed in the same manner as the overall infrastructure: from private sources for infrastructure such as commercial buildings and industrial plants, and from public sources for infrastructure such as roads and public buildings. Public resources will also be needed

to provide adequate support and incentives for new private infrastructures that are vulnerable to climate change to be adequately adapted. The latter might be necessary in order to avoid severe damages that can have important impacts on sectoral or overall economic development. The design of adequate national policies including the integration of adaptation considerations into sectoral agencies might have an important role to play in ensuring that an optimal amount of resources both domestic and private are available to cover the cost of adaptation.

473. The World Bank/Stern Review estimated the share of ODA and concessional finance investments sensitive to climate change to be higher (20 per cent) than the global average (2 – 10 per cent). They estimated the annual cost of adapting such infrastructure to the impacts of climate change at 2000 USD 1 – 4 billion. This would be equivalent to as much as a 30 per cent increase in the ODA infrastructure spending between 2005 and 2030.

Table V-53. **Additional investment needed to adapt infrastructure to climate change risks in 2030 (millions of United States dollars)**

	Estimate based on Munich Re data		Estimate based on ABI data	
Region	5 per cent additional investment	20 per cent additional investment	5 per cent additional investment	20 per cent additional investment
Africa	22	87	92	371
Developing Asia	1,901	7,605	8,106	32,424
Latin America	405	1,620	1,726	6,906
Middle East	66	264	282	1,127
OECD Europe	1,000	3,999	4,262	17,050
OECD North America	3,736	14,943	15,925	63,702
OECD Pacific	473	1,892	2,017	8,067
Transition Economies	24	97	102	412
World Total	7,627	30,508	32,514	130,058

Box V-15. **Infrastructure**

Investment and financial flows needed in 2030
The additional investment needed to adapt new infrastructure vulnerable to climate change is estimated at 5 to 20 per cent of its cost. The additional investment needed is estimated at USD 8 – 130 billion, or less than 0.5 per cent of global investment in 2030. About one third of the additional investment would be needed in non-Annex I Parties, and more than 80 per cent of that in Asian developing countries.

Current investment and financial flows
Total investment in physical assets was estimated to be about USD 6.8 trillion in 2000. Current sources for investment in infrastructure are private sources for infrastructure such as commercial buildings and industrial plants, and from public sources for infrastructure such as roads and public buildings. Total ODA for infrastructure is estimated at more than USD 13 billion in 2005, this represents a 36 per cent increase in real terms from 2000. South Asia was the largest recipient in 2005, although Africa was close behind.

5.5. AVOIDED DAMAGES

474. Although the adaptation costs described in the previous chapters may seem significant, it is clear that the value of the climate change impacts that these expenditures would avoid could be as large or greater. This study does not estimate the total value of impacts avoided by adaptations to climate change. However, the adaptation costs can be put in perspective by looking at the cost associated with extreme events and reviewing the literature on total damages from climate change, even though it is unlikely that the adaptations discussed in this study would avoid all of these damages.

475. A major component of the total impacts from climate change is likely to be losses from extreme weather events. Climate change is projected to increase the intensity of storms, cyclones, droughts, heat waves and other events. Estimating how losses from extreme events will change as a result of climate change is challenging for a number of reasons including:

- Since there is considerable variability in year to year damages from extreme climate (e.g. Hurricane Katrina dramatically increased weather related losses in 2005), establishing a baseline for extreme weather damages can be difficult;
- Estimating the change in total infrastructure stock over time is challenging. For example, it is not clear whether infrastructure investments will grow proportionately with output or fixed capital investment or another set of data;
- It is very difficult to estimate how extreme climate events will change and how they will affect infrastructure;
- Clearly a lot of present infrastructure will be replaced over coming years. Whether climate change is factored into the replacement or redesign of infrastructure is not clear, nor is it clear how effective such adaptations would be in reducing risks from climate change.

476. In the context of this study, an attempt is made to estimate expected changes in damages due to extreme weather events. The analysis is based on different sources of data from the insurance industry on current losses. As mentioned in the infrastructure sector above, Munich Re catalogued "great natural catastrophes" which involve the loss of thousands of lives or severe economic impacts from extreme events. Such a database can substantially underestimate damages from climate because only large events are included. Taking into account differences in various insurance industry estimates of losses, estimates of current losses to climate range from about USD 160 billion to as much as USD 330 billion, and most likely between USD 200 and 300 billion. The estimates are in the order of 0.5 per cent of current gross world product.

477. The Munich Re data suggest that damages are increasing at a rate of 6 per cent per year in real terms. A paper by Risk Management Solutions (RMS) estimates that the increase in damages caused by climate change is 2 per cent per year in real terms, although it is a weak signal.[41] Accounting for the under-reporting of losses in the Munich Re "great disaster" data and extrapolating the trend at 6 per cent per year, or at 2 per cent plus economic growth results in a range of estimates of annual climate damages in 2030 of approximately USD 850 – 1,350 billion. This corresponds to approximately 1.0 – 1.5 per cent of gross world product. These estimates consider climate change and make no allowance for reduced losses following new adaptation strategies. Losses are very likely to escalate non-linearly when events become more extreme. Thus, a reduction in the increase in global mean temperature through mitigation would probably have a greater proportional effect in reducing losses from extreme events.

478. Estimating the total damages from climate change is very difficult because all potential adverse impacts need to be not only identified but also costed. This is relatively more straightforward for impacts of climate change on sectors such as agriculture and infrastructure, but is more challenging for non-market impacts such as human health and ecosystem impacts. Indeed the term "damages" includes financial impacts of climate change such as building sea walls, but also includes impacts on services such as those provided by ecosystems. These services are often not offered in markets and can be challenging to monetize.

479. In spite of these challenges, several economists have developed estimates of the total damages from climate change. The magnitude of these estimates differs quite substantially across studies. However, in spite of these differences, there are two important common findings across the studies:

- Damages increase with the magnitude of climate change. The more climate changes, with climate change typically measured as the average increase in global mean temperature, the greater the total damage. Some studies anticipate initial net benefits with up to 1 to 3° C of increase in global mean temperature, whereas others studies anticipate net damages with any increase in temperature. Even

those studies estimating initial benefits find that benefits peak and become net damages at some level of climate change. Net damages keep rising with greater magnitudes of climate change;

- On average, developing countries are estimated to have larger damages as a percentage of their gross product (i.e., relative to their national incomes) than developed countries. This implies that damages and benefits are not spread evenly. In some studies, developed countries are estimated to have benefits up to some level of warming, whereas developing countries suffer damages. Note that there will probably be variation among individual countries.

480. The IPCC AR4 (Yohe *et al.*, in preparation) reported findings from numerous studies, including those from Mendelsohn *et al.* (2000), Nordhaus and Boyer (2000), and Tol (2002). It also cited in the Stern Review (Stern *et al.*, 2006). In a comparison of damage estimates from these studies,[42] the IPCC reported the following range of possible outcomes:

- A 0.5° C increase in global mean temperature could lead to negligible damages, or a possible increase in welfare equivalent to between 0.5 and 2 per cent of world GDP;
- A 2° C increase in global mean temperature could lead to negligible damages, or damage equivalent to between a 0.5 per cent and 1.5 per cent loss in world GDP;
- A 4° C increase in global mean temperature could lead to negligible damage, or damage equivalent to between a 1 per cent and 6 per cent loss in world GDP.

481. Mendelsohn *et al.* (2000) reported country-specific results according to which a 2° C global-mean warming would result in net market benefits for most OECD countries and net market damages for most non-OECD countries. The study applies response (to climate change) functions that were developed empirically for the United States of America to all countries in the world. The two types of response functions used (reduced-form and Ricardian) yield different results.

482. The more recently released Stern Review (Stern *et al.*, 2006) estimated substantial losses, particularly for large amounts of warming. Their findings suggest that the economic effects of a 5–6° C increase in global mean temperature by 2100 could reduce welfare by an amount roughly equivalent to an average reduction in GDP of 5–10 per cent.[43] Estimates in the Stern Review increase to:

- 11 per cent of GDP when non-market impacts are included (e.g., environment, human health);
- 14 per cent when evidence indicates that the climate system might be more responsive to GHG emissions than previously thought;
- 20 per cent when using weighting that reflects the expected disproportionate share of damages that will fall on poor regions of the world.

483. The Stern Review has been criticized for relying on the most pessimistic literature on climate change impacts and for using very low discount rates for estimating the present value of climate change impacts (e.g., Tol, 2006; and Yohe, 2006).

484. Although there is uncertainty about whether there will be initial net benefits or damages with a small amount of warming and about the magnitude of damage with a large amount of warming, there is agreement across the economic studies that the effects of climate change will be uneven and will on average hurt developing countries the most, and that the damages will eventually increase as warming continues.

5.6. CONCLUSION

485. The sectoral analysis demonstrates that for all sectors and regions covered, several tens of billions of dollars of additional investment and financial flows will be needed for adaptation to the adverse impacts of climate change.

486. In the sectors dependent on privately owned physical assets (such as the AFF sector and a portion of the infrastructure sector), private sources of funding may be adequate to meet adaptation needs, especially in developed countries. The additional spending likely to be required will be for climate-proofing physical assets or for shifting investment to infrastructure or productive activities that are less vulnerable to the adverse impacts of climate change. Policy changes, incentives and direct financial support will be needed to encourage a shift in investment patterns and additional spending of private resources.

[41] Even if trends in regional climate could be isolated, attributing them to anthropogenic climate change could be difficult if not impossible for many regional trends.

[42] Mendelsohn *et al.* (2000) estimate aggregate regional monetary damages (both positive and negative) without equity weighting. Nordhaus and Boyer (2000) estimates track aggregated regional monetary estimates of damages with and without population-based equity weighting; they do include a "willingness to pay (to avoid)" reflection of the costs of abrupt change. Tol (2002) estimates aggregated regional monetary estimates of damages with and without utility-based equity weighting.

[43] Based on the recently released IPCC report on the science of climate change, such a warming by 2100 is possible but unlikely (IPCC, 2007a).

487. In all sectors at least some additional external public funding will be needed. This will be particularly the case in sectors and countries that are already highly dependent on external support, such as the health sector in LDCs or for coastal infrastructure in developing countries vulnerable to sea level rise.

488. National policies may play an important role in ensuring that the use of resources, both public and private, is optimized. In particular there is a need for:

- Domestic policies that provide incentives for private investors to adapt new physical assets to the potential impacts of climate change;
- National policies that integrate climate change adaptation in key line ministries; and
- Local government adaptation policies in key sectors.

489. Bilateral donors and multilateral lenders have been directing financial resources to support the design of policies in developing countries in the sectors analyzed in this study. A particularly high amount of resources is allocated to support agricultural policies when compared with other sectors (see TABLE 13-ANNEX V). It is not possible to determine how much of these financial resources address climate change issues, let alone adaptation issues. However, the current level of support channeled explicitly for adaptation purposes is likely to be suboptimal.

490. These estimates should be treated as indicative of adaptation needs but may represent a lower bound of the amount actually required for adaptation because some activities that are likely to need additional financial and investment flows to adapt to climate change impacts have not been included. For example, the water supply sector does not address other aspects of water resource management. The estimate for the health sector does not include many diseases that are expected to become more widespread because of climate change. The estimates for coastal zones are based on the additional costs related to investment in dykes and beach nourishment. The estimate for infrastructure includes only the cost of building new infrastructure with a design that takes climate change into account.

491. There are other reasons why the estimates of costs of adapting to climate change presented in this work should be considered preliminary and be treated with caution. One of the most important reasons is that simple assumptions were used to develop all of the specific estimates. On the ground, adaptations may vary considerably in type and their costs. In addition, cost estimates may be too high, as there might be some amount of double counting. This may be the case with the estimate for infrastructure investment, which may overlap with some of the estimates for water supply and coastal zones. Also, the estimates do not take into account the potential for learning to do adaptation better. The analysis assumes a fixed cost. With a significant need for adaptation, there will probably be lessons learned on how society will adapt more efficiently. In addition, new technologies or technological applications will probably be developed which could reduce costs. The costs of adaptation by people resulting from migration, loss of employment and switching of livelihoods, have not been estimated for this study.

492. Although the additional investment and financial flows needed for adaptation described above are significant, the value of the climate change impacts that those expenditures would avoid could be larger. This study does not estimate the total value of impacts avoided by adaptation to climate change and therefore does not determine whether benefits of avoided damage exceed the adaptation costs. Existing estimates of the future damage caused by climate change vary substantially; however, available studies yield three important common findings:

- Damages increase with the magnitude of climate change;
- Investment needs for adaptation would almost certainly increase substantially in the latter decades of the twenty-first century. They will be particularly high if no mitigation measures are implemented; and
- On average, developing countries suffer more damage as a percentage of their GDP than developed countries, which implies that damages and benefits are not distributed evenly.

493. The global cost of adaptation to climate change is difficult to estimate, largely because adaptation measures to climate change will be widespread and heterogeneous. More analysis of the costs of adaptation at the sectoral and regional levels is required.

VI. PRIORITIES FOR MITIGATION AND ADAPTATION AS REPORTED BY DEVELOPING COUNTRIES UNDER THE CONVENTION

494. This chapter summarizes priority areas for climate change mitigation and adaptation as identified by non-Annex I Parties under the Convention process. It should be noted that, as these priorities have been identified in different contexts, they do not comprise a comprehensive view of the priorities and needs of non-Annex I Parties. However, they complement the discussions of investment and financing needs in CHAPTERS IV and V by highlighting particular mitigation and adaptation areas/activities important for non-Annex I Parties. These priorities should also be considered when discussing the role of different sources of investment and financial flows and their future potential.

495. Information on priority areas for mitigation and adaptation provided by developing countries under the Convention has been mostly of a qualitative nature, as Parties were not required to calculate costs of priority actions. Therefore, the analysis in this chapter does not include an assessment of total costs of mitigation and adaptation measures. It should also be noted that the priority rankings in this summary correspond to the rankings provided by Parties in different reporting contexts and, because the data is only qualitative, it is difficult to compare these priorities with priorities for funding when costs are considered, as in the previous chapters.

496. This chapter provides information contained in initial national communications (INCs), technology needs assessments (TNA), NAPAs, reports from regional workshops and expert meetings on adaptation and response measures, and submissions from Parties under the Nairobi Work Programme on impacts, vulnerability and adaptation to climate change, in particular on climate-related risks and extreme events.

6.1. PRIORITY AREAS FOR MITIGATION

497. Two thirds of non-Annex I Parties[44] reported on the need for mitigation measures in the energy sector. Roughly half of the Parties identified measures to limit emissions and enhance removals by sinks in the LULUCF sector. About a third of the Parties reported on measures to abate GHG emissions in the agriculture and waste sectors. FIGURE VI-17 shows the distribution of mitigation project proposals by sector and region.[45]

498. FIGURE VI-18 summarizes the needs for mitigation technologies identified in TNAs by sector.

[44] Information here and further is based on the Sixth compilation and synthesis of initial national communications from Parties not included in Annex I to the Convention (FCCC/SBI/2005/18). Additional 12 initial national communications submitted since then are still to be examined by the Consultative Group of Experts.

[45] FCCC/SBI/2005/18/Add.3. From Europe, only Georgia, and from Middle East, only Jordan, submitted project proposals.

Figure VI-17. **Regional and sectoral distribution of mitigation project proposals**

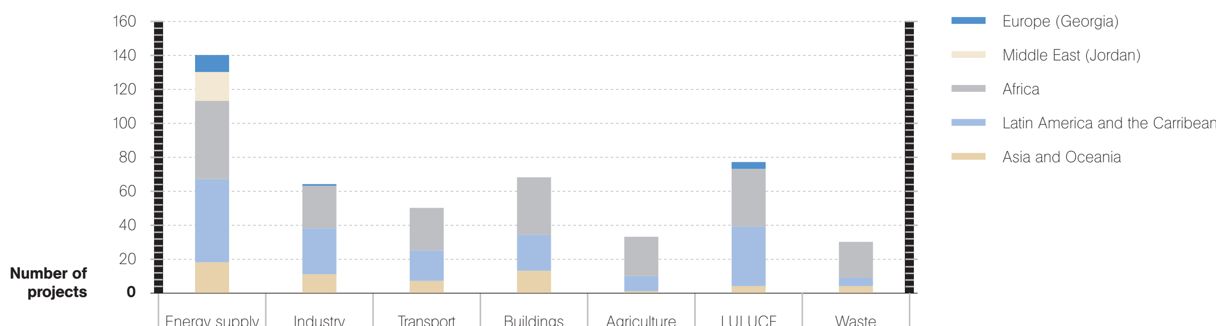
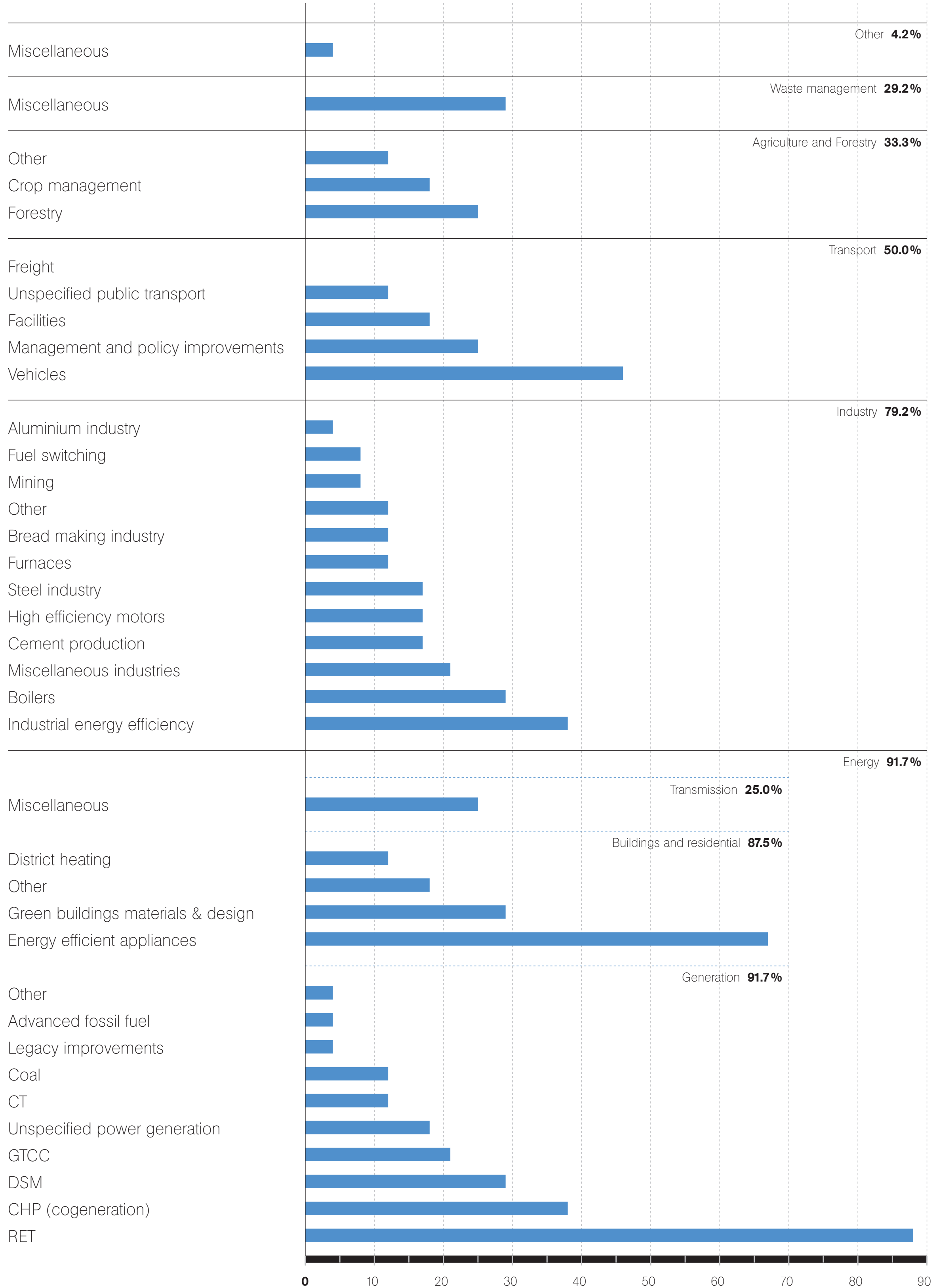


Figure VI-18. **Mitigation sectors, sub-sectors and technologies commonly identified by Parties in technology needs assessments**



Source: FCCC/SBSTA/2006/INF.1.
Abbreviations: CHP = combined heat and power; CT = combustion turbine; DSM = demand side management; RET = renewable energy technology; GTCC = gas turbine combined cycle.

6.1.1. SECTORAL ANALYSIS OF PRIORITY AREAS

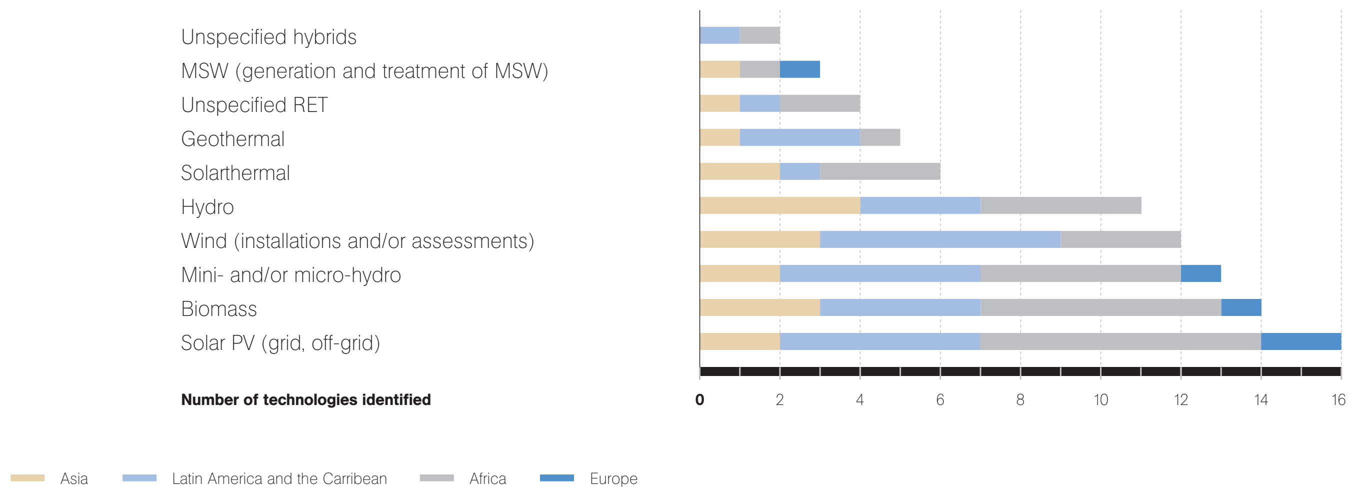
6.1.1.1. ENERGY SUPPLY

499. In INCs, nearly half of reporting Parties reported that they are implementing, or considering the implementation of small hydropower applications to increase their energy supply in order to meet their pressing needs for power, and considering alternative fuels in the transportation sector. Many Parties reported that they do have measures in place to encourage the use of cleaner alternative fuels.[46]

500. Of the 140 mitigation project proposed by Parties in the energy sector, 103 involve switching to renewable sources of energy, 25 deal with the efficient conversion of fossil fuels to electricity and 11 suggest a switch to lower-carbon fossil fuels. This distribution of projects matches the technology needs most commonly identified in TNAs. Solar photovoltaic (grid and off-grid), wind farms, biomass, and micro- and mini-hydro plants were the most frequently mentioned renewable energy technology needs. Figure VI-19 provides an overview of commonly identified renewable energy technology needs.

[46] FCCC/SBI/2005/18/Add.3

Figure VI-19. **Needs for renewable energy technology commonly identified by non-Annex I Parties**



Source: FCCC/SBSTA/2006/INF.1.

6.1.1.2. INDUSTRY

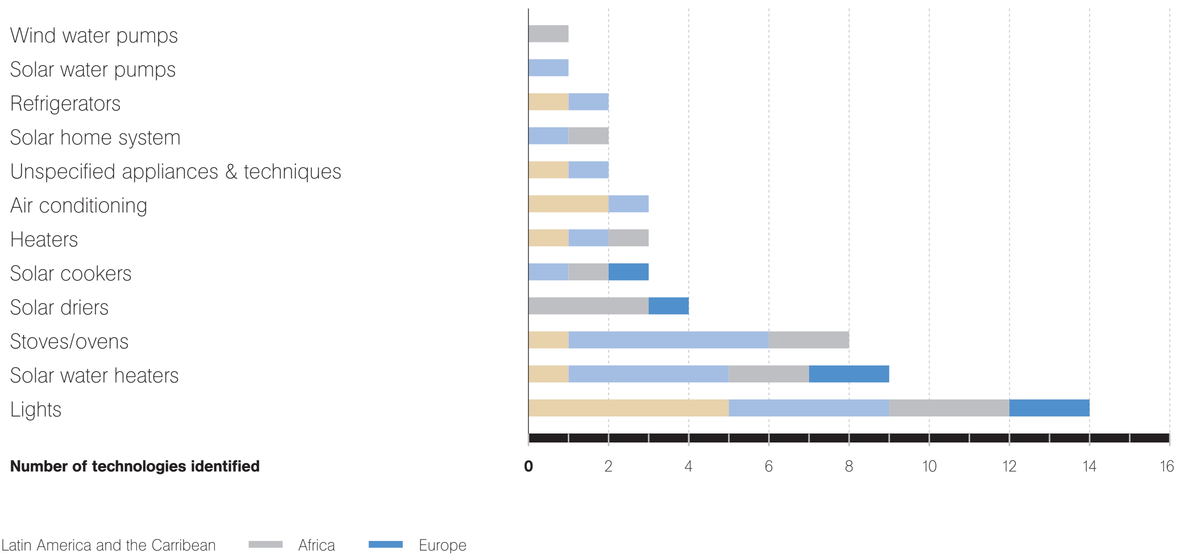
501. Priority areas identified in INCs and TNAs in the industrial sector were in the cement and steel production industries. Mitigation options considered by Parties include the modernization of industrial processes and equipment, and the promotion of energy efficient technologies. Examples of specific measures proposed are the introduction of efficient fuel for boilers and the introduction of efficient coal-fired boilers, electrical motors and lighting in industrial buildings.

502. Sixty-five mitigation projects proposed by Parties in their INCs fall in the industry category. Twenty nine involve the introduction of new technologies and processes (e.g., technology in the cement industry) and 18 target non-energy-related process improvements to reduce GHG emissions.

6.1.1.3. RESIDENTIAL AND COMMERCIAL SECTOR

503. In INCs Parties identified the following mitigation measures in the residential and commercial sector: improving efficiency of cooking stoves; promoting more efficient household appliances; enhancing efficiency of lighting; increasing efficiency in the building sector; promoting solar energy for water heating in the residential sector; and implementing demand-side management programmes. Half of the mitigation projects in this category are proposed by African countries, mostly targeting improved cooking stoves and more efficient lighting. Figure VI-20 below provides details on needs for energy efficient technology in the buildings and residential sector.

Figure VI-20. **Needs for energy efficient technology in the buildings and residential sectors commonly identified by non-Annex I Parties**



Source: FCCC/SBSTA/2006/INF.1.

6.1.1.4. TRANSPORTATION

504. In INCs nearly two thirds of the Parties identified mitigation measures in the transportation sector that focussed on technologies, such as the introduction of electric or compressed natural gas vehicles and hybrid vehicles, and the implementation of vehicle emission standards, and measures focused on mode switching and other behaviors affecting transportation. Almost half of the Parties reported that they are considering alternative fuels in the transportation sector, with the greatest interest coming from Latin America. Thirty four of the 50 mitigation project proposed by parties in the transportation sector include the promotion of public transport and the use of bicycles.

6.1.1.5. WASTE SECTOR

505. In INCs most mitigation measures identified focussed on solid waste. Measures focuses on the reduction of waste generation at the source and on the promotion of integrated waste management, waste recycling and composting. Mitigation measures dealing with waste water focused on the recycling and treatment of municipal waste water, and on the recovery of methane from waste-water treatment as biogas. Most mitigation project proposals in the waste sector (14 out of 32) focus on methane recovery from solid-waste disposal and methane reduction from waste water.

6.1.1.6. AGRICULTURE AND LULUCF

506. Frequently identified mitigation measures in the agriculture sector in INCs relate to changes in cattle management practices, rice cultivation and the use of fertilizers. Fourteen mitigation project out of 33 proposed in the agriculture sector involve improvement in the management of ruminant livestock and six involve improvement in rice production practices.

507. Mitigation measures mentioned in the INCs for the LULUCF sub-sector include the promotion of forest conservation and restoration, afforestation and reforestation activities; improvement of forest management practices and the promotion of sustainable forest development; the promotion of conservation and substitution of fuel wood; and the promotion and development of agroforestry.

508. Eighty-six mitigation projects are proposed by parties in their INC in the LULUCF sector. Thirty of these aim at the reduction of deforestation and assistance with regeneration, 12 of these target fuel conservation and substitution (all in African countries). Fifty-six project proposed target reforestation or afforestation of lands, with 28 focusing on the development of production forestry or agroforestry (mostly in Latin American countries).

509. The technology needs related to these sectors identified in TNAs included better land processing techniques, forest fire monitoring and prevention, mechanization of timber processing and logging, valuation of forest waste (for biomass energy) and tree planting. As for avoided deforestation, Parties highlighted needs for capacity building and technology transfer to implement adequately their policies, and measures to reduce emissions from deforestation.[47]

6.2. PRIORITIES AREAS FOR ADAPTATION

510. Overall, Parties emphasized the need for a holistic approach to adaptation planning, as many adaptation measures can simultaneously address vulnerabilities in several sectors. Parties also noted that adaptation measures are country specific. Among the sources of information reviewed, only NAPAs contain financial estimations of needs. These estimates are indicative only. Parties used different methodologies to calculate costs of NAPA priority activities. Of the 17 NAPAs submitted by June 2007, 16 contain cost estimates of NAPA projects amounting to a total of USD 292 million (see FIGURE VI-21).[48] As of June 2007, eight NAPA activities have been formulated as PIFs and submitted to the Least Developed Countries Fund (LDCF) (and its co-financing) and the total funding expected from the GEF is USD 21.56 million.

511. FIGURE VI-22 shows the costs of NAPA priority activities by sector. Actual project proposals submitted for GEF funding may comprise priority activities across several sectors.

512. With regard to technology needs for adaptation, agriculture, fisheries and coastal zones were identified as priority sectors by most Parties, according to the INCs and TNAs. FIGURE VI-23 lists the technologies for adaptation which were prioritized in TNAs.

[47] Submissions from Parties. FCCC/SBSTA/2007/MISC.2 and Add.1.

[48] This does not include Niger, which did not provide an estimation of project costs.

Figure VI-21. **Cost of priority activities identified in national adaptation programmes of action, by country (in millions of United States dollars)**

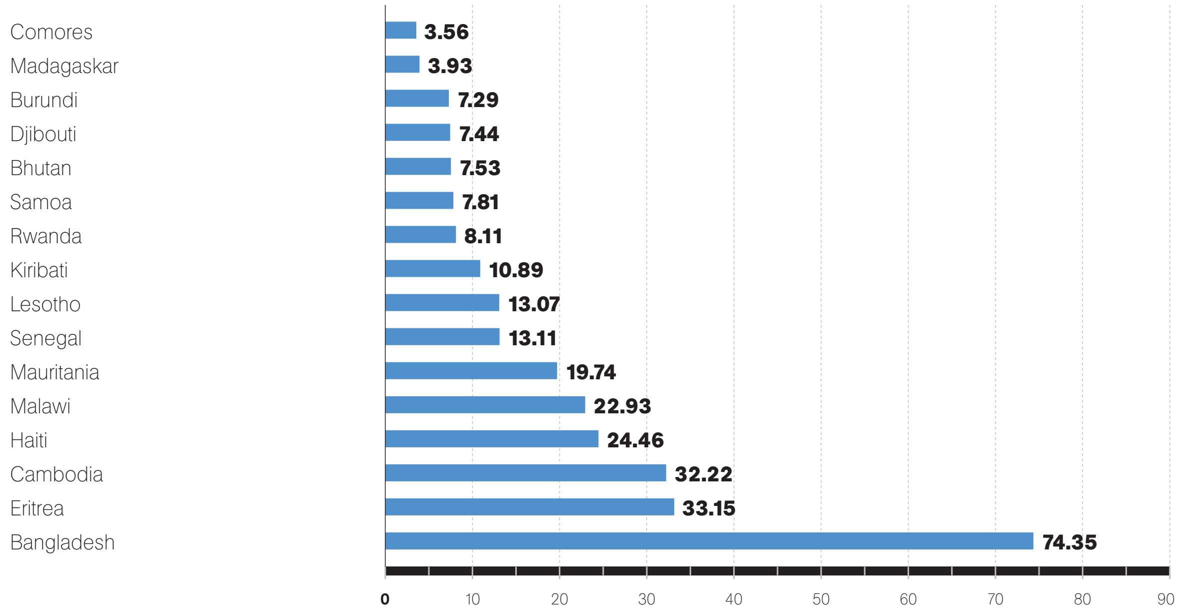
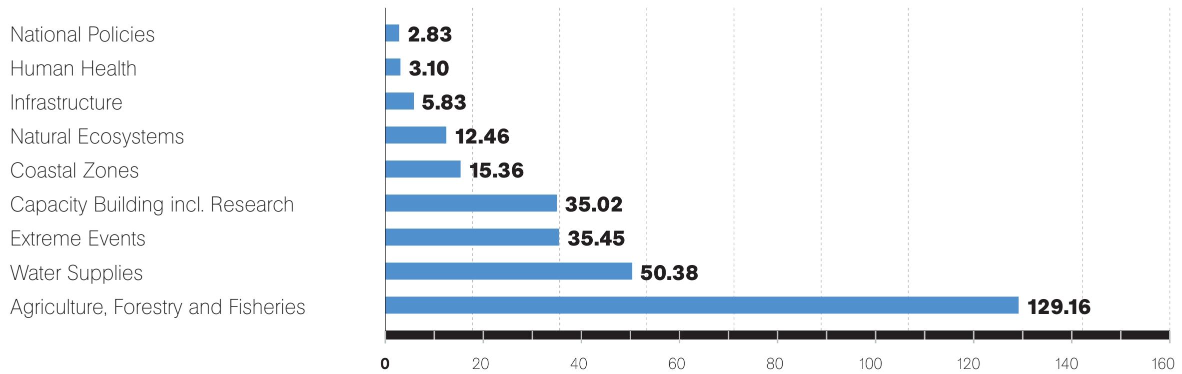
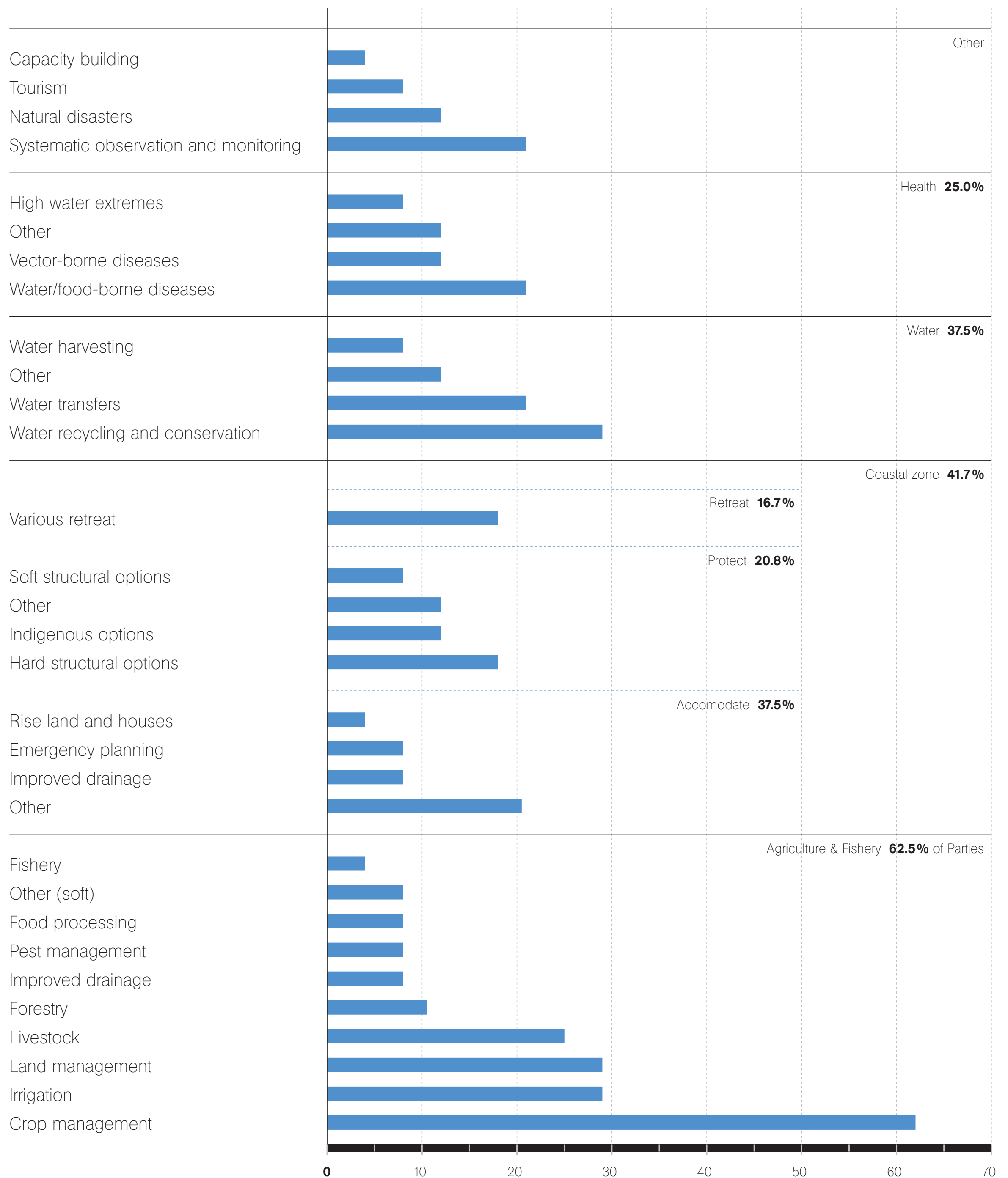


Figure VI-22. **Costs of priority activities identified in national adaptation programmes of action, by sector (in millions of United States dollars)**



Note: National policies include enabling activities other than capacity building such as integration of adaptation into national policies.

Figure VI-23. **Adaptation sectors, sub-sectors and technologies commonly identified by Parties in technology needs assessments**



Source: FCCC/SBSTA/2006/INF.1.

6.2.1. SECTORAL ANALYSIS

6.2.1.1. AGRICULTURE, FORESTRY AND FISHERIES

513. In agriculture, needs reported by countries in INCs and TNAs relate to crop management (with a clear emphasis on developing and using tolerant/resistant crop varieties), land management and soil and water conservation.

514. In their INC, for the forestry and terrestrial ecosystems sector Parties in their INCs referred to the need for: protection of forest areas, through targeting forests under stress; forest expansion and the preservation of genetic resources and biological diversity; and promoting sustainable forest management. Parties also suggested the need for measures to combat mud torrents, forest fires, pests and diseases.

515. In the fisheries sector, Parties called for improved understanding of climate change effects on the pelagic fishery resources.

516. Technologies identified by countries in TNAs included early warning systems for forest fires, afforestation and reforestation and development of fast-growing species to adapt to new conditions.

517. The cost of NAPA projects in this sector amounts to USD 122 million. Priority activities included developing resistant crop and livestock varieties, promoting diversification of activities for rural communities, advancing food security (seed and food banks), community-based forest management and afforestation projects, improving veterinary services as well as promoting agricultural techniques and irrigation methods to fight salinity in coastal countries. As for fisheries, developing the culture of salt tolerant fish and fish conservation were considered as adaptation options. NAPA projects to protect ecosystems included establishing conservation programmes for terrestrial and marine ecosystems, coral reef restoration and sustainable use of natural resources.

6.2.1.2. WATER SUPPLY

518. This sector was prioritized in all regions and in all sources examined. Adaptation measures identified in INCs include: increasing water supply; promoting water conservation; water demand management; establishing flood and drought monitoring, forecast, control and protection systems; improving watershed management; ensuring long-term integrated water management with land use, cropping pattern, and zoning and improving water monitoring. At the Asian adaptation workshop, representative from Azerbaijan estimated the cost of construction of new water reservoirs and the increase in efficiency of existing ones at USD 305 million.[49]

519. Technologies identified in TNAs included those related to water transfers, water recycling and conservation, water harvesting and water management (mostly research and monitoring).

520. Projects reported in NAPAs included protecting the water supply infrastructure, improving management of surface water, constructing storage facilities, water-harvesting, improving watershed management as well as improving water monitoring system and raising community awareness on sustainable use of water resources. Coastal LDCs also submitted projects aimed at slowing down salinization of water stemming from sea-level rise. The indicative total cost of priority activities is about USD 59 million.

6.2.1.3. COASTAL ZONES

521. Measures to protect coastal areas reported in INCs include preventing soil erosion, limiting the development of coastal areas, building coastal infrastructure, restoring beach vegetation, and waste management. This sector was a priority for small island developing states (SIDS) and countries with long coastlines and low-lying areas.

522. For coral reef protection Parties identified the creation of protected areas, sustainable harvesting and fishing practices as necessary measures.

523. As an example of indicative costs, the representative from Sierra Leone reported at the African adaptation workshop that that country would need USD 590 million for the protection of its coastal areas (the cost involves only the design and construction of a seawall and does not include the cost of maintenance). The representative also noted that the cost of protection may be far more than the cost of relocation of the population in the long-term.[50]

524. The NAPA priority activities included integrated management of coastal zones, the construction and upgrading of coastal defences and causeways, and mangrove planting. The total cost of the NAPA projects is estimated at USD 13 million.

6.2.1.4. EXTREME EVENTS

525. Adaptation priorities related to extreme events were highlighted by SIDS and countries with long coastlines and low-lying areas. Insurance as an adaptation policy was prioritized by SIDS, especially for coastal communities and the tourism sector.

526. The main strategies reported in INCs are disaster management, efficient warning systems, and enhancing adaptive capacity through various measures in education and communication. Asian countries emphasized the need for adaptation planning in mountainous regions which are particularly vulnerable to extreme events such as Glacial Lake Outburst Floods. Adaptation measures included an inventory of glacial lakes, hydrological monitoring and forecasting.

527. As an indicative estimate of costs, mainstreaming disaster risk reduction and disaster management in the Pacific region would require USD 3.8 million according to the presentation by the Pacific Islands Forum at the SIDS adaptation expert meeting.[51]

528. NAPAs prioritized the installation of early warning systems, measures for flood prevention (e.g., construction of flood dykes) and coping with droughts as well as strengthening of community disaster preparedness and response capacity. The cost of these activities is about USD 29 million.

6.2.1.5. HUMAN HEALTH

529. In INCs Parties reported on general options for adaptation such as the improvement of living standards, increase in the awareness about hygiene, and strategies to control disease vectors. Specific health sector measures included vaccination and chemical prevention measures, and monitoring of risk groups, especially in exposed areas.

530. Technology needs for adaptation included disease monitoring, disease prevention/treatment options, access to health services and health alert information systems.

531. Priority actions reported in NAPAs included the development of health infrastructures, increasing immunization against common diseases, various measures to combat the spread of malaria (e.g., by disseminating bed nets) as well as training of and raising awareness among medical personnel. The total cost of NAPA projects on public health is among the lowest across sectors (USD 3.15 million).

6.2.1.6. INFRASTRUCTURE

532. In their INCs Parties gave special attention to protecting tourism infrastructure as well as the enhancing resilience of urban infrastructure to the impacts of climate change including floods and cyclones. Adaptation options listed in NAPA projects also included development of communications and telecommunications infrastructure and road protection. These activities would cost about USD 5.8 million.

6.3. CAPACITY-BUILDING NEEDS

533. Capacity-building needs cut across all sectors in climate change mitigation and adaptation.

534. On the mitigation side, many Parties reported insufficient human and institutional capabilities and financial resources to prepare mitigation project proposals for funding, including the identification and development of CDM projects. Many Parties mentioned the need for better institutional arrangements to facilitate data collection and analysis, and all indicated the need for further capacity-building and human resource development to prepare national communications. Parties also indicated the need to improve the capabilities of national climate change coordinators and national institutions to manage climate change programmes. Some Parties expressed the need to improve research and systematic observation through capacity building in scientific research.

535. In adaptation, many Parties identified the need for capacity building in human resources development, institutions, methodologies, technology and equipment, and information and networking. Participants of the regional adaptation workshops and expert meeting recognised the need for strengthening environmental and sectoral institutions (in particular, existing regional centres and hydro meteorological networks), establishing regional centres of excellence, and training for stakeholders to aid the development of specialized tools for planning and implementing adaptation activities. Parties also reported insufficient human and institutional

[49] Presentation by Azerbaijan at the Asian adaptation workshop: <http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/verdiyev_water.pdf>.

[50] Presentation by Sierra Leone at the African adaptation workshop: <http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200609_sierra_leone_coast_paper.pdf>.

[51] Presentation by Dr. Padma Lal: <http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200702_pifs_-_ms._padma_lal.pdf>.

capabilities, and financial resources, to formulate and prepare adaptation project proposals for funding. Some Parties expressed the need to improve research and systematic observation through capacity building in scientific research, particularly in modeling. Overall, participants of the regional adaptation workshops and expert meeting called for a long-term programmatic and comprehensive approach in external support activities to capacity-building.

536. LDCs submitted several NAPA priority activity proposals in capacity building to address immediate adaptation needs. Those projects included upgrading meteorological services, exploring options for insurance to cope with enhanced climatic disasters, research on drought, flood and saline tolerant varieties of crops, as well as raising awareness and disseminating information to vulnerable communities for emergency preparedness. The indicative total cost of priority activities amounts to USD 35.5 million.

6.4. BARRIERS TO TECHNOLOGY TRANSFER

537. Technology transfer plays an important role in addressing climate change. The biggest barrier to technology transfer identified in TNAs and INCs was the lack of financial resources. High investment costs, subsidies and tariffs were also considered important economic/market barriers. Other barriers included insufficient information and awareness as well as those related to policy. The measures identified by Parties to address existing barriers to technology transfer were most commonly placed in the following categories: regulatory and policy options, information and awareness building, and economic and market measures. A detailed summary is provided in figures VI-24 and VI-25.

6.5. IMPACT OF THE IMPLEMENTATION OF RESPONSE MEASURES

538. Information from Parties on measures necessary to address risks from the impact of response measures is very limited. They include outcomes of the expert meetings[52] on response measures and economic diversification[53], and submissions by Parties under the agenda item 3 “Analysis of mitigation potentials and ranges of emission reduction objectives of Annex I Parties of the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol”[54]. Four INCs (from Saudi Arabia, Islamic Republic of Iran, South Africa and Singapore) also contain some information on this issue.

539. Two main strategies have been identified under the Convention: insurance and risk management, and economic diversification. The first is believed to serve for short-term goals whereas the second is considered as a long-term solution. Parties recognize a knowledge gap for both options.

540. Participants in the expert meeting[55] on response measures also acknowledged the role of technology transfer. Proposed technological measures include developing low-cost carbon capture and sequestration technologies, promoting renewable energy, development of GHG-friendly energy technologies and implementing energy efficiency measures.

541. During the expert meeting on response measures, the following financial risk management approaches were identified: commodity price hedging; economic shock funds; commodity price insurance; alternative risk transfer; hedge funds; alternative risk financing; structured risk financing mechanisms; effective use of developed captive insurance, credit and political risk coverage; hybrid insurance products; and catastrophe bonds.

542. For economic diversification[56], areas in need of technical and financial support include development of the key infrastructure necessary for economic activity, promotion of FDI, labour-intensive exports (manufacturing and services), access to markets in developed countries, price and ownership reforms in the energy-related industry, capacity-building , and activities and projects that promote synergy between poverty reduction, adaptation and economic diversification.

543. Saudi Arabia reported that it would require assistance from Annex I Parties in the areas of power generation, desalinization of seawater, expansion of petrochemical industry, and education in order to diversify its economy.

[52] Pre-sessional Expert Meeting on Response Measures, Montreal, Canada, 23–24 November, 2005; Pre-sessional Expert Meeting on Economic Diversification, Bonn, 16–17 May 2006. Reports available at: <http://unfccc.int/adaptation/adverse_effects_and_response_measures_art_48/items/2535.php>.

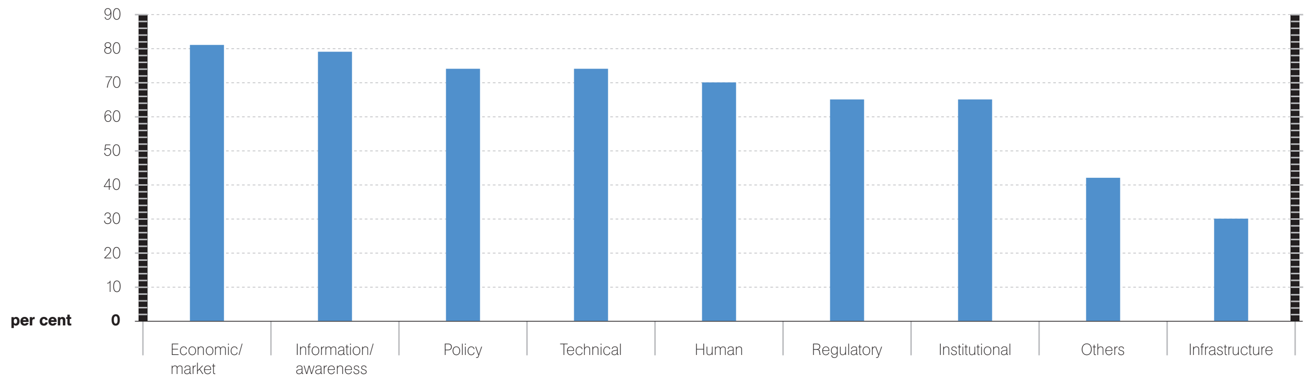
[53] Decision 1/CP.10 paragraph 16.

[54] FCCC/KP/AWG/2007/MISC.1.

[55] FCCC/SBI/2006/13.

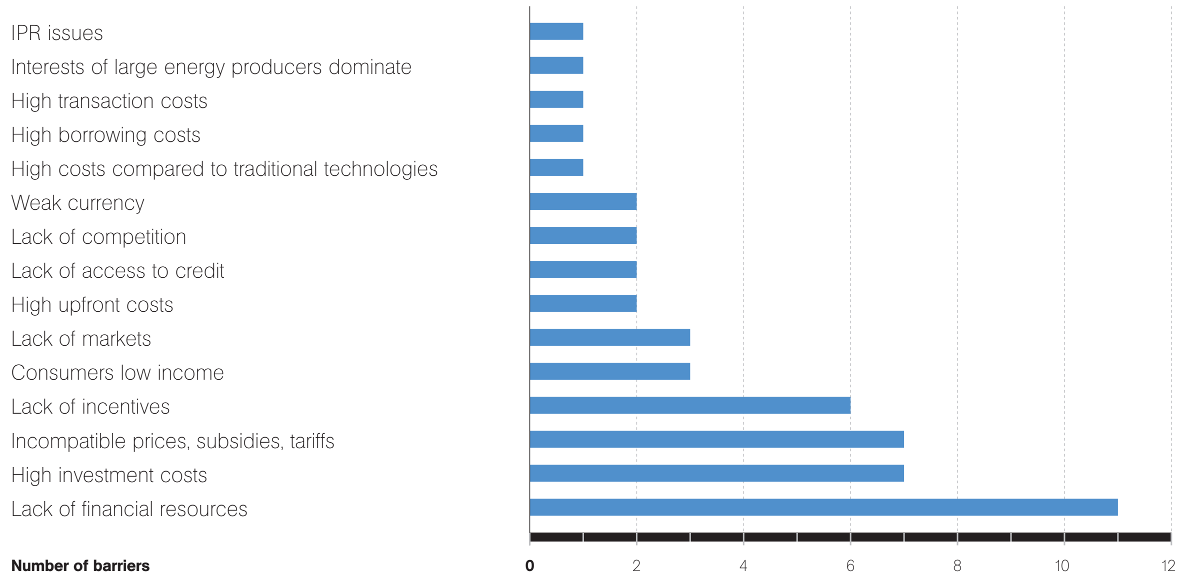
[56] FCCC/SBI/2006/18.

Figure VI-24. **Barriers to technology transfer identified by Parties**



Source: FCCC/SBSTA/2006/INF.1.

Figure VI-25. **Economic and market barriers to technology transfer**



Source: FCCC/SBSTA/2006/INF.1.

VII. POTENTIAL OF CARBON MARKETS

7.1. INTRODUCTION

544. This chapter provides an analysis of the carbon market to 2030. The carbon market is the market for GHG emission reductions (credits) and rights to release GHG emissions (allowances).[57]

545. Chapter VII.2 reviews the existing markets. The largest markets are those established by the Kyoto Protocol and Parties that have emissions limitation commitments under the Protocol. Chapter VII.3 focuses on prospects for those markets in the short term – 2008 to 2012. Chapter VII.4 develops estimates of the potential size of the carbon market in 2030.

7.2. CARBON MARKETS

7.2.1. EXISTING CARBON MARKETS

546. The Kyoto Protocol established emissions limitation commitments for industrialized country (Parties included in Annex B to the Kyoto Protocol or Annex B Parties) Parties for the period 2008–2012 and established three mechanisms – the CDM, JI and International Emissions Trading – they can use to help meet those commitments. Most Annex B Parties plan to use emissions trading systems to regulate the emissions of fossil-fired electricity generators and large industrial emitters to help comply with their Kyoto Protocol commitments for the period 2008–2012. Those emissions trading systems are already operational in the Member States of the EU and Norway. The United Kingdom of Great Britain and Northern Ireland has sources that participate in the emissions trading scheme (ETS of the EU) and that participate in a domestic scheme.

547. The EU ETS is by far the largest market in terms of number of participants and trading activity. Trading activity is shifting from allowances that can be used for compliance during Phase I (2005–2007) to allowances that can be used for compliance during Phase II (2008–2012). Credits created by CDM projects (certified emissions reductions or CERs) are the second largest market. The CDM was the first of the three Kyoto mechanisms to be implemented.

548. Emissions trading systems are also operating in Australia (the New South Wales–Australian Capital Territory GHG abatement scheme) and the United States (the Chicago Climate Exchange). The quantities traded in the markets established by these systems and the voluntary market[58] are much smaller than those in the EU ETS and the CDM market.

549. Figure VII-33 at the end of this chapter VII.2.8 and table 18-annex V provide an overview of the existing carbon markets in 2006.

7.2.2. KYOTO PROTOCOL MARKETS

550. Annex B Parties can meet their Kyoto Protocol commitments for the period 2008–2012 through a combination of domestic emission reduction and sink enhancement actions and purchases of various allowances and credits from other countries, through the three Kyoto mechanisms. Each of these mechanisms creates a market for specific units (allowances/credits). These markets are at different stages of development, with the CDM market being the most advanced.

7.2.2.1. CLEAN DEVELOPMENT MECHANISM

551. The CDM enables a project to mitigate climate change in a non-Annex I Party to generate CERs.[59] The CDM was launched in November 2001, the first project was registered about three years later, and the first CERs were issued in October 2005. CERs can be issued for verified emission reductions achieved since 1 January 2000. Rules for some categories of CDM projects were adopted later; afforestation and reforestation projects (December 2003), small-scale afforestation and reforestation projects (December 2004) and programmes of emission reduction activities (December 2005).

552. CDM projects must use an approved methodology and be validated by an accredited designated operational entity (DOE). CERs are issued by the CDM Executive Board only after the emission reductions achieved have been verified and certified by an accredited DOE. Thus a CDM project incurs costs (validation of the project) before it can be registered, and further costs (certification of the emission reductions) before CERs are issued.[60]

ANNUAL EMISSIONS REDUCTIONS AND REVENUE FROM CERS

553. To help defray the cost of implementing the project, proponents often agree to sell some of the expected CERs before the project has been implemented. Capoor and Ambrosi (2007) indicate that expected CERs from projects at an early stage command 2006 USD 10.40 – 12.40, registered project transactions command close to 2006 USD 14.70 and issued CERs are trading at 2006 USD 17.75. The lowest prices reflect risks that the proposed project might not be registered and might not deliver the expected emission reductions. Once a project is registered the uncertainty is limited to the timing and size of the emission reductions.[61] Once CERs are issued, delivery to an Annex B Party registry where they can be used for compliance is the only uncertainty and they therefore command the highest prices.[62]

554. At the end of 2006 the 1,468 projects in the CDM pipeline were expected to yield annual emission reductions of 251 Mt CO_2 eq.[63] Experience to-date suggests that CDM projects achieve about 85 per cent of the projected emission reductions (Fenhann, 2007).

[57] Allowances and credits are also called permits, quotas, offsets, and names unique to the specific market.

[58] For details, see CHAPTER VII.2.8.

[59] Afforestation and reforestation projects under the CDM can generate temporary certified emission reduction (tCERs) or long term certified emission reduction (lCERs), which have limited lifetimes. For ease of exposition CERs will include tCERs and lCERs unless explicitly stated.

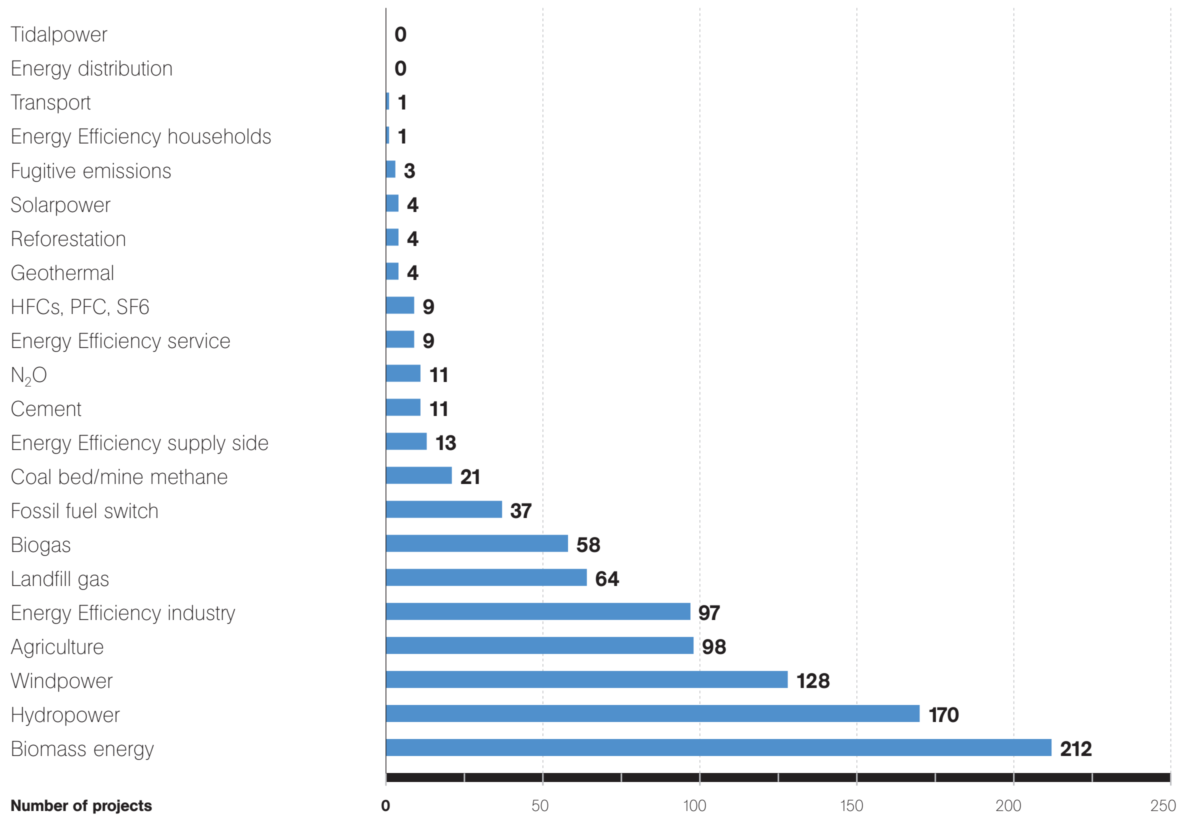
[60] This staged approach to issuing CERs increases environmental integrity and reduces financial risks for project proponents.

[61] In each, the price also depends on how the risks are shared between the buyer and the seller, through penalty provisions or requirements to replace CERs that could not be delivered.

[62] CERs issued are delivered to the buyer in a special account in the CDM registry by the CDM Executive Board, but they cannot be transferred to an account in an Annex B Party national registry until the International Transaction Log (see CHAPTER II.2.2) is operational.

[63] The number of projects in the pipeline at the start of the year was 513, with estimated annual emission reductions of 107 Mt CO_2 eq.

Figure VII-26. **Projects that entered the clean development mechanism pipeline in 2006, by project type/sector**



555. FIGURES VII-26 and -27 provide the sectoral distribution of projects under the CDM pipeline and related emission reductions.

556. Because the CDM is still in its infancy, the number of projects registered and the projects entering the CDM pipeline (having a public project design document) are used as measures of activity.[64] The distribution of projects registered and those that entered the pipeline during 2006 are shown in TABLE 19-ANNEX V together with the estimated annual emission reductions, and potential revenue from the sale of the CERs (see FIGURES VII-28 and VII-29).

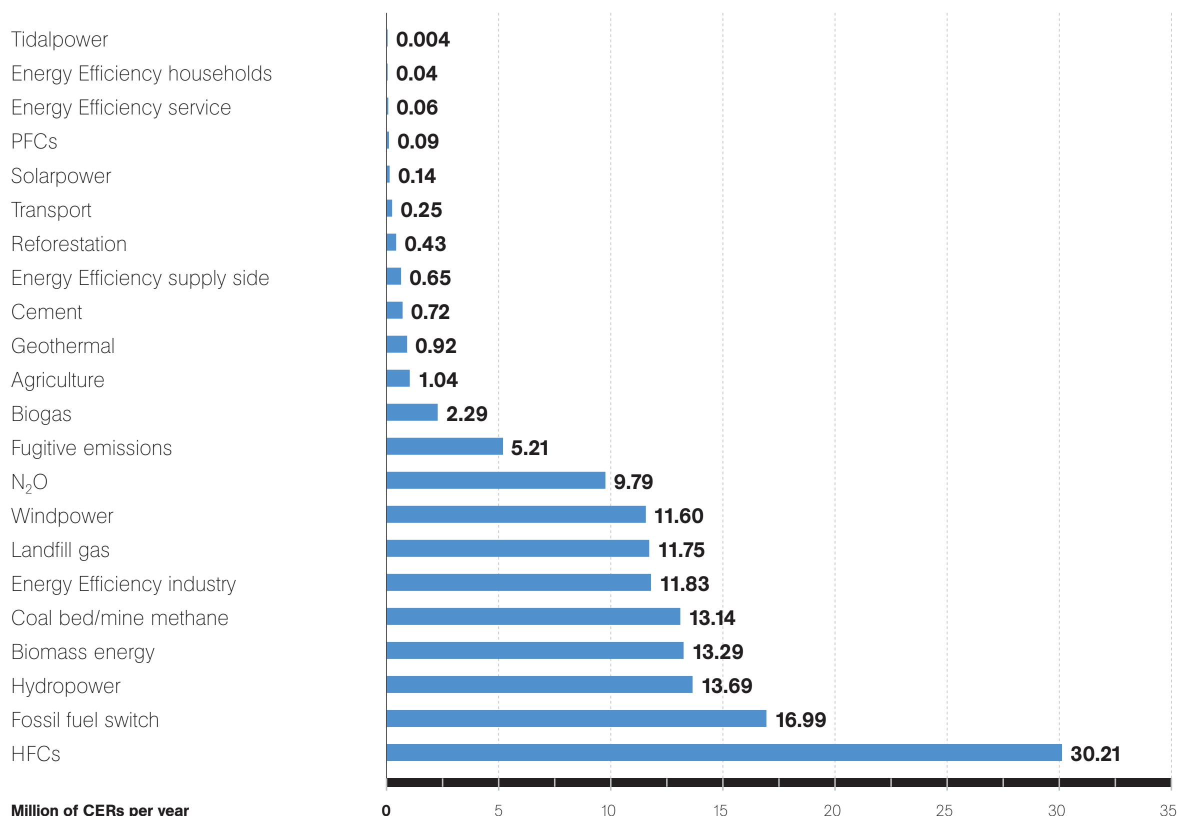
557. The estimated annual emission reduction from the projects registered during 2006 is 88 Mt CO_2 eq and from projects that entered the pipeline during 2006 is 144 Mt CO_2 eq. The estimated revenue from the sale of CERs generated by the CDM projects registered during 2006 is USD 1–1.5 billion per year and the estimated revenue from the sale of the CERs generated by the CDM projects that entered the pipeline during 2006 is USD 1 billion higher. Capoor and Ambrosi report transactions for about 450 Mt CO_2 eq in this market during 2006 at an average price of about USD 10.70 per t CO_2 eq. Thus the transactions averaged about three to five years of projected emission reductions for the new projects.

558. China dominates the CDM market, as it is the source of over 53 per cent of the estimated annual emission reductions of the projects that entered the pipeline during 2006. Capoor and Ambrosi note that, as the dominant supplier in the CDM market, China's informal policy of requiring a minimum acceptable price (around USD 10.40–11.70 or EUR 8–9 in 2006) before providing approval to projects had a significant stabilizing impact on the market price.

ANNUAL INVESTMENT IN CDM PROJECTS

559. The capital[65] that is, or will be, invested in CDM projects registered during 2006 is estimated at about USD 7 billion whereas the capital that is, or will be, invested in projects that entered the CDM pipeline during 2006 is estimated at over 2006 USD 26.4 billion (TABLE 19-ANNEX V).[66]

Figure VII-27. **Estimated certified emission reductions from projects that entered the clean development mechanism pipeline in 2006, by project type/sector**



560. Of the USD 26.4 billion approximately 50 per cent represents capital invested in unilateral projects by host country project proponents. Unilateral projects are these for which the project proponent in the developing country Party bears all costs before selling the CERs. At the end of 2006, about 60 per cent of the projects, representing about 33 per cent of the projected annual emission reductions, were unilateral projects.[67] India is home to the most unilateral projects (33 per cent of projected annual emission reductions of projects in the pipeline at the end of 2006), followed by China (20 per cent), Brazil (11 per cent) and Mexico (6 per cent).

561. Over 80 – 90 per cent of the capital, USD 5.7 billion for registered projects and almost USD 24 billion for projects that entered the pipeline, went into renewable energy and energy efficiency projects. Although these projects represent only about 20 per cent of emission reductions, as can be seen in TABLE 20-ANNEX V, they have high capital costs per unit of emission reductions.

562. The estimated investment of USD 5.7 billion for CDM renewable energy and energy efficiency projects registered during 2006 is roughly triple the ODA support for energy policy and renewable energy projects in the same countries – about USD 2 billion (TABLE 20-ANNEX V). It is almost as much as the private investment in renewable energy and energy efficiency (2006 USD 6.5 billion) in the same countries.[68] China and India receive most of the CDM investment and private investment.

[64] Almost all projects that enter the pipeline get registered. Only 10 of the 1,478 projects to enter the pipeline by the end of 2006 had been rejected or withdrawn.

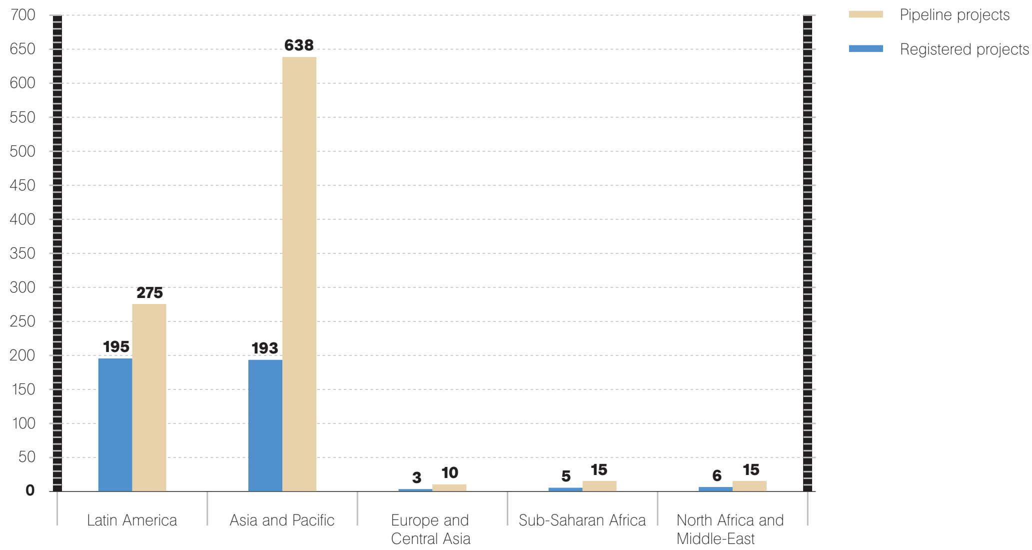
[65] Capital costs as reported in Project Design Documents (PDDs) (data from 250 projects and from the World Bank).

[66] Many of the projects that entered the pipeline during 2006 will not have been completed by the end of the year, so some of the investment will occur during 2007 and 2008. For further information, see Ellis and Kamel, 2007.

[67] These figures indicate that unilateral projects are about half the size of the average CDM project.

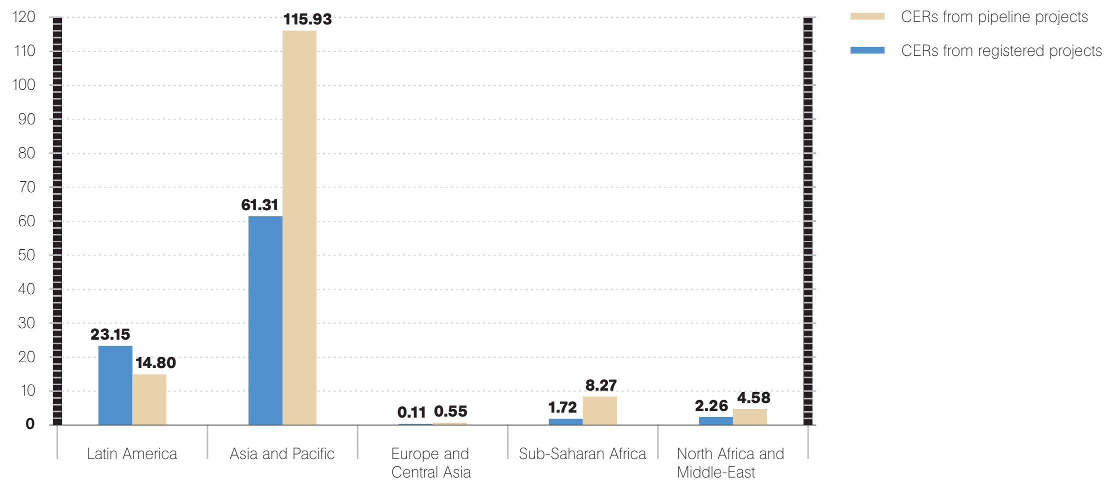
[68] This does not mean that most private investment in renewable energy and energy efficiency in developing countries took the form of CDM projects. The investment for CDM projects registered during 2006 may not have been made during 2006.

Figure VII-28. **Regional distribution of clean development mechanism project activities registered and in the pipeline in 2006**



Note: Central Asia includes Kyrgyzstan, Tajikistan and Uzbekistan which are not considered under Asia and Pacific region

Figure VII-29. **Volume of certified emission reductions from clean development mechanism project activities registered and in the pipeline in 2006, by region**



Note: Central Asia includes Kyrgyzstan, Tajikistan and Uzbekistan which are not considered under Asia and Pacific region.

563. The capital invested in afforestation and reforestation has been very low. Only three afforestation and reforestation projects were among the 1,468 projects in the pipeline at the end of 2006. The recent authorization of such projects is part of the explanation. But the attractiveness of these projects is reduced by uncertainty stemming from the temporary nature of temporary CERs (tCERs) and long term CERs (lCERs) and the fact that installations in the EU ETS can use CERs, but not tCERs or lCERs, for compliance.

564. The revenue earned from the emission reductions credits has very different impacts on the profitability of different types of projects. TABLE VII-54 shows the effect of different CER prices on the profitability, measured by the internal rate of return, of HFC-23, methane from landfill, and renewable energy projects. The sale of CERs makes HFC-23 projects, which have a low capital cost per unit of emissions reduced, much more profitable. In contrast, the sale of CERs has little effect on the profitability of renewable energy projects, which have a high capital cost per unit of emissions reduced. Thus the carbon market alone is unlikely to provide a significant stimulus to the deployment of renewables in developing countries.

Table VII-54. **Incremental impact of the CER price on the internal rate of return (IRR) of the project (percentage per purchase period)**

CER prices (in USD)	Five years (2008 to 2012)	Seven years	Ten years	Fourteen years	Twenty-one years	Impact per unit (in USD)
Renewable energy IRR						
5	0.5	0.6	0.8	1.0	1.2	3.16/MWh
10	1.0	1.4	1.7	2.1	2.3	6.33/MWh
15	1.6	2.1	2.7	3.1	3.3	9.49/MWh
20	2.2	2.9	3.6	4.1	4.5	12.65/MWh
Solid waste IRR						
tSW (ton solid waste)	**tSW**	**tSW**	**tSW**	**tSW**	**tSW**	
5	17.9	24.1	29.2	31.7	32.8	41/MWh
10	52.3	59.1	62.4	63.5	63.8	82/MWh
15	88.2	93.3	95.4	95.9	96.0	124/MWh
20	123.7	127.3	128.6	128.8	128.9	165/MWh
HFC/23 IRR[a]						
5	110.8	112.3	112.7	112.7	112.7	–
10	176.7	177.3	177.4	177.4	177.4	–
15	227.3	227.6	227.7	227.7	227.7	–
20	270.0	270.2	270.2	270.2	270.2	–

Source: World Bank.

[a] Sixty-five per cent tax applied on revenue from sale of CERs.

TECHNOLOGY TRANSFER AS IDENTIFIED IN CDM PROJECT DESIGN DOCUMENTS (CDM-PDDS)

565. Roughly one-third of all CDM projects accounting for almost two thirds of the annual emission reductions in 2006, identify some technology transfer in their project design documents (CDM-PDDs)[69] (Haites, *et al.*, 2006). TABLE 21-ANNEX V shows that technology transfer varies widely across project types: cement, coalbed/coalmine methane, fossil fuel switching, and transport involve very little technology transfer whereas almost all energy supply, household energy efficiency and solar projects claim technology transfer. Technology transfer is more common for larger projects and projects with foreign participants. Equipment transfer only is more common for larger projects whereas smaller projects involve transfers of both equipment and knowledge or knowledge only.

566. Statistical analyses reported by Haites, *et al.* (2006) find that the host country has a significant impact on technology transfer for 12 of the 23 countries analysed. Technology transfer was found to be more likely for projects in China, Ecuador, Guatemala, Honduras, Malaysia, Mexico, Peru, South Africa, Thailand and Viet Nam and less likely for projects in Chile and India. The reasons for the higher or lower level of technology transfer are not given.[70] Since the host country must approve each project, it can influence the extent of technology transfer involved in its CDM projects.

SECONDARY MARKET[71]

567. Trades of CERs issued do not involve project or registration risks. The higher price, USD 17.75 per t CO_2 eq, reflects the absence of these risks. The first CERs were issued during 2005 and many of these had already been purchased (through forward contracts). The volume traded is approximately equal to the quantity of CERs issued.

568. The secondary market has been growing rapidly and this is expected to continue as more CERs are issued and as the international transaction log links the CDM and Annex B Party national registries in 2007.[72]

569. As the quantity of CERs issued rises, exchanges are beginning to trade them. This will facilitate trades of CERs on an exchange, with the assistance of a broker, or directly between the buyer and seller.

7.2.2.2. JOINT IMPLEMENTATION

570. Joint implementation (JI) enables a project to mitigate climate change in an Annex B Party to generate emission reduction units (ERUs) that can be used by another Annex B Party to help meet its emission limitation commitment. Projects can be implemented under rules established by the host country (Track 1) or international rules administered by the Joint Implementation Supervisory Committee (JISC) (Track 2). The JISC was established in December 2005 and no national track 1 process had been established by the end of 2006, therefore JI is just starting.[73]

571. At the end of 2006 there were 146 JI projects in the pipeline with expected annual emission reductions of 25 Mt CO_2 eq[74] (see FIGURES VII-30 and -31). Of these, 53 projects with estimated annual reductions of 15 Mt CO_2 eq entered the pipeline during 2006. No JI projects had yet been approved. Capoor and Ambrosi report JI transactions totaling 16 Mt CO_2 eq at an average price of USD 8.80 per t CO_2 eq. In effect, the purchases were equivalent to the expected annual emission reductions of the projects that entered the pipeline during the year.

572. ERUs are equivalent to CERs for purposes of compliance with Annex B Party commitments under the Kyoto Protocol and for compliance use by industry during Phase II of the EU ETS. Thus the price of ERUs is expected to be very similar to that of CERs. During 2006 the price of ERUs was lower than the primary market[75] price for CERs because the regulatory structure for JI was still being developed, and therefore the risks were higher.

573. The distribution by country of the 53 JI projects that entered the pipeline during 2006 is shown in TABLE 22-ANNEX V together with the estimated annual emission reductions, potential revenue from the sale of ERUs and estimated capital invested. The Russian Federation dominates the market, being the source of over 80 per cent of the estimated annual emission reductions of the new projects in 2006. The Russian Federation's dominance of the supply of ERUs does not have much impact on the overall market price because ERUs and CERs are substitutes and the JI emission reductions are much smaller than those for the CDM.

574. The estimated revenue from the sale of the ERUs generated by the JI projects that entered the pipeline during 2006 is 2006 USD 0.1 – 0.3 billion per year. Applying the same estimation method for investment by project type for CDM projects to the JI projects that entered the pipeline during 2006 yields an estimated capital investment for JI projects of 2006 USD 6 billion.

575. Only about 30 per cent of the JI investment, almost USD 2 billion, was for renewable energy and energy efficiency projects. This compares with 2006 USD 4.5 billion of private investment in renewable energy and energy efficiency in the same countries during 2005 (see TABLE 22-ANNEX V). However, this comparison is distorted by Germany, which accounts for over 90 per cent of the total private investment in renewable energy and energy efficiency in these countries. In all of the other countries renewable energy and energy efficiency JI projects generate more investment. The only JI host country to receive ODA for renewable energy and energy efficiency during 2005 was Ukraine, which received USD 143 million.

[69] See chapter A.4.3 of the CDM-PDD, available at: <http://cdm.unfccc.int/Reference/Documents/Guidel_Pdd_most_recent/English/Guidelines_CDMPDD_NM.pdf>.

[70] The results are based on a statistical analysis which cannot explain the causes. The analysis includes project size and type therefore the result is not due to the project mix of the different countries. Other analyses indicate that host country population, GDP and per capita GDP are not statistically significant.

[71] The secondary market is the resale of CERs that have already been purchased.

[72] Transfers of issued CERs are governed by the rules for international emissions trading. Annex B Parties must meet specified conditions before they are eligible to participate in international emissions trading.

[73] Contracts to purchase ERUs generated by projects that expect to be approved as JI projects have been announced since 2002.

[74] A current list of JI projects is available at: <http://cdmpipeline.org/>.

[75] The primary market is the initial purchase of CERs or ERUs.

Figure VII-30. **Number of joint implementation projects that entered the pipeline in 2006, by type of project/sector**

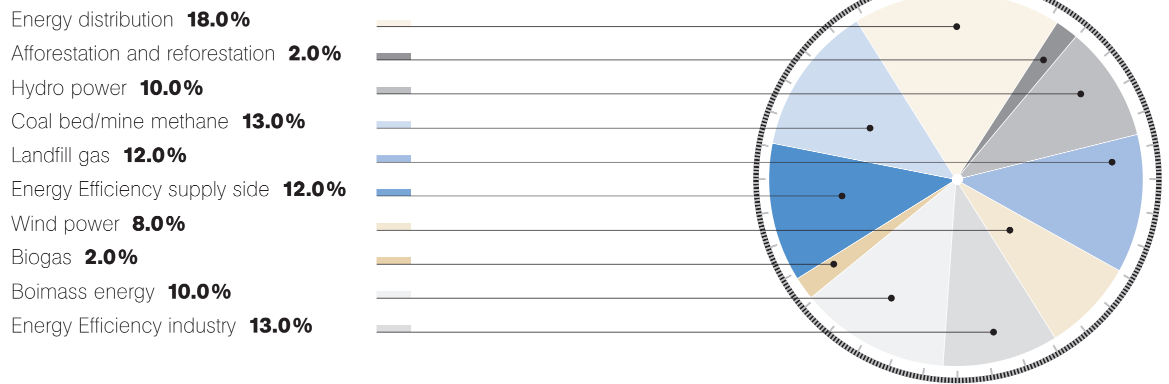
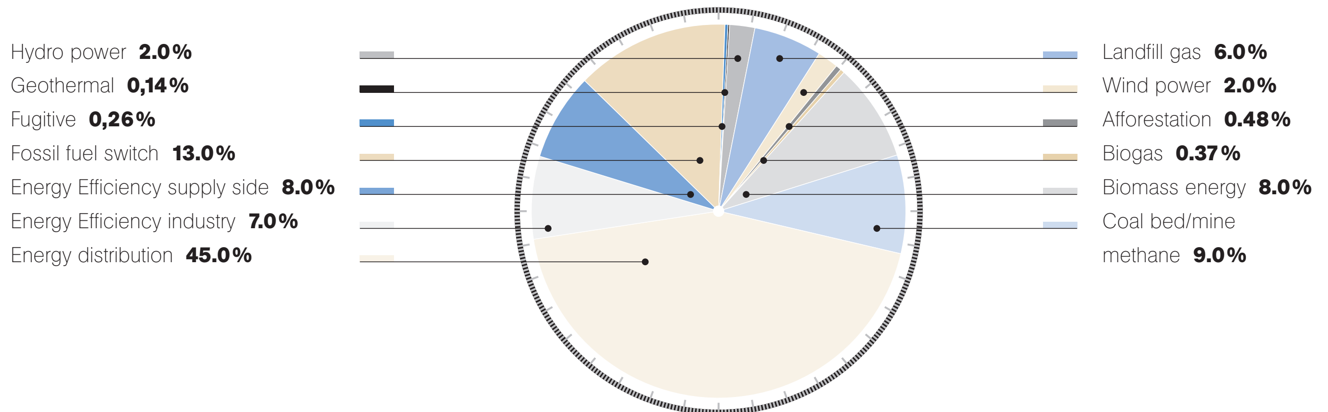


Figure VII-31. **Annual emission reduction units from joint implementation projects that entered the pipeline in 2006, by type of project/sector**



7.2.2.3. INTERNATIONAL EMISSIONS TRADING

576. International emissions trading allows an Annex B Party to transfer some of its allowable emissions to another Annex B Party. This is enacted through transferring Kyoto units (assigned amount units (AAUs), ERUs, CERs, lCERs, tCERs and removal units (RMUs)), from one Party's national registry to that of another, and may include units originally issued by that Party or any units acquired earlier from another Party. Some Parties have allowed the participation of companies and other entities in trading by establishing national or regional trading schemes.

7.2.3. EUROPEAN UNION EMISSIONS TRADING SCHEME

577. Almost all EU Member States are Annex B Parties and hence have emission limitation commitments for 2008 – 2012. To help meet those commitments, each Member State is required to implement an ETS covering CO_2 emissions by electricity generators and specified industrial sources. Allowances issued by a Member State can be used for compliance by an installation in any Member State.

578. The ETS is being implemented in phases: from 2005 to 2007, and from 2008 to 2012 and in five-year periods thereafter. To facilitate compliance with Kyoto Protocol commitments, surplus Phase I allowances cannot, with very limited exceptions, be carried over to Phase II.[76] Beginning in 2008, surplus allowances can be carried over indefinitely with no restrictions. During Phase I, installations can use CERs, but not tCERs or lCERs, for compliance. During Phase II, installations can also use ERUs for compliance.

7.2.3.1. PHASE I: 2005 – 2007

579. During 2005 the ETS covered about 10,500 installations responsible for about 45 per cent of the EU's CO_2 emissions,[77] and approximately 2,088 million allowances were issued. Actual emissions were about 2,007 Mt CO_2, leaving about 80 million surplus allowances (Ellerman and Buchner, 2006). The 2005 emissions data, released in April 2006, confirmed the likelihood of a surplus of Phase I allowances causing the price to drop from over EUR 30 to EUR 12 and to decline to EUR 4 by the end of the year (see FIGURE VII-32).

580. During 2006 actual emissions increased to 2,028 Mt CO_2, but that still left a surplus of about 61 million allowances for the year (Point Carbon, 2007b). With only one year remaining, this confirmed that a surplus of allowances was virtually certain for Phase I. Since Phase I allowances cannot be carried over for use in Phase II, surplus allowances at the end of the compliance period for 2007 will have no value. As a result, the price of Phase I allowances continued to decline, reaching EUR 0.25 on 1 June 2007.

581. Was the surplus due to allocation of too many allowances or due to larger than anticipated emission reductions? Ellerman and Buchner (2006) estimate that emissions were reduced by between 50 and 200 Mt CO_2 and that up to 100 million excess allowances were issued. They conclude that at least part of the price decline is due to the excess allocation, but over half, and perhaps all, of the surplus is due to emission reductions. Responses to surveys conducted by Point Carbon suggest that 65 – 75 per cent of installations have implemented some emission reduction measures, but that the reductions are not large (Point Carbon, 2007b).

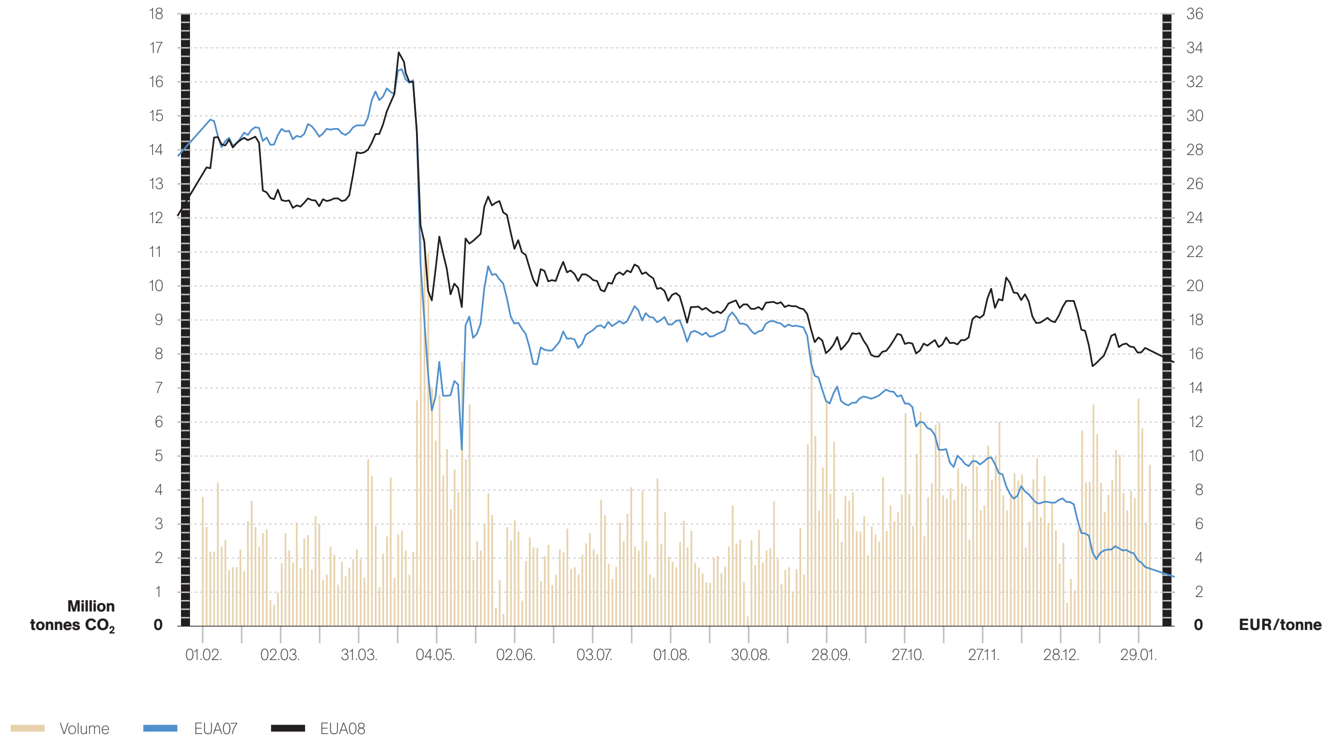
582. As can be seen in FIGURE VII-32, with the decline in the price of Phase I allowances, trading started to shift to Phase II allowances.[78] Of the 1,101 million allowances traded during 2006, about 820,000 were Phase I allowances and 220,000 were Phase II allowances. Phase I allowances traded at prices ranging between EUR 4 and EUR 30 whereas the Phase II allowances traded at prices between EUR 16 and EUR 30.

[76] If installations can bank surplus Phase 1 allowances for use after 2007, their emission reductions during the period 2008 – 2012 can be smaller. That would make compliance with the Kyoto Protocol commitments for 2008 – 2012 more difficult.

[77] New installations increased the total allocation for 2006 and 2007. In addition, Bulgaria and Romania joined the ETS when they entered the European Union on 1 January 2007.

[78] Phase II allowances had not yet been issued. These trades are contracts to deliver Phase II allowances in December 2008.

Figure VII-32. **Daily EU allowance prices and traded volumes, February 2006 – January 2007**



Source: Point Carbon, 2007c.

7.2.3.2. PHASE II: 2008 – 2012

583. As shown in FIGURE VII-32, the price of Phase II allowances remained between EUR 16 and EUR 20, whereas the price of Phase I allowances declined, reflecting the expectation that allocations for Phase II would be more stringent. Based on national allocation plans approved through 15 May 2007, Phase II allocations will be about 8 per cent lower than in Phase I. As a result, a shortage of Phase II allowances expected, which has kept the price of Phase II allowances over EUR 20 through 18 May 2007.

584. Installations will be able to use CERs and ERUs for compliance in Phase II.[79] The limits established by the 21 national allocation plans approved by 18 May 2007 would allow the use of over 200 million CERs or ERUs per year.[80] If the price of CERs or ERUs is lower than the price of Phase II allowances, an installation can profit by selling some of its allowances and buying as many CERs or ERUs as it can use for compliance.[81] Given this incentive, the use of CERs and ERUs could approach the overall limit even though the quantity each installation can use is limited. As a result, the prices of Phase II European Union allowances (EUAs) and those of CERs and ERUs in the secondary market are expected to converge, but not necessarily become equal.

7.2.4. NORWAY

585. Norway implemented an emissions trading system, the design of which is very similar to that of the EU ETS on 1 January 2005 for 51 onshore installations with annual emissions of about seven Mt CO_2. Actual emissions were lower than the allocations for both 2005 and 2006. There has been little trading. Prices are not disclosed, but were probably equal to or lower than those for Phase I EU allowances. On 1 January 2008 Norway's ETS is expected to be integrated into the EU ETS, with coverage expanded to 104 installations with annual emissions of about 23 Mt CO_2.

7.2.5. UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

586. At the start of 2002 the United Kingdom launched an emissions trading system with two components – Direct Entry and Climate Change Levy Agreements (CCLA).[82]

587. Direct Entry participants submitted bids for declining absolute emission targets for the years 2002 through 2006 in return for incentive payments. The 32 successful bidders promised emission reductions of 20.78 Mt CO_2 eq over the five years.[83] Actual allocations declined from slightly over 30 Mt CO_2 eq for 2002 to just over 20 Mt CO_2 eq for 2005 (Enviros, 2006). The Direct Entry component of the scheme concluded at the end of 2006 and many of those participants are now covered by the United Kingdom component of the EU ETS.

588. CCLAs with energy efficiency improvement or GHG emission reduction targets for two-year intervals through 2012 were negotiated with roughly 10,000 establishments in 43 energy-intensive sectors. Compliance with the target reduces its climate change levy, an energy tax, for the period by 80 per cent. CCLA participants can earn tradable allowances for the difference between their target and their actual CO_2 emissions.

589. The number of trades peaks every two years in advance of the compliance deadline for CCLA participants. Direct Entry participants have annual compliance deadlines and are, on average, much larger emitters so the quantity traded has an annual peak. The price increased from GBP 5 in April 2002 to GBP 12 in September 2002, and then fell to GBP 4 by the end of the year, and has remained between GBP 2 and GBP 4 since. The price spike was due to a limited supply of allowances, caused by administrative delays, at the time of its first compliance deadline.

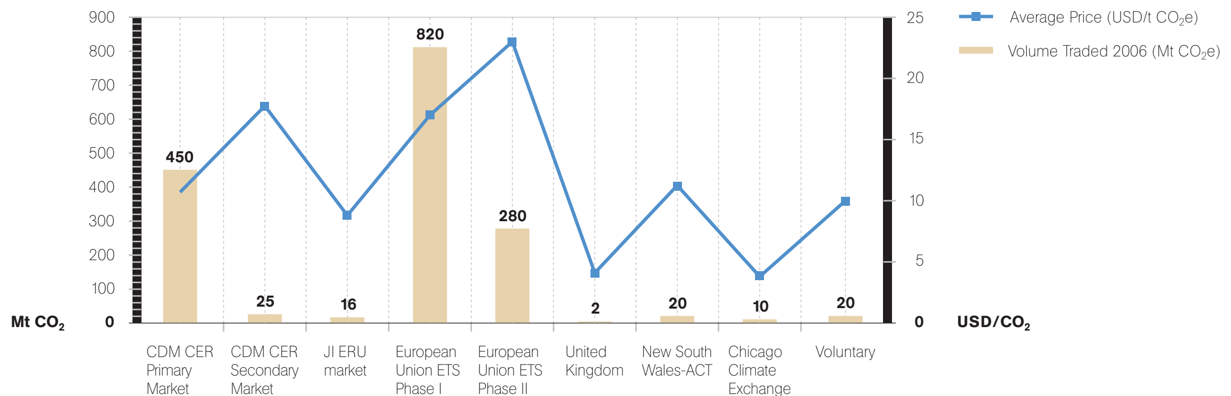
7.2.6. NEW SOUTH WALES–AUSTRALIAN CAPITAL TERRITORY GREENHOUSE GAS ABATEMENT SCHEME

590. This scheme establishes a cap on GHG emissions associated with electricity consumption in New South Wales, and since 1 January 2005, the Australia Capital Territory (ACT).[84] Electricity retailers and industries supplied directly by the grid (33 firms) must purchase GHG abatement certificates equal to the emissions associated with the electricity they sell/use. Abatement certificates can be generated by accredited projects that reduce emissions or enhance removal of GHG. During 2005 about 10 million certificates were generated by 206 accredited projects and about eight million were used for compliance. About 20 million certificates were traded during 2006 at an average price of USD 11.25.[85] This price is close to the non-compliance penalty.[86]

7.2.7. CHICAGO CLIMATE EXCHANGE

591. Members of the Chicago Climate Exchange (CCX) made a voluntary, legally-binding commitment to reduce their GHG emissions by 1 per cent per year from their 1998 to 2001 baseline, a 4 per cent reduction during

Figure VII-33. **Trade volumes and prices in the world's carbon markets in 2006**



Abbreviations: CDM = clean development mechanism, JI = joint implementation, CER = certified emission reduction, ERU = emission reduction unit, ACT = Australian Capital Territory.

2006.[87] The members had an overall emissions limit of 221 Mt CO_2 eq for 2006.[88] The CCX transacted 10.3 Mt CO_2 in 2006 at an average price of about USD 3.80.[89]

7.2.8. VOLUNTARY MARKET

592. Many companies and non-profit organizations offer to offset emissions from vehicle use, air travel, and other energy consumption for individuals and entities not subject to a regulatory obligation to reduce their emissions (Bayon *et al.*, 2007). The integrity of the offsets offered varies significantly and is determined by:

- Additionality of the project (making sure the project is not claiming reductions that would already occur);
- Actual existence of the emission reductions (making sure the project activity is monitored and the emission reductions claimed are verified);
- Exclusion of double-counting (making sure the same emission reductions are not sold to several buyers);
- Permanence of the reduction, and;
- Existence of community benefits.

593. To address these issues a voluntary standard for emission reductions is being developed and regulations are being considered in some countries.

594. The voluntary market has existed for more than a decade, but grown significantly since 2003 to 2004. Bellassen and Leget report that prices range from USD 1–78 per t CO_2 eq. Capoor and Ambrosi estimate the size of the market during 2006 at about 20 million tonnes with an average price of about USD 10 per t CO_2 eq. Hamilton, *et al.* (2007) estimate that 13.4 Mt CO_2 eq were traded at an average price of USD 4.10 during 2006 for a total value of USD 54.9 million.

[79] In Phase I CERs can be used for compliance, but this option is unlikely to be used because the price of allowances is much lower than the price of CERs.

[80] Point Carbon, *Carbon Market Europe*, 18 May 2007a estimates the limit as 217.23 million per year relative to emission caps of 1,859.27 Mt CO_2.

[81] Actual emissions are expected to exceed the EUA allocation by more than the overall limit on the use of CERs and ERUs. Therefore CERs and ERUs are expected to be purchased for compliance during Phase II. Currently there are no restrictions on carry over of EUAs after 2008, but there are limits on carry over of both CERs and ERUs, therefore CERs and ERUs should be used before EUAs for compliance. If the price of CERs or ERUs is lower, net of transaction costs, than the price of EUAs it will be profitable for an installation to sell (or bank) surplus EUAs and purchase CERs or ERUs for compliance.

[82] During the first four years of the scheme, Direct Entry participants received about 96 per cent of the 122 million allowances allocated (Enviros, 2006).

[83] Establishments not covered by a CCLA were eligible to offer emission reduction commitments in return for incentive payments through an auction. Bids by 32 firms promised emission reductions of 11.88 Mt CO_2 eq over the five years. At the end of 2004 six of the firms agreed to revised commitments, bringing the total emission reduction to 20.78 Mt CO_2 eq.

[84] See also IPART, 2006.

[85] See in TABLE 18-ANNEX V.

[86] The average price of USD 11.25 is equal to about AUD 14.95. The non-compliance penalty is AUD 11 which is not tax deductible. The cost of purchasing certificates is a tax deductible business expense. Given the 30 per cent corporate income tax rate, the penalty of Australia AUD 11 is equivalent to a purchase price of AUD 15.70. This is only 5 per cent above the average price.

[87] CCX Members who emit above the targets comply by purchasing CCX Carbon Financial Instrument™ (CFI™) contracts.

[88] About 33 of the 237 members have emissions limitation commitments. Their actual emissions during 2005 were about 197 Mt CO_2 eq and over 70 Mt CO_2 eq were banked from previous years.

[89] When trading began in 2003 the price was about USD 1 per t CO_2. The price remained roughly constant for about a year and then rose to USD 1.70 per t CO_2 at the end of 2004 and remained at that level through 2005. During 2006 the price rose to USD 4 per t CO_2.

7.2.9. LINKS AMONG EMISSIONS TRADING SYSTEMS

595. Although there are a number of different carbon markets, they can be, and to a limited extent are, linked. At present the trading systems are linked as follows:

- The national systems that comprise the EU ETS are fully linked with each other and all allow the use of CERs, but not tCERs or lCERs, and, beginning in 2008 to use of ERUs;
- Norway's ETS allows the use of Phase I EU allowances and CERs, but not tCERs or lCERs, for the period 2005–2007. It is expected to become part of the EU ETS in 2008;
- The NSW–ACT greenhouse gas abatement scheme has no links to other systems;
- The United Kingdom domestic scheme has no links to other systems;
- The CCX allows the use of CERs and EU allowances for compliance, but suspended imports of Phase I EU allowances in December 2006.

596. The surplus of Phase I allowances in the EU ETS means that participants will not use CERs for compliance during the period 2005–2007. During Phase II of the EU ETS participants are expected to use CERs and ERUs for compliance, which should cause the prices of CERs, ERUs and Phase II allowances to converge.

7.2.10. CARBON FUNDS

597. Carbon funds are a significant feature of the carbon market, especially the market for CERs and ERUs. A carbon fund is a vehicle to pool investments in the carbon market. The first fund, the Prototype Carbon Fund (PCF), was established by the World Bank in 1999. Its investors, national governments and private firms from several Annex B Parties, provided capital of USD 180 million. The PCF played an important role in the development of the CDM and JI.

598. The number of funds has grown rapidly from three, with capital of EUR 351 million in 2000, to 54, with capital of over EUR 6,250 million early in 2007 (ICF International, 2007). Investors include Annex B governments (24 per cent), private firms (29 per cent) or both (47 per cent) (ICF International, 2007). Their structure and role vary. Some focus exclusively on purchasing CERs and/or ERUs for compliance use by their investors. Others purchase allowances and credits and hope to resell them at a higher price. More recent funds take equity stakes in emission reduction projects and provide both financial returns and credits to their investors.

599. The importance of carbon funds in the carbon market is illustrated in TABLE 23-ANNEX V. It shows the annual increase in secured capital relative to the market value of transactions for verified emission reductions for Kyoto compliance and the voluntary market. The capital contributed in 2003 was almost double that for previous years as the pace of CDM project development accelerated. Entry into force of the Kyoto Protocol in 2006 brought another doubling of the capital contributed.

600. From 2000 through 2004 the annual increase in contributed capital exceeded the value of the market transactions by a large margin. During the past two years the value of the transactions has exceeded the capital contributed to carbon funds, suggesting that the diversification and expertise provided by the funds has become less important for project development as the market has grown.

601. It is not possible to determine the quantities of CERs and ERUs that have been purchased by carbon funds because virtually all funds keep this information confidential for competitive reasons.

7.3. PROSPECTS FOR THE CARBON MARKET FOR THE PERIOD 2008 – 2012

602. The Kyoto Protocol mechanisms (CDM, JI and international emissions trading) and the emissions trading systems established by Annex B Parties (EU ETS) will be the dominant carbon markets for the 2008 to 2012 period. They are already the largest markets by far. The EU ETS is expected to expand to include Norway, Iceland and Liechtenstein in 2008, to link with a Swiss emissions trading system, incorporate Turkey if it joins the EU, and to cover aviation beginning in 2011.

603. The Regional Greenhouse Gas Initiative (RGGI), covering the CO_2 emissions of electricity generating units in 10 states in the northeastern United States, is scheduled to begin in 2009. Canada has announced a system for 2010. Proposals for a national emissions trading system are under consideration in Australia. New Zealand is working on the design of a system. And various regional and national systems have been proposed for the United States. Those systems are unlikely to begin operation before 2011.

604. Since the EU ETS allows Kyoto Protocol mechanisms to be used for compliance, this chapter focuses on the market for Kyoto Protocol compliance units. Capoor and Ambrosi conclude that the current projected demand-supply balance, excluding Canada, implies that the price of CERs/ERUs is likely to help set the market equilibrium price for EUAs during this period (Capoor and Ambrosi, 2007). The analysis considers 2010 as a representative year for the 2008 to 2012 compliance period.

7.3.1. DEMAND

605. Annex B Parties can use Kyoto Protocol units to help meet their commitments. The demand for these units is the difference between the actual emissions and the commitment for each Party whose emissions exceed its commitment. Thus the forecast demand depends on the forecast emissions of individual Annex B Parties and respective success of their policies and measures.

606. Three recent estimates of the demand are presented in TABLE 24-ANNEX V. The estimates vary widely, from about 400 Mt CO_2 eq per year to over 850 Mt CO_2 eq per year. The Canadian demand is a significant uncertainty for the estimates. In April 2007 the Canadian government stated that it does not plan to purchase Kyoto units, but firms covered by the emissions trading system will be able to use specified types of CERs for up to 10 per cent of their total emissions.[90] If purchases by the Canadian government are excluded, the Point Carbon and Capoor and Ambrosi estimates are virtually identical at 400 Mt CO_2 eq, whereas the ICF International range of 500 – 671 Mt CO_2 eq is somewhat higher.

607. Annex B governments have already committed to purchase CERs and ERUs equivalent to 917 Mt CO_2 eq, 183 Mt CO_2 eq per year, which is over 45 per cent of the demand as estimated by Point Carbon and Capoor and Ambrosi (2007).

608. The estimates of the demand by EU ETS installations are all close to the maximum use of CERs and ERUs allowed by the national allocation plans.

609. The demands estimated in TABLE 24-ANNEX V are unlikely to change significantly. Canada's decision reduced the projected demand substantially, but no further reductions are anticipated. Any growth in demand will be limited and come after 2010. Expansion of the EU ETS to include aviation could increase the demand for CERs/ERUs and new emissions trading systems in Australia or the United States could allow the use of Kyoto units, which might also increase the demand. ICF International estimates an average demand of zero to 30 Mt CO_2 eq per year for CERs/ERUs from the United States (RGGI) during the period 2008 – 2012 (ICF International, 2007).

610. Capoor and Ambrosi estimate that half of the potential demand has been contracted or is yet to be contracted.

[90] Canada, 2007, p.14, "The Government of Canada will not purchase credits or otherwise participate in the carbon market." The proposed emissions trading system will begin in January 2010. It will allow participants to use approved CERs to cover up to 10 per cent of their total emissions. The Government will determine which types of CERs will be approved. Participants will use CERs only if their price is less than the price cap of CAD 15 per t CO_2 eq.

7.3.2. SUPPLY

611. Figure VII-34 shows Kyoto units supplied by CDM projects in 2010, JI projects and Annex B Parties with surplus allowances (AAUs). Detailed estimates of the supply are presented in table 25-annex V.

612. The flow of new projects and the CERs/ERUs they can generate by 2012 is uncertain because of delays in negotiating the post-2012 regime. Until a new international agreement is negotiated, the ability of emission reductions after 2012 to earn CERs or ERUs is uncertain. This means delays in negotiating a post-2012 regime will progressively reduce the period during which investors can recover their costs (Capoor and Ambrosi, 2007; Haites, 2004). Soon, only the most profitable projects, such as HFC and N_2O destruction projects, will be able to recover their investment prior to 2013.

613. The Russian Federation, Ukraine and some eastern European countries will have surplus AAUs they can sell to other Annex B Parties. Some of these countries are establishing green investment schemes, which use the revenue from the sale of AAUs to fund emission reduction measures. ICF International assumes that only AAUs from green investment schemes will be purchased by other Annex B Parties. Point Carbon and Capoor and Ambrosi estimate the surplus AAUs available, but do not assume they will be sold.

614. Point Carbon and Capoor and Ambrosi find that the projected supply of CERs and ERUs is almost sufficient to meet the estimated demand, excluding Canada. The supply of surplus AAUs is huge relative to the residual demand. In its mid-case, ICF International projects that, in addition to CERs and ERUs, some AAUs from green investment funds will be used to meet the estimated demand. All of the estimates suggest that supply will exceed the demand.

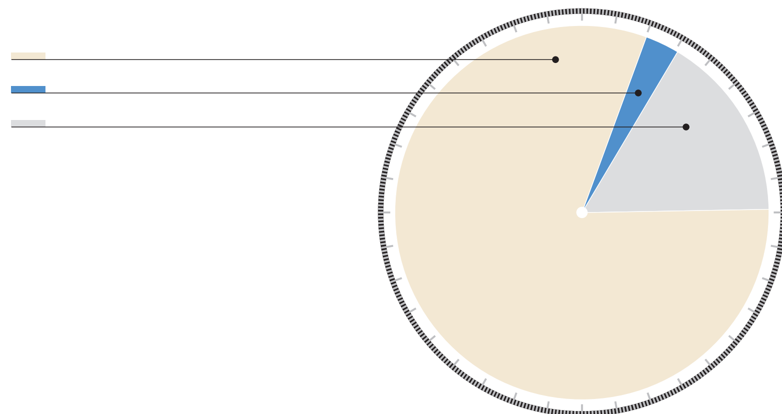
615. The supply of Kyoto units could increase further due to:

- CDM projects for "programmes of emission reduction activities". No project of this type has been registered yet, but such projects could generate relatively large emission reductions;
- HFC-23 destruction projects at new HCFC-22 plants. The eligibility of such projects has been under negotiation for a few years. If approved, they could generate large quantities of CERs;
- CO_2 capture and storage. The eligibility of such projects has been under negotiation for a few years. If approved, they could generate large quantities of CERs, although the time needed to implement such projects would limit the quantity issued before the end of 2012;
- Tradable credits for reduced deforestation. This has been proposed, but it now appears unlikely during the period 2008–2012;
- Emissions limitation commitments proposed by Belarus and Kazakhstan. The proposed commitments probably would leave each country with surplus AAUs, although it could take some time for them to meet the eligibility conditions to sell AAUs.

616. In summary, the analyses suggest the supply will be abundant relative to the demand. Demand for the period 2008–2012 is unlikely to change significantly, but the supply of Kyoto units could increase substantially.

Figure VII-34. **Estimated supply of Kyoto units in 2010 (Mt CO_2 eq per year)**

Estimated AAUs **81%**
Estimated ERUs issued **3%**
Estimated CERs issued **16%**



Abbreviations: CER = certified emission reduction, AAU = assigned amount unit, ERU = emission reduction unit.

617. The supply of CERs and ERUs will be affected by several factors over the next few years, including:[91]

- Uncertainty about the post-2012 regime. The value of emission reductions after 2012 is uncertain, so projects with longer payback periods become progressively less attractive, reducing the flow of new projects;
- Administrative uncertainty. Inconsistent decisions, possible review upon registration, and possible review on issuance present relatively small risks for project developers. Owing to the relative lack of experience, the risks are higher for JI projects than for CDM projects;
- Market liquidity. The secondary market for CERs is still small so accurate price information is not readily available. This should change over the coming year as the number of issued CERs rises. The secondary market for ERUs will lag by a year or more;
- Possible changes to the rules. The rules for the CDM could be changed to generate a wider geographic distribution of projects and/or to favour projects that have more development benefits.

7.3.3. PRICES

618. Will the surplus supply lead to a collapse of CER/ERU/AAU prices, as happened during Phase I of the EU ETS? Probably not. Phase I EU allowances cannot be carried over for use beyond 2007, so they have no value after the end of the period. In contrast, Kyoto units can be carried over (banked), so they should have a value at the end of the period provided they can be used for compliance after 2012. The EU ETS will allow the use of CERs and ERUs after 2012. A post-2012 international agreement is also expected to retain the Kyoto mechanisms and thus maintain the market for those units.

619. To date, all government purchases have been CERs and ERUs and participants in the EU ETS can only use CERs and ERUs for compliance. The supply of CERs and ERUs is still less than the demand, even without Canada. So long as these policies continue, the demand for AAUs from the Russian Federation, Ukraine and Eastern European countries will be limited to the demand not supplied by CERs and ERUs, causing them to carry over most of their surplus AAUs.

620. Banking (carry over) of different units by an Annex B Party is restricted as follows:[92]

- RMUs may not be carried over;
- ERUs which have not been converted from RMUs may be carried over up to a maximum of 2.5 per cent of the Party's assigned amount;
- CERs may be carried over up to a maximum of 2.5 per cent of the Party's assigned amount;
- tCERs and lCERs may not be carried over;
- AAUs may be carried over without restriction.

621. There are no provisions governing carry over of CERs, tCERs and lCERs by non-Annex I Parties or legal entities.

622. To comply with these rules EU ETS participants should use any issued CERs or ERUs they own for compliance by the end of 2012[93] and Annex B governments should comply by submitting CERs, RMUs, and ERUs and carrying over AAUs.

623. If the uncertainty relating to carry over by non-Annex I Parties and their legal entities is not resolved, it could cause the price to decline in 2012 as they try to sell the CERs they own. Early resolution of this uncertainty to avoid such a price drop is desirable.

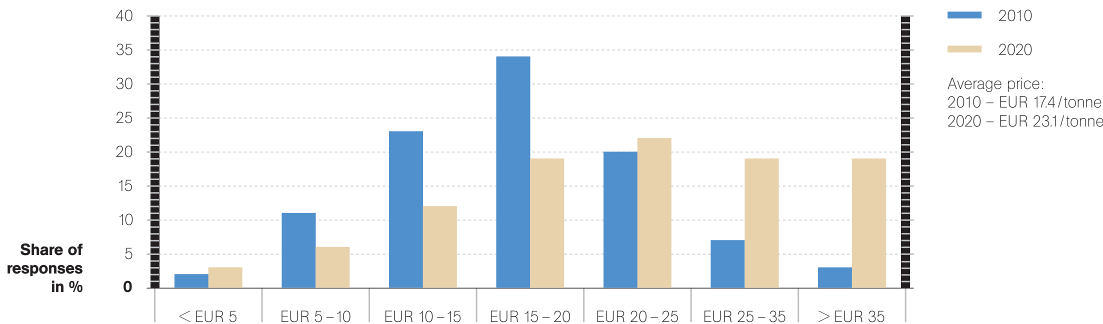
624. Since CERs and ERUs can, and probably will, be used for Phase II compliance by EU ETS installations the prices for issued CERs, ERUs and Phase II EU allowances should be similar if not identical. As of May 2007 there is still a substantial difference in the prices; CERs issued trade at EUR 12 – 13 whereas Phase II EU allowances trade at EUR 19. FIGURE VII-35 shows the price expectations for EU allowances in 2010 and 2020 of participants in an online survey conducted early in 2007. For 2010 the average is EUR 17.40, with a roughly symmetrical distribution ranging from less than EUR 5 to over EUR 35.

[91] See also Capoor and Ambrosi, 2006; Point Carbon, 2007; and ICF International, 2007.

[92] Decision 19/CP.7, annex paragraphs 15 and 16.

[93] Each installation has a limit on the quantity of CERs and ERUs it can use for compliance. An installation that owns fewer CERs/ERUs than its limit could buy more CERs/ERUs and sell or bank its surplus EU allowances.

Figure VII-35. **Expected prices for EU allowances in 2010 and 2020, based on response to Point Carbon survey**



Source: Point Carbon, 2007c.

625. ICF International forecasts the price for CERs/ERUs/ Phase II EU allowances at EUR 8, with a range of EUR 8 – 20 (ICF International, 2007, table 3). ICF recognizes, however, that market behaviour may lead to an average price over the period higher than forecast by market fundamentals. For example, industrial installations with surplus EUAs have tended to bank them, rather than sell them, and there may be delays in the delivery of CERs or ERUs into the EU ETS.

626. Based on the above information, the market price of issued CERs, ERUs and Phase II EU allowances is estimated to average EUR 17.50 (USD 23.60) with a range of EUR 10 (USD 13.50) to EUR 25 (USD 33.75) for the period 2008 – 2012.

7.3.4. MARKET SIZE

627. With an annual demand of 400 to 600 Mt CO_2 per year (excluding the Canadian government) the price of 2006 USD 23.60 suggests a market of USD 9.4 – 14.2 billion per year, say 2006 USD 10 – 15 billion per year (see FIGURE VII-36).

628. The above calculation assumes that all CERs, ERUs and AAUs bought for compliance are purchased at the market price. Many CERs and ERUs have already been purchased by Annex B governments in the primary market at lower prices, so the annual compliance cost should be somewhat lower. CERs and ERUs purchased by other buyers could be sold multiple times, so the annual value of transactions could be higher or lower.[94]

7.3.4.1. ANNUAL INVESTMENT

629. Annual sales of CERs are projected to be between 300 and 450 million. With an average capital cost of USD 137.39 per 1,000 t CO_2 eq of annual emission reductions (see TABLE 21-ANNEX V), that represents an annual investment of 2006 USD 40 – 60 billion. However, the remaining scope for low cost projects – HFC-23 and N_2O destruction – is limited. If such projects are excluded, the average capital cost rises to about USD 200 per 1,000 t CO_2 eq of annual emission reductions, and the annual investment would be 2006 USD 60 – 90 billion. Thus, the annual investment in CDM projects is estimated at 2006 USD 40 – 90 billion. At present about half of the capital invested in CDM projects is invested in unilateral projects by host country project proponents.

630. Annual sales of ERUs are projected to be between 40 and 100 million. Assuming the same range of capital costs per 1,000 t CO_2 eq of annual emission reductions yields an estimated annual investment in JI projects of 2006 USD 5 – USD 20 billion.

7.3.5. SHARE OF PROCEEDS FOR THE ADAPTATION FUND

631. The Adaptation Fund receives a “share of proceeds” equal to 2 per cent of the CERs issued for a CDM project activity to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to assist in meeting the costs of adaptation.[95] With annual sales of CERs of 300 – 450 million and a market price of USD 23.60 per t CO_2 eq (range USD 13.50 – 33.75) the Adaptation Fund would receive 2006 USD 80 – 300 million per year for 2008 to 2012[96] (see TABLE VII-55).

7.3.6. VOLUNTARY MARKET

632. The voluntary market accounted for sales of about 20 Mt CO_2 eq globally in 2006. Trexler estimated that United States demand for voluntary offsets could almost double annually to 250 Mt CO_2 eq by 2011 (Trexler, 2007).[97] ICF International projects an annual demand in the voluntary market of 250 Mt CO_2 eq (range 120 – 400) for the period 2008 – 2012 (ICF International, 2007). Assuming an average price of USD 10 per t CO_2 eq this represents an annual market of 2006 USD 1 – 4 billion. With a compliance market of 2006 USD 5 – 25 billion the voluntary market would represent about 15 per cent of the total market. This growth is contingent on satisfactory resolution of the integrity issues discussed in CHAPTER VII.2.8.

633. FIGURE VII-36 summarizes the estimates for demand for emission reduction units in 2010.

[94] The total value of primary and secondary CER and ERU transactions during 2006 is reported as USD 5.4 billion by Capoor and Ambrosi, 2007, annex 5, table 18.

[95] Decisions 3/CMP.1 and 28/CMP.1. CDM projects in least developed country Parties are exempt from the share of proceeds levy and small-scale afforestation and reforestation projects are exempt from the share of proceeds regardless of their location.

[96] The quantity of CERs issued for projects exempt from the share of proceeds is assumed to be negligible relative to the uncertainty of the estimates.

[97] This would be less than 1 tonne per person when per capita emissions are over 20 tonnes, offsetting about 4 per cent of total emissions.

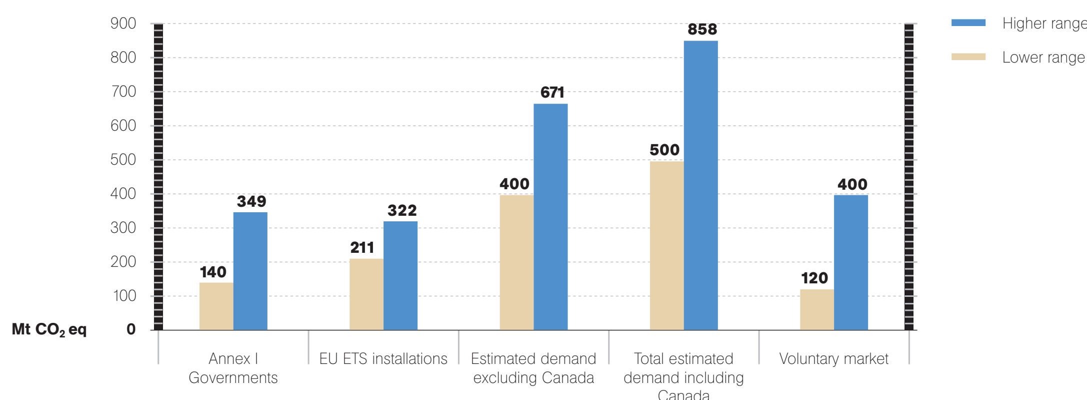
Table VII-55. **Possible levels of funding for the Adaptation Fund trustee account to 2012**

Total quantity of CERs issued through 2012 (million)	Total quantity of CERs collected by the Adaptation Fund holding account through 2012 (million)	Total revenue received by the Adaptation Fund trustee account at various prices per CER (million Euro)		
		Assumed price per CER		
		EUR 10	EUR 17.5	EUR 25
1,500	30	N.A.[a]	525	750
2,000	40	400	700	1,000
2,500	50	500	875	N.A.[a]

Abbreviations: CER = emission reduction unit.

[a] This comination of price an quantity is considered to be very unlikely

Figure VII-36. **Estimated demand for emission reduction units in 2010**



7.4. POTENTIAL SIZE OF THE CARBON MARKET TO 2030

634. Apart from the voluntary market, the carbon market depends on the demand for compliance units by national governments or entities that subject themselves to a regime with compliance obligation (e.g. the Chicago Climate Exchange) and the supply of units from countries with commitments or without commitments.

635. Analyses of the future carbon market focus on the potential demand by Annex I Parties that can be met cost-effectively with credits purchased from non-Annex I Parties.

636. This chapter begins with estimates of the potential demand in 2050. It then it reviews demand estimates for earlier periods. After the demand estimates are reviewed, the potential to expand the supply to meet the demand in 2030 is considered.

7.4.1. ESTIMATED DEMANDS

7.4.1.1. ESTIMATED DEMAND IN 2050

637. Two estimates of demand for credits from developing countries in 2050 are available.

7.4.1.2. REDUCTIONS AT 60 – 80 PERCENT

638. Assuming emission reductions by industrialized countries in the order of 60 – 80 per cent of their 1990 emissions by mid-century, half of which we anticipated to be met through investment in developing countries, generates emission reduction purchases of up to USD 100 billion per year, this reduction would correspond to stabilization of greenhouse gas concentrations at 450 – 500 ppmv CO_2 eq (i.e. multigas) or 350 – 400 ppmv CO_2 only.

639. Greenhouse gas emissions by all Annex I or Annex B Parties, including Australia and the United States, in 1990 were about 18,100 Mt CO_2 eq. A reduction of 60 – 80 per cent is 10,900 – 14,500 Mt CO_2 eq. If half of the reduction is purchased from developing countries, the annual purchases are 5,400 – 7,200 Mt CO_2 eq. Assuming the price of CERs issued remains at the current level of EUR 12 – 13, about USD 17 per t CO_2 eq, this represents a market value of USD 92 to USD 122 billion.

7.4.1.3. WORLD BANK (2006)[98]

640. The future flows to developing countries depend on four parameters:

- The objective and scope of post-Kyoto climate policies;
- Baseline emissions in each region of the world;
- Abatement costs in each region;
- The burden-sharing agreement between Parties.

641. IPCC stabilization paths for 450 and 550 ppmv are used as the objective of post-Kyoto climate policies. The 450 ppmv path allows total emissions of 272 GtC between 2000 and 2050, whereas the 550 ppmv path allows 333 GtC between 2000 and 2050.

642. The six IPCC SRES scenarios provide the baseline emissions. Cumulative emissions range between 392 and 574 GtC from 2000 through 2050.

643. Two sets of abatement costs are used – the emissions prediction and policy analysis (EPPA) model and higher costs based on bottom-up studies. Abatement costs are assumed to rise by 1 per cent per year from 2000 through 2050.

- Total discounted (at 4 per cent) abatement costs for the 450 ppmv path from 2000 through 2050 are between 1995 USD 1.2 and 14.9 trillion – annualized costs of USD 72 – 775 billion;
- For the 550 ppmv path total abatement costs from 2000 through 2050 are between 1995 USD 0.2 and 8.2 trillion – annualized costs of USD 12 – 427 billion.

644. Efficiency dictates that half to two-thirds of total abatement spending between 2000 and 2050 occur in developing countries (EPPA 67 – 72 per cent, other cost curves 58 – 65 per cent). This is due to existing opportunities and high growth of emissions in developing countries.

645. Distributing abatement expenditures on the basis of GDP yields annualized payments by developed countries between 2013 and 2050 of 1995 USD 20 – 130 billion for the 450 ppmv path; and 1995 USD 3 – 68 billion for the 550 ppmv path.

7.4.1.4. ESTIMATED DEMAND IN 2030

646. The Energy Modeling Forum[99] (EMF) examines topics to which many existing models can be applied. EMF 21 analysed the importance of non-CO_2 greenhouse gases and land use in climate policy.[100]

647. Each participating model developed a reference scenario that excludes any climate policies, including the Kyoto Protocol. Each model also developed a multi-gas mitigation scenario to stabilize radiative forcing at 4.5 Wm^2 relative to pre-industrial times by 2150 or to a comparable global emissions trajectory.[101] This corresponds to an equilibrium temperature increase of 3.8° C, for a climate sensitivity of 3° C per CO_2 doubling, which corresponds to a stabilization scenario under the IPCC of 650 ppmv.[102]

648. Results for 16 models with a regional structure were analysed. For each model developing countries were assumed to sell credits equal to the difference between their reference scenario and multi-gas mitigation scenario to Annex I Parties, including Australia and the United States. The implied commitments of Annex I Parties as a group are the sum of their reductions from the reference scenario plus their credit purchases. These are expressed as reductions from their 1990 emissions.

649. TABLE 26-ANNEX V shows the results for 2030; the implied commitment of Annex I and/or Annex B Parties as a group, their annual purchases, the projected market price, and the market size. The analysis ignores trading among Annex I and/or Annex B Parties – JI and international emissions trading – since this depends on arbitrary assumptions of how the overall commitment would be shared among these Parties.

650. The results correspond to the maximum demand for the mitigation scenario. Current Annex I and/or Annex B Parties, including Australia and the United States, are assumed to have commitments that induce them to purchase all cost-effective emission reductions available in non-Annex I Parties. Rules for credit creation, transaction costs, and other considerations would prevent all cost-effective reductions estimated by the models being realized in practice. Failure of some Annex I and/or Annex B Parties to ratify the agreement in place in 2030, or adopt equivalent commitments, would reduce the demand. Adoption of targets by some current non-Annex I Parties would reduce the estimated supply and hence the maximum demand.[103]

651. The results vary enormously due to differences in the reference scenario, marginal abatement costs and model structure. Estimates of the annual sales range from less than 2000 USD 1 billion to over USD 1,850 billion and estimates of the price range from less than USD 1 to over USD 100 per t CO_2 eq. The low estimate is due to both a small quantity and a low price, indicating that the reference scenario and mitigation scenario emissions are very similar. The high estimate is due to a reference scenario that has much higher emissions than the mitigation scenario, leading to a high marginal abatement cost and large purchases. The high estimate implies a commitment of Annex I and/or Annex B Parties greater than their 1990 emissions.

652. The median quantity traded is roughly 6,400 Mt CO_2 eq per year.[104] The corresponding commitment is a 30 per cent reduction from 1990 emissions for all Annex I and/or Annex B Parties including Australia and the United States. The market price is modelled to about 2000 USD 16.50 per t CO_2 eq. This is a little lower than the current price for issued CERs and in the lower half of the range estimated for 2010. The size of the market in 2030 is estimated at USD 107 billion with three quarters of the estimates falling between 2000 USD 17 and USD 314 billion.

7.4.1.5. ESTIMATED DEMAND IN 2020

653. Potential demand in 2020 can be estimated from the EMF 21 model results in the same manner as described in TABLE 26-ANNEX V. The median estimate of the market size is about 3,150 Mt CO_2 eq per year. The corresponding commitment is about a 20 per cent reduction from 1990 emissions for all Annex I Parties including Australia and the United States.

654. Because the EMF 21 scenarios exclude the Kyoto Protocol, emission reductions and marginal abatement costs rise gradually from 2000. The 2020 marginal abatement cost (price) – 2000 USD 6.50 per t CO_2 eq – is lower than both the current and projected 2010 price. Given the bias introduced by the scenarios, the best assumption is that prices remain roughly constant from 2010 through 2030 at 2000 USD 23.60 (range USD 13.50 – 33.75).

[98] Annex H, World Bank (2006).

[99] The EMF (Energy Modeling Forum) was established at Stanford University and provides for a forum for discussing energy and environmental issues, see: <http://www.stanford.edu/group/EMF/>.

[100] See de la Chesnaye and Weyant, 2006 for results of EMF 21.

[101] The emissions trajectory depends on the emissions sources covered by the model. For models that cover CO_2 emissions from fossil fuel use, cement and land use, CH_4 emissions and N_2O emissions, but exclude HFCs, PFCs and SF6, global emissions are slightly below 40 GT CO_2 eq in 2030.

[102] When the scenario was developed, a climate sensitivity of 2.5° C per CO_2 doubling was assumed, resulting in an equilibrium temperature increase of 3.0° C.

[103] The targets of non-Annex I Parties could take a variety of forms including "no lose" targets, sectoral targets, and national commitments similar to those of Annex I Parties. Such targets should represent a reduction from reference case emissions, so only the emission reductions beyond compliance with the target could be sold to current Annex I and/or Annex B Parties. To estimate the impact on the market price would require new model runs.

[104] When values cannot be symmetrically distributed as in this case – market size and price can not be less than zero – the median is a better indicator of the central value than the average. Half of the values are higher and half are lower than the median. The average (mean) is the sum of the values divided by 16 (the number of values).

655. The annual purchases in 2020 estimated from the EMF 21 scenarios are 2000 USD 25 billion (USD 2.5 – 70 billion). The low end of the range up to 2006 USD 25 billion per year is the same as the estimate for 2010.

7.4.1.6. ESTIMATED DEMAND IN 2015

656. ICF International projects the average demand of Annex I and/or Annex B Parties for the period 2013 – 2017 at 2,600 Mt CO_2 eq per year (1,200 to 3,100 Mt CO_2 eq per year) (ICF International, 2007). The high demand case includes additional demand of 4,400 Mt CO_2 eq per year by non-Annex I Parties that adopt sectoral targets. ICF International projects the 2013 to 2017 price at 2006 EUR 30 per t CO_2 eq (range EUR 18 – 40 per t CO_2 eq).[105] The implied annual purchases by Annex I and/or Annex B Parties are about 2006 EUR 75 billion (range EUR 2 – 120 billion) (ICF International, 2007 table 3).

7.4.1.7. SUMMARY OF DEMAND ESTIMATES

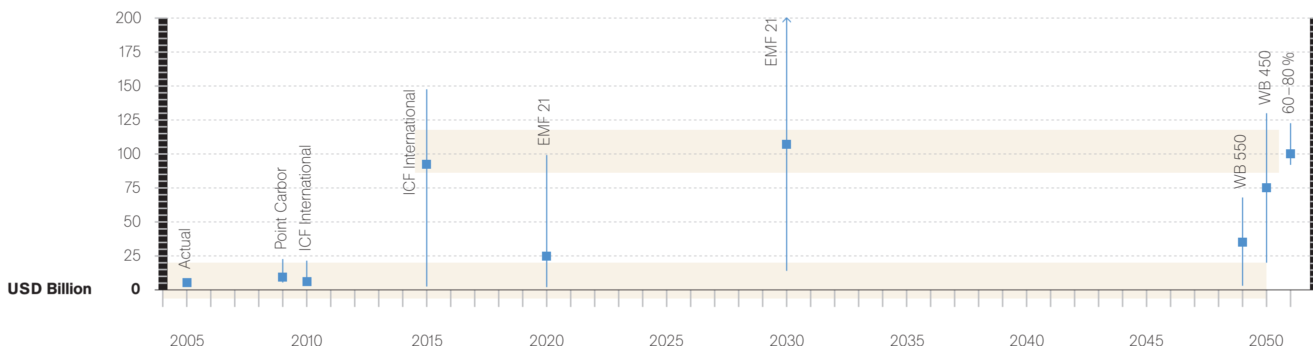
657. The foregoing estimates of demand are shown in FIGURE VII-37. The estimates cover only purchase credits by Annex I and/or Annex B Parties from non-Annex I Parties. The estimates do not include trades between Annex I and/or Annex B Parties, such as JI and international emissions trading. To estimate the size of those mechanisms requires arbitrary assumptions about the commitments of different Annex I and/or Annex B Parties. The estimates assume that all cost effective emission reductions in Annex I and/or Annex B Parties are implemented as domestic actions or for sale to other Annex I and/or Annex B Parties through JI or international emissions trading.

658. Each estimate spans a wide range. The low end of the ranges suggests that the demand remains in the range of 2006 USD 5 – 25 billion per year. TABLE 18-ANNEX V indicates that CDM transactions during 2006 were a little over USD 5 billion and the demand estimated in CHAPTER VII.3.4 for 2010 is USD 10 – 15 billion with a range 2006 USD 5 to USD 25 billion per year. The value of credit purchases by Annex I and/or Annex B Parties from non-Annex I Parties could remain in that range through 2050.

659. The high end of the ranges suggests that annual demand could reach USD 100 billion, but probably not much more. The high demand assumes commitments – 30 per cent below 1990 by 2030 and 60 – 80 per cent below by 2050 – by all current Annex I and/or Annex B Parties including Australia and the United States, no commitments of any type by any current non-Annex I Party, and purchase of all cost effective emission reductions available in non-Annex I Parties.

[105] ICF International, 2007.

Figure VII-37. **Comparison of demand estimates**



7.4.2. POTENTIAL SUPPLY

660. The demand estimates presented above are for purchases of emission reduction credits by Annex I and/or Annex B Parties from non-Annex I Parties. At present the only mechanism for such purchases is the CDM. The demand could also include credit sales under other mechanisms suggested in the literature, such as "no lose" targets and sectoral targets.

661. The potential supply is assessed relative to both the low and the high estimates of demand. The low demand of USD 5–25 billion represents purchases of 400–600 Mt CO_2 per year, ranging up to 1,000 Mt CO_2 per year. The high demand of about USD 100 billion corresponds to purchases of ten times the volume – about 4,000 Mt CO_2 per year at a price of USD 23.60 per t CO_2 eq and about 6,000 Mt CO_2 per year based on the model results presented in TABLE 26-ANNEX V.

7.4.2.1. LOW DEMAND ESTIMATE

662. A 20–200 per cent increase in emission reductions appears manageable. The existing project pipeline has developed largely in the past two years, so maintaining the current trend for a few months to a few years would be sufficient. Growth of the pipeline will involve a shift in the mix of projects because the potential of a few project types, notably HFC-23 destruction and N_2O destruction at adipic acid plants, has been largely exhausted. On the other hand, project types approved more recently, afforestation, reforestation and programmes of activities, are virtually absent from the pipeline.

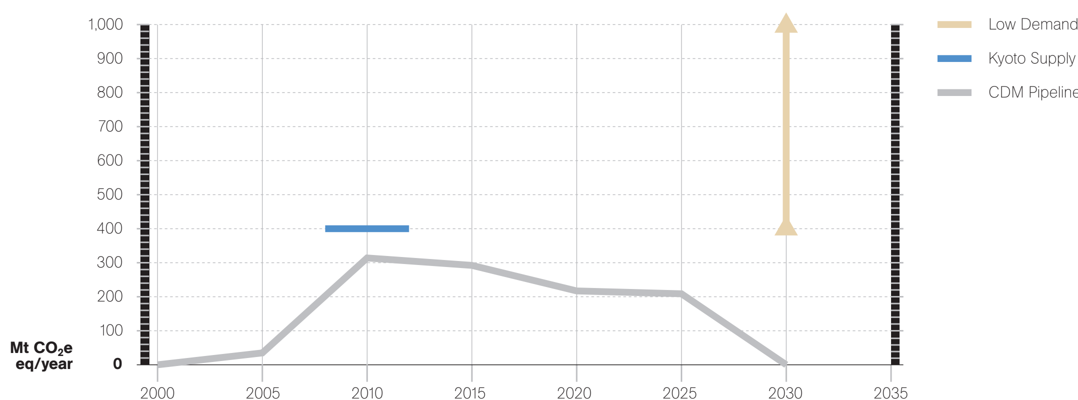
663. FIGURE VII-38 shows the estimated emission reductions of projects in the CDM pipeline as of May 2007 as a function of time. It assumes that each project with a renewable crediting period earns the same annual emission reductions for each renewable. The estimated annual reductions rise rapidly beginning in 2005 as new projects are implemented, reaching 315 Mt CO_2 eq in 2010. The emission reductions achieved by these projects decline between 2010 and 2020 as the projects with 10 year crediting periods lose their eligibility. After 2025 most of the remaining projects lose their eligibility as their third seven year crediting period concludes.

664. The data in FIGURE VII-38 are based on the estimated annual emission reductions reported in the PDDs. The experience to-date is that CERs are issued for approximately 85 per cent of the estimated reductions (Fenhann, 2007).

665. FIGURE VII-38 also shows the estimated average annual emission reductions available for the period 2008–2012, which includes reductions during the period as well as reductions prior to 2008. This is almost 400 Mt CO_2 eq, the low end of the range for 2030. Taking the experience to-date into account, meeting the low demand in 2030 would mean a 20–200 per cent increase in the emission reductions of projects already in the pipeline and then replacing the reductions in those projects as they come to the end of their crediting periods.

666. In summary, it appears that the current flow of projects under the CDM would be sufficient to meet the low demand estimate for 2030 although with some changes in the mix of projects.

Figure VII-38. **Estimated supply from current CDM pipeline, 2000–2030**



7.4.2.2. HIGH DEMAND ESTIMATE

667. The high demand would require credits for a large fraction of the potential emission reductions, from existing and some new categories of project types. To process the volume of emission reductions cost-effectively is likely to require new mechanisms, such as "no lose" targets, sectoral targets and policy CDM, in addition to the current types of CDM projects.[106]

668. The high demand is about ten times higher; some 4,000 – 6,000 Mt CO_2 eq per year in 2030. Estimates of the maximum annual emission reduction potential in non-Annex I Parties in 2030 are provided in TABLE 27-ANNEX V. The estimates indicate that current non-Annex I Parties could supply the high demand if a large fraction, 50 – 75 per cent, of the maximum potential is realized and additional categories of emission reductions, reduced deforestation and CCS, are included (see FIGURE VII-39).

669. Currently the average CDM project estimates an annual emission reduction of 165,000 t CO_2 eq per year. Annual reductions of 4,000 – 6,000 Mt CO_2 eq per year would require 25,000 – 35,000 registered projects. Roughly 1,000 projects entered the pipeline during 2006.[107] To have 25,000 – 35,000 registered projects would mean a four to five-fold increase in the flow of registration and renewal requests.

7.4.2.3. AAUS CARRIED OVER FROM THE PERIOD 2008 – 2012

670. It is expected that AAUs carried over by the Russian Federation, Ukraine and other Eastern European countries can be used to meet the commitments of Annex I and/or Annex B Parties for subsequent periods.[108] The amount carried over at the end of 2012 is projected to be 2,500 – 5,500 million AAUs. Under the high demand estimate, that surplus could be absorbed relatively quickly. With the low demand estimate, it could affect the market for a decade or more.

7.4.3. SUMMARY

671. Estimates of credit purchases by Annex I and/or Annex B Parties from non-Annex I Parties span a wide range. The low end of the ranges suggests that the demand remains in the range of USD 5 – 25 billion per year, with purchases of 400 – 600 Mt CO_2 eq. The current flow of projects under the CDM, with some changes in the mix of projects, would be sufficient to meet that demand. That would represent an annual capital investment of 2006 USD 50 – 120 billion. At 2 per cent the annual contribution to the Adaptation Fund would be 2006 USD 100 – 500 million.

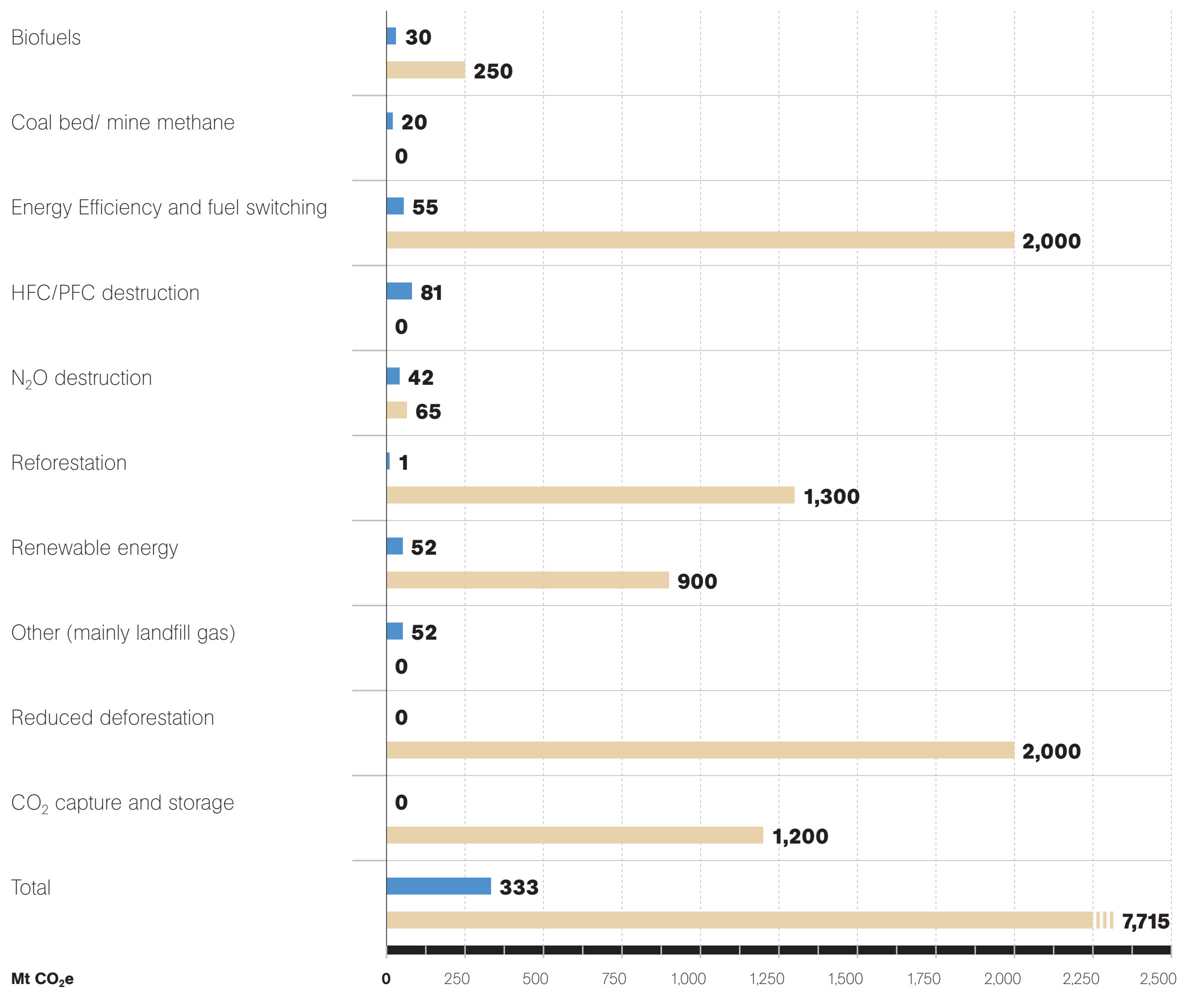
672. The high end of the ranges suggests that annual demand could reach 4,000 – 6,000 Mt CO_2 eq per year with a market value of USD 100 billion, by 2030, but probably not much more. It assumes commitments by all current Annex I and/or Annex B Parties including Australia and the United States, and no commitments of any type by any current non-Annex I Party. To supply this demand a large fraction of the potential emission reductions from all existing and some new categories of projects would need to earn credits. That is likely to require new mechanisms in addition to the current types of CDM projects. The high demand would represent an annual capital investment of 2006 USD 500 – 1,200 billion. At 2 per cent the annual contribution to the Adaptation Fund would be 2006 USD 1 – 5 billion.

[106] As discussed above, such mechanisms have the effect of reducing the potential supply somewhat.

[107] The average crediting period is seven-and-a-half years (Fenhann, 2007, analysis sheet shows 86 per cent of project proponents choose a seven-and-a-half year crediting period and 14 per cent a 10-year crediting period, giving an average of seven-and-a-half years). Thus the current flow yields about 7,500 registered projects, thereafter crediting periods need to be renewed.

[108] Some, or all, of the surplus could be used by those countries to meet their post-2012 commitments and the balance could be sold to other Annex I and/or Annex B Parties.

Figure VII-39. **Estimated carbon market size for high demand estimate**



Maximum annual emmission reductions potential in non-Annex I Parties in 2030 (Mt CO_2e) Estimated annual emission reductions in current CDM pipeline (Mt CO_2e)

VIII. FINANCIAL COOPERATION UNDER THE CONVENTION AND ITS KYOTO PROTOCOL

8.1. INTRODUCTION

673. The Convention and its Protocol foresee financial assistance from developed country Parties to developing country Parties. Developed country Parties (Annex II Parties) shall provide new and additional financial resources to assist developing country Parties implement the Convention (Article 4.3)109 and its Protocol (Article 11). This assistance may be through bilateral or multilateral channels or through a financial mechanism defined in Article 11 of the Convention and referred to in Article 11 of the Kyoto Protocol.

674. Financial assistance through bilateral and multilateral channels is addressed in CHAPTER III. Annex II Parties are to provide details of measures taken to give effect to their commitments under Articles 4.3, 4.4, and 4.5 of the Convention as part of their national communications. Owing to gaps and inconsistencies in reporting approaches in the third and fourth national communications from Annex II Parties, it is difficult to reach specific funding figures. However, it is possible to discover trends. The analysis of bilateral and multilateral funding in this paper therefore corresponds mainly to information relating to ODA.

675. The GEF was assigned as an operating entity of the financial mechanism of the Convention on an on-going basis, subject to review every four years. The financial mechanism is accountable to the COP, which decides on its climate change policies, programme priorities and eligibility criteria for funding, based on advice from the SBI.

676. In addition to the guidance to the financial mechanism, Parties have established two special funds[110]: the Special Climate Change Fund (SCCF) and the Least Developed Countries Fund (LDCF), under the Convention. These two funds are managed by the GEF.

677. The Adaptation Fund, under the Kyoto Protocol, was also established[111] by Parties in order to finance concrete adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol.

678. Chapter VIII.2 below provides an overview of the funding available under the financial mechanism of the Convention (through the GEF, SCCF and LDCF). Chapter VIII.3 provides an overview of the Adaptation Fund under the Kyoto Protocol.

8.2. FINANCIAL MECHANISM UNDER THE CONVENTION

679. As an operating entity of the financial mechanism of the Convention, the GEF receives guidance from the COP on policy, programme priorities, and eligibility criteria related to the Convention. The COP has provided general guidance with regard to operation of the financial mechanism, and has also provided specific guidance in the following areas:

- Support to national communications of non-Annex I Parties;
- Capacity-building;
- Public awareness and outreach (Article 6 activities);
- Development and transfer of technologies;
- Support for adaptation;
- Support for activities referred to in Article 4, paragraph 8(h) of the Convention;
- Support for mitigation.

680. The GEF has responded to COP guidance through the climate change focal area[112] of the GEF Trust Fund (in support of enabling activities, operational programmes relating to mitigation and the strategic priority on adaptation), the SCCF and the LDCF.

681. Article 11, paragraph 3(d) of the Convention calls for arrangements to determine in a predictable and identifiable manner the amount of funding necessary and available for the implementation of the Convention. In accordance with decision 11/CP.1, "in mobilizing funds, the operating entity or entities should provide all relevant information to developed country Parties and other Parties included in Annex II to the Convention, to assist them to take into full account the need for adequacy and predictability in the flow of funds. The entity or entities entrusted with the operation of the financial mechanism should take full account of the arrangements agreed with the Conference of the Parties, which, inter alia, shall include determination in a predictable and identifiable manner of the amount of funding necessary and available for the implementation of the Convention, as provided for in Article 11.3(d) of the Convention".

682. In accordance with the annex[113] to the memorandum of understanding (MOU) between the COP and the GEF (decision 12/CP.3), "in anticipation of a replenishment of the GEF, the COP will make an assessment of the amount of funds that are necessary to assist developing countries, in accordance with guidance provided by the COP, in fulfilling their commitments under the Convention over the next GEF replenishment cycle, taking into account":

- The information communicated to the COP under Article 12 of the Convention;
- National programmes formulated under Article 4, paragraph 1(b) of the Convention and progress made by Parties in the implementation of such national programmes and towards the achievement of the Convention's objective;
- Information communicated to the COP from the GEF on the number of eligible programmes and projects that were submitted to the GEF, the number that were approved for funding, and the number that were turned down owing to lack of resources;
- The GEF replenishment negotiations should take into account the assessment by the COP.

683. The replenishments of funds in the GEF depend on voluntary contributions from donors. The trust fund contributions follow a pre-defined "basic" burden share (GEF, 2005a). The amount of funding under the GEF after 2010 will depend on negotiations on the fifth replenishment of the GEF (GEF 5). The trustee will probably need to start making arrangements for the fift replenishment in 2008. Negotiations and conclusion of the GEF 5 should occur in 2009.

684. The fourth review of the financial mechanism should start at COP 13 (December 2007) and it is expected that the COP will make an assessment of the amount of funds that are necessary to assist developing countries and provide an input to GEF 5.

[109] Article 4.3 stipulates that developed country Parties shall provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties to prepare national communications and to meet the agreed full incremental costs of implementing measures that are covered by paragraph 4.1 of the Convention. Article 4.4 further stipulates that developed country Parties shall assist particularly vulnerable developing country Parties to meet the costs of adaptation and Article 4.5 stipulates that developed country Parties shall take all practicable steps to promote, facilitate and finance the transfer to, or access to, environmentally sound technologies and know how.

[110] Decision 7/CP.7.

[111] Decisions 10/CP.7 and 28/CMP.1.

[112] The GEF's climate change programme is one of six focal areas managed by the entity, and is the second largest after its biodiversity focal area. Most of the GEF's climate change activities are financed by a trust fund (GEF Trust Fund). The LDCF and SCCF were established by decision 7/CP.7 and are managed by the GEF.

[113] FCCC/CP/1996/9.

8.2.1. GEF TRUST FUND

8.2.1.1. LEVEL OF FUNDING

685. As of July 2007 the GEF had allocated (since its inception)[114] a total of just over USD 3.3 billion to climate change projects from the GEF Trust Fund. Further co-financing in excess of USD 14 billion has been leveraged for these GEF projects, or USD 4.2 per dollar of GEF grant.[115] However, in the last reporting period (from September 2005 to August 2006), this ratio was higher – USD 6.4 per GEF dollar.[116] Six project proposals approved in the recent Work Programme (June 2007) leveraged an exceptionally high amount of co financing, making this ratio USD 21.6 per GEF dollar.

686. The total GEF climate change funding allocations (including enabling activities[117]) and co financing amounts are shown below for the different replenishment periods (TABLE VIII-56).

687. The proposed programming for GEF 4 (for the period 2006–2010) climate change activities amounts to USD 990 million. Most of the resources will go to mitigation activities. The balance will be allocated to the remainder of the strategic priority on adaptation (Piloting an Operational Approach to Adaptation or SPA, the Small Grants Programme (SGP), cross-cutting capacity-building activities and support to LDCs and SIDS (GEF, 2006).[119] A revised climate change strategy and climate change programming framework (GEF, 2007) is being discussed currently by the GEF Council and provides for a set of links between the GEF's mission, its strategic approach, priorities, operational programmes and project areas (see more detail in the discussions on the climate change portfolio below).

688. As shown in TABLE VIII-57, GEF funding represented 1.6 per cent of funds from bilateral and multilateral sources for energy projects during the period 1997–2005 (Tirpak and Adams, 2007).

689. As noted in CHAPTER IV.4.7.3, even if not focused on climate change, the forestry activities financed through the biodiversity focal areas of the GEF account for an important part of financing of forestry mitigation activities and acts as an important catalyst for additional resources (see TABLE 12-ANNEX V). The focal areas for biodiversity, land degradation and international water are also important catalysts of financing for adaptation, as acknowledged in different sectors analysed in CHAPTER V.

[114] Not all of these funds have been fully disbursed as projects are in various stages of implementation.

[115] GEF/C.31/10, annex 2, "Climate Change Focal Area Strategy and Strategic Programming for GEF-4".

[116] Total allocations were USD 355 million, with leveraged funds more than USD 2.3 billion (FCCC/CP/2006/3).

[117] Excludes project development facility (PDF) grants. A total of USD 14.7 million has been approved for PDF-Bs, for the information gathering necessary to complete full project proposals and the essential supporting documentation.

[118] FCCC/CP/2006/3.

[119] See CHAPTER VIII.2.1.3 for more detail on allocations across sectors.

Table VIII-56. **GEF Trust Fund allocations and co-financing (millions of United States Dollars)**

GEF phase	GEF grant[118]	Co-financing amount
Pilot phase	280.60	2,402.89
GEF 1	507.00	2,322.10
GEF 2	667.20	3,403.40
GEF 3	881.80	4,609.69
GEF 4	990.00	–
From which in 2007	76.35	1,651.82
Total	**3,326.60**	**14,389.90**

Source: GEF secretariat (2007).

8.2.1.2. RESOURCE ALLOCATION FRAMEWORK

690. A major element of the GEF 3 replenishment reform agenda was the establishment of a framework for allocation to countries based on global environmental priorities and performance.

691. The resource allocation framework (RAF) was adopted by the GEF Council in September 2005. The RAF is designed to increase the predictability and transparency in the way the GEF allocates resources. The resources each eligible country can expect from the GEF will be specified for the four years of the replenishment period, and initial allocations will be updated in the middle of the replenishment period. The RAF began implementation in GEF 4. Each eligible country can expect to receive a minimum allocation of USD 1 million. The total amount that a country receives from the GEF climate change focal area cannot exceed a ceiling of 15 per cent of the resources available. Two indices, the GEF Benefits Index and the GEF Performance Index, will be used in combination to determine the share of resources that each country is allocated. The GEF Benefits Index measures the potential of a country to generate global environmental benefits,[120] and the GEF Performance Index measures a country's capacity, policies and practices relevant to successful implementation of GEF programmes and projects. The GEF Performance Index relies on World Bank Country Policy and Institutional Assessment data.

692. The RAF does not change the GEF project cycle. Each country still needs to work with a GEF implementing/ executing agency to develop and prepare concepts for review, pipeline entry and inclusion in a work programme.

693. China, India and the Russian Federation are likely to receive the most under the RAF formula, followed by Brazil, Mexico and South Africa, followed by a group of countries that includes Argentina, Egypt, Indonesia, Islamic Republic of Iran, Kazakhstan, Malaysia, Pakistan, Romania, Thailand, Turkey, Ukraine and Venezuela (GEF, 2005b). In the past, the GEF tended to provide a higher level of resources to those countries with a greater potential for GHG emission reduction. This trend continues in GEF 4.

694. There will be an independent mid-term review of the RAF to be considered by the GEF Council in November/ December 2008.

695. The COP, by its decision 5/CP.11, requested the GEF to include in its regular annual reporting information on the initial application of the RAF in the allocation of resources in the fourth replenishment period and inform the COP as to how the RAF is likely to affect funding available to developing countries for the implementation of their commitments under the Convention.

696. The COP, by its decision 3/CP.12, also requested the GEF to give a detailed report on the resources available to each developing country Party in the initial implementation of the resource allocation framework, including a list of activities funded with these resources during this initial period in the climate change focal area.

[120] For climate change, the global environmental benefit index (GBI) weights the baseline emissions of a country with the carbon intensity adjustment factor. GHG emissions from land-use change and forestry are not included in this calculation.

Table VIII-57. **Multilateral and bilateral funding for energy during the period 1997 – 2005 (millions of United States dollars)**

Type of funding	Total 1997 – 2005	Percentage of Total Multilateral and Bilateral Funding
Bilateral Development Assistance	20,104	31.0
World Bank Group	24,898	38.4
EBRD	5,158	8.0
GEF	1,054	1.6
Asian Development Bank	6,593	10.2
Inter-American Development Bank	6,987	10.8
Total	64,794	100.00

Abbreviation: EBRD = European Bank for Reconstruction and Development
Source: Tirpak and Adams, 2007

8.2.1.3. CLIMATE CHANGE PORTFOLIO

697. The largest share of GEF climate change resources has been assigned to long-term mitigation projects. These were envisaged by the GEF to have "much greater impact because the projects would drive down costs, build capacity, and start to put in place the technologies that can ultimately avoid GHG emissions".[121] A key element of the GEF Trust Fund is its requirement that projects meet agreed incremental costs for delivering global environmental benefits. Climate change mitigation projects fell so far within four operational programmes (OP) approved by the GEF Council:

- Removal of barriers to energy conservation and efficiency (OP5);
- Promotion of the adoption of renewable energy by removing barriers and reducing implementation costs (OP6);
- Reduction of the long-term costs of low-GHG-emitting energy technologies (OP7);
- Promotion of environmentally sustainable transport (OP11).

698. A further programme, integrated ecosystem management (OP12), also encompasses climate change objectives, such as removals by sinks. Most of the GEF climate change funds have been spent on OP5 and OP6 (FIGURE VIII-40). To date, a smaller proportion of the GEF's resources have been allocated to adaptation activities, through the SPA.

699. The GEF Council is revising the GEF focal priorities under the fourth replenishment period. A proposal for focal area strategies and strategic programming for GEF 4 has been prepared by the GEF secretariat and is under consideration. The following priorities for climate change mitigation are proposed in the paper (GEF, 2007a):

- Promoting energy efficiency in residential and commercial buildings;
- Promoting energy efficiency in the industrial sector;
- Promoting market approaches for renewable energy;
- Promoting sustainable energy production from biomass;
- Promoting sustainable innovative systems for urban transport.

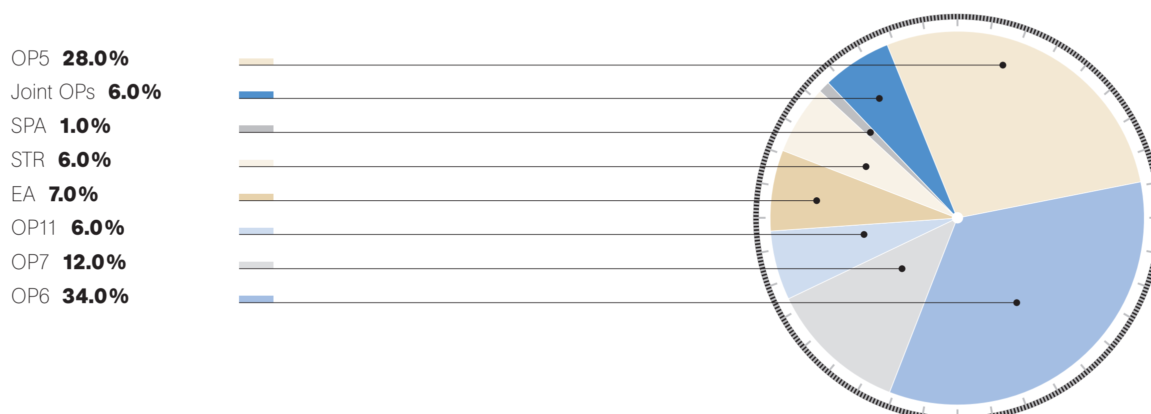
700. The proposal also outlines priorities and issues relating to enabling activities and adaptation. The GEF Council is considering the inclusion of another priority focusing on LULUCF.

701. The largest number of projects has been in the renewable energy portfolio. Although fewer projects have been approved in energy efficiency, these projects have tended to be larger and hence the overall amount allocated for energy efficiency is only slightly less than that allocated for renewable energy. An almost equivalent amount has been allocated for a small number of large projects on solar thermal electricity, power production and fuel cells. Within the energy efficiency portfolio, projects have concentrated on energy efficient buildings, appliances and industry. A relatively new focus has been projects that aim to increase the efficiency of power plants. Within the renewable energy portfolio, there has been a marked shift away from photovoltaic projects (although these have not entirely disappeared) and a greater emphasis on a range of resource and technology options, including biomass, hydropower and wind. Although there are some grid-connected renewable energy projects, most of the portfolio is oriented towards rural energy services. There are fewer isolated, one-off rural interventions, and more emphasis on integrated, sustainable national programmes.

702. FIGURE VIII-40 provides a breakdown of GEF resources allocated to climate change activities by OPs from the pilot phase through the three replenishment periods and including six projects approved under GEF 4 so far (as at June 2007). One third of the resources (USD 861.1 million) has been allocated to support renewable energy (OP6). A comparable amount (USD 719.8 million) has been approved for energy efficiency (OP5). Funding for low GHG-emitting energy technologies (OP7) equalled USD 318.2 million, whereas support for sustainable transport activities (OP11) – a relatively new but rapidly growing operational programme – came to USD 160.6 million. To date, 1 per cent of GEF resources has been allocated to adaptation activities, through the SPA.

703. As for trends, TABLE VIII-58 illustrates that from the pilot phase to GEF-3, the share of the energy efficiency portfolio (OP5) in the GEF climate change focal area saw a steady increase from 25 per cent to nearly 34 per cent. The share of the GEF renewable energy portfolio, including OP6 and OP7, also experienced an increase from less than one third to nearly 47 per cent (OP6 saw a decrease from 39 per cent to 34 per cent, whereas OP7 saw an increase from less than 4 per cent to nearly 13 per cent). Short-term response measures (STRMs) were the only area among all GEF climate change activities that saw a sharp decline in financing over time, from 25 per cent during the pilot phase to less than 1 per cent during GEF 3. Among the first the projects approved for funding under GEF 4 in June 2007, three aim at energy efficiency, one at renewables and two at sustainable transport.

Figure VIII-40. **Allocation of funds available through the Global Environment Facility among its operational programs**



Source: GEF, 2007b.[122]
Abbreviations: EA = Enabling Activity, Joint OPs = Joint operational programmes, OP5 = Removal of Barriers to Energy Efficiency and Energy Conservation, OP6 = Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs, OP7 = Reducing the Long Term Cost of Low Greenhouse Gas-emitting Energy Technologies, OP11 = Sustainable Transport, SPA = Strategic Priority on Adaptation, STRM = Short Term Response Measures.

Table VIII-58. **Allocation of GEF resources to climate change activities for the period 1991 – 2007 (millions of United States dollars)**[123]

	Pilot phase (1991 to 1994)	GEF 1 (1995 to 1998)	GEF 2 (1999 to 2002)	GEF 3 (2003 to 2006)	GEF 4 (June 2007)	Total
OP 5: Energy efficiency	70.6	128.6	200.1	286.7	33.8	719.8
OP 6: Renewable energy	108.8	191.3	251.8	299.2	10	861.1
OP 7: Low GHG-emitting energy technologies	10.1	98.4	98.6	111.1	–	318.2
OP 11: Sustainable transport			46.4	82.2	32	160.6
Enabling activities	20.2	46.5	45.3	73.9		185.9
Short Term Response Measures	70.8	42.2	25.1	3.7	–	141.8
Strategic pilot approach to adaptation	–	–	–	25	–	25.0
Total	280.5	507	667.3	881.8	75.8	2,412.4

Abbreviation: OP5 = Removal of Barriers to Energy Efficiency and Energy Conservation, OP6 = Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Implementation Costs, OP7 = Reducing the Long Term Cost of Low Greenhouse Gas-emitting Energy Technologies, OP11 = Sustainable Transport.

[a] As of July 2007, six project proposals have been approved under GEF 4.

[121] FCCC/CP/1995/4.

[122] CCC/CP/2006/3.

[123] FCCC/CP/2006/3.

704. *Enabling activities:* Total funding for enabling activities amounted to USD 186 million. The GEF has provided financing to support 139 non-Annex I Parties in preparing their initial national communications.[124] As of July 2007, About 110 countries received assistance to undertake stocktaking in preparation for their second national communications. The National Communication Support Programme, phase II, is currently assisting 106 countries in preparing their second national communications.

705. *Small grants programme:* According to information provided by the GEF secretariat in July, cumulative funding allocations for the SGP since 1992 have amounted to USD 365.8 million. The ratio of projects for climate change is increasing, starting from 15 per cent in the 1990s to more than 20 per cent currently.

706. *Strategic Priority on Adaptation (SPA):* In response to guidance by the COP,[125] the GEF established the strategic priority "Piloting an Operational Approach to Adaptation (SPA)". An allocation to the pilot of USD 50 million was included in the GEF business plan in November 2003. As of June 2007, eleven projects have been approved with financing from the SPA, totalling USD 28 million. The remaining funds of the pilot programme have been carried over to GEF 4. According to information provided by the GEF secretariat, there are now six projects in the pipeline.[126]

8.2.2. SPECIAL CLIMATE CHANGE FUND

707. The SCCF finances activities, programmes and measures relating to climate change that are complementary to those funded by the resources allocated to the climate change focal area of the GEF and by bilateral and multilateral funding, in the following areas: (a) adaptation, (b) transfer of technologies, (c) energy, transport, industry, agriculture, forestry and waste management; and, (d) activities to assist developing countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products in diversifying their economies (GEF, 2004).

708. As of June 2007, the original pledges to the SCCF totalled USD 67 million. Of this sum, USD 57 million was pledged for the SCCF Programme for Adaptation and USD 10 million for the SCCF Programme for Transfer of Technology. The total amount available for allocation was USD 43.67 million.[127]

709. To date, eight projects (four medium size projects and four full size projects) have been approved under the SCCF adaptation programme[128]. TABLE 28- and 29-ANNEX V summarizes the approved projects and the projects currently in the pipeline.

8.2.3. LEAST DEVELOPED COUNTRIES FUND

710. The LDCF is designed to support projects addressing the urgent and immediate adaptation needs of the LDCs as identified by their national adaptation plans of action (NAPAs). The LDCF contributes to the enhancement of adaptive capacity to address the adverse effects of climate change, including, as appropriate, in the context of national strategies for sustainable development. The priority sectors that are expected to receive the most attention under the NAPA are water resources, food security and agriculture, health, disaster preparedness and risk management, infrastructure and natural resources management. Community-level adaptation may also be a cross-cutting area of concern (GEF, 2007b).

711. As of 30 June 2007, the LDCF had received USD 160 million in contributions and investment income. Allocations of USD 20.7 million had been made and USD 139.3 million remained available for allocation[129].

712. According to information provided by the GEF Secretariat, to date, 44 out of 49 eligible LDCs have been allocated funds to prepare their NAPAs, as well as for two global support programmes, for a funding total of USD 9.6 million.

713. As of July 2007, there are 6 approved NAPA implementation projects under LDCF. These projects are country driven, presenting a differentiated range of options to address urgent and immediate risks due to adverse impacts of climate change, and demonstrate links between adaptation and development. The six projects in the pipeline are summarized in TABLE 30A-ANNEX V.

8.3. ADAPTATION FUND

714. The Adaptation Fund, under the Kyoto Protocol was established to finance concrete adaptation projects and programmes in developing country Parties that are Parties to the Kyoto Protocol, in particular those that are particularly vulnerable to the adverse effects of climate change. This fund shall function under the guidance of, and be accountable to, the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP).

715. Although initial guidance from the CMP on principles, modalities and some key governance elements for the operationalisation of the Adaptation Fund was agreed upon in December 2006,[130] negotiations on the details for operationalising the Adaptation Fund, in particular institutional arrangements, are currently ongoing.

716. The Adaptation Fund is to be financed with a share of proceeds from CDM project activities and other sources of funding. The share of proceeds amounts to 2 per cent of CERs issued for a CDM project activity, with exemptions for some project types.[131]

717. The level of funding for the Adaptation Fund depends on the quantity of CERs issued and the price of CERs. Assuming annual sales of 300 – 450 million CERs and a market price of USD 24 (range of USD 14 – 34) the Adaptation Fund would receive USD 80 – 300 million per year for 2008 to 2012.

718. Funding for the Adaptation Fund for post-2012 depends on the continuation of the CDM and the level of demand in the carbon market. Assuming a share of proceeds for adaptation of 2 per cent continues to apply post-2012, the level of funding could be USD 100 – 500 million per year in 2030 for low demand by Annex I Parties for credits from non-Annex I Parties and USD 1 to USD 5 billion per year for high demand. The level of CERs issued in the account from the CDM registry for the Adaptation Fund, as of July 2006, is 1,264,201.[132]

[124] FCCC/CP/2006/3.

[125] Decision 6/CP.7.

[126] Information has been received from personal communication with the GEF Secretariat.

[127] Personal communication with the GEF Secretariat.

[128] "LDCF and SCCF Programming Update", in GEF/LDCF.SCCF.2/Inf.3.

[129] Personal communication with the GEF Secretariat.

[130] Decision 5/CMP.2.

[131] Article 12, paragraph 8 of the Kyoto Protocol and decisions 17/CP.7 and 3/CMP.1.

[132] For updated information on the number of CERs issued in the Adaptation Fund account in the CDM registry please see: <http://cdm.int/Issuance/SOPByProjectsTable.html>.

IX. POTENTIAL FOR ENHANCED INVESTMENT AND FINANCIAL FLOWS

9.1. INTRODUCTION

719. This chapter provides an overview of the key findings of the paper and considers how future investment and financial flows can be shifted, optimized and scaled up to meet the needs for mitigation and adaptation to climate change.

9.2. KEY FINDINGS

720. The *estimated additional investment and financial flows needed in 2030* to address climate change is large compared with the funding currently available under the Convention and its Kyoto Protocol, but small in relation to estimated global GDP (0.3 – 0.5 per cent) and global investment (1.1 – 1.7 per cent) in 2030.

721. In many sectors the lifetime of capital stock can be thirty years or more. The fact that total *investment in new physical assets is projected to triple between 2000 and 2030* provides a window of opportunity to direct the financial and investment flows into new facilities that are more climate friendly and resilient. The investment decisions that are taken today will affect the world's emission profile in the future.

722. When *considering means to enhance investment and financial flows to address climate change in the future,* it is important to focus on the role of private-sector investments; as they constitute the largest share of investment and financial flows (86 per cent). Although ODA funds are currently less than 1 per cent of investment globally, ODA represents a larger share of the total investments in some countries such as the LDCs (6 per cent).

723. Particular attention will need to be given to *developing countries,* because although they currently account for only 20 – 25 per cent of global investments, their expected rapid economic growth means that they will require *a large share of investment and financial flows.*

724. With *appropriate policies and/or incentives,* a substantial part of the additional investment and financial flows needed could be covered by the currently available sources. However, *improvement in, and an optimal combination of, mechanisms,* such as the carbon markets, the financial mechanism of the Convention, ODA, national policies and, in some cases, *new and additional resources,* will be needed to mobilize the necessary investment and financial flows to address climate change.

725. The *carbon market,* which is already playing an important role in shifting private investment flows, would have to be significantly expanded to address needs for additional investment and financial flows. *National policies* can assist in shifting investments and financial flows made by private and public investors into more climate-friendly alternatives and optimize the use of available funds by spreading the risk across private and public investors. *Additional external funding for climate change mitigation and adaptation will be needed,* particularly for sectors in developing countries that depend on government investment and financial flows.

726. If the funding available under the *financial mechanism* of the Convention remains at its current level and continues to rely mainly on voluntary contributions, it will not be sufficient to address the future financial flows estimated to be needed for mitigation and adaptation.

727. Several *other options* for generating additional funds have been suggested. Some of these options, such as the expansion of the carbon market and the auction of allowances for emissions from international bunkers, could generate revenues commensurate with the additional needs.

9.2.1. OVERVIEW OF CURRENT INVESTMENT AND FINANCIAL FLOWS

728. As indicated in CHAPTER III and TABLES 1 – 4-ANNEX V, most investment (75 – 80 per cent) occurs in Annex I Parties. Globally, corporations are responsible for about 60 per cent of total investment, but this varies from 50 to 75 per cent in different regions, with Africa at the low end and developing Asia at the high end. Households, individuals, farmers and small businesses are responsible for 26 per cent of global investment, ranging from 20 per cent in developing countries to 30 per cent in OECD countries. Governments are responsible for 14 per cent of total investment, ranging from 10 per cent in some regions to 25 per cent in Africa.

729. Globally, about 60 per cent of total investment comes from domestic sources, and about 20 per cent each from FDI and international debt. The domestic share ranges from 20 per cent in the EU to 90 per cent in Africa and the Middle East. ODA funds less than 1 per cent of investment globally, but this rises to over 2 per cent in Africa and over 6 per cent in LDCs.

730. In almost every sector and region, domestic sources account for most of the funds invested. FDI tends to be invested in mining, including oil and gas production; manufacturing; and financial services. Only small amounts of FDI are invested in agriculture, forestry and construction. ODA is invested in energy and water supply in LDCs.

731. The Convention and its Kyoto Protocol have established mechanisms that provide investment and financial flows for adaptation and mitigation. These include the CDM, JI, the GEF, LDCF, SCCF, and the Adaptation Fund of the Kyoto Protocol. The TABLE IX-59 provides an overview the current investment and financial flows generated by these mechanisms.

Table IX-59. **Overview of current sources of financial flows relevant to climate change**

Sources	Amount (in millions of United States dollars)	Notes
Mitigation		
Clean development mechanism	2006 USD 5,259	Value of trades during 2006
	2006 USD 947 to 1,572	Value of estimated annual emission reductions for projects registered during 2006
	2006 USD 1,569 to 2,602	Value of estimated annual emission reductions for projects that entered the pipeline during 2006
	2006 USD 6,939	Investment by projects registered during 2006
	2006 USD 26,467	Investment by projects that entered the pipeline during 2006
Joint implementation	2006 USD 140	Value of trades during 2006
	2006 USD 132 to 266	Value of estimated annual emission reductions for projects that entered the pipeline during 2006
	2006 USD 6,269	Investment by projects that entered the pipeline during 2006
Carbon funds	2006 USD 6,996	Subscribed capital at end of 2006
	2006 USD 2,110	Increase in subscribed capital during 2006
Global Environment Facility (GEF)	3,326.6	Cumulative funding allocated since GEF inception for operational programmes (OPs) 5, 6, 7, 11, EA, STRM and joint OPs. Pilot phase and three replenishment periods and six projects approved under the fourth GEF replenishment (GEF 4) as at June 2007
	990	Targeted allocations as per GEF 4 to be spent between 2006 and 2010
Adaptation		
GEF strategic priority "Piloting an Operational Approach to Adaptation (SPA)"	50 (over 3 years)	Pilot to be evaluated
Least Developed Countries Fund (LDCF)	160 (pledged)	
Special Climate Change Fund (SCCF)	67 (pledged)	Adaptation part only
Adaptation Fund (AF)	2006 USD 80 – 300	Estimated annual revenue during 2008 to 2012 from 2 per cent share of proceeds levy on CERs issued

Source: CHAPTERS VII and VIII.
Note: Activity under the clean development mechanism and joint implementation is relatively recent and growing rapidly, so data for 2006 are presented.

732. The financial mechanisms of the Convention, including the LDCF and SCCF, depend on replenishments through voluntary contributions from donors, and in particular, on how much Annex II Parties allocate to the financial mechanisms in accordance with their obligations in Article 4, paragraph 3, of the Convention. The target for GEF 4 is USD 990 million over 2006 to 2010. The LDCF and SCCF are replenished on an ongoing basis with total pledges to date amounting to USD 227 million.

733. The revenue received by the Adaptation Fund depends on the quantity of CERs issued and the price of CERs. Assuming annual sales of 300 million to 450 million CERs and a market price of USD 24 (range of USD 14–34) the Adaptation Fund would receive USD 80 to 300 million per year for 2008 to 2012.

734. The current and projected size of the international *carbon markets* is analysed in detail in CHAPTER VII and summarized in TABLE IX-60.

9.2.2. KEY FINDINGS ON INVESTMENT AND FINANCIAL FLOWS NEEDED FOR MITIGATION IN 2030

735. It is estimated that global additional investment and financial flows of USD 200–210 billion will be necessary in 2030 to return global GHG emissions to current levels (see TABLES IX-61–63). In particular:

- *For energy supply,* investment and financial flows would be reduced by about USD 59 billion for fossil fuel supply and by USD 7 billion for power supply owing to increased investment in energy efficiency and biofuels of about USD 158 billion. Investment in fossil fuel supply is expected to continue to grow, but at a reduced rate. About USD 148 billion out of USD 432 billion of projected annual investment in power sector is predicted to be shifted to renewables, CCS, nuclear energy and hydropower. Currently most of the power sector investment is made by government-owned or private, usually regulated, electric utilities, and is made domestically in most regions;
- *For industry,* additional investment and financial flows are estimated at about USD 36 billion. More than half of the additional investment is for energy efficiency, one-third for installation of CCS and the rest for reduction of non-CO_2 gases. Implementation of these measures is likely to require government policies, but the investment would come mostly from the private sector;
- *For buildings,* additional investment and financial flows amount to about USD 51 billion. Currently, commercial and residential energy efficiency investment comes from building owners and is financed domestically;
- *For transportation,* additional investment and financial flows amount to about USD 88 billion. Efficiency improvements for vehicles and increased use of biofuels are likely to require government policies, but the investment would come mostly from the private sector;
- *For waste,* additional investment and financial flows are estimated at about USD 1 billion. Capture and use of methane from landfills and wastewater treatment could reduce emissions by about 50 per cent in 2030, mainly in non-Annex I Parties;
- *For agriculture,* additional investment and financial flows are estimated at about USD 35 billion. Non-CO_2 emissions from agriculture production could be reduced by about 10 per cent at a cost of USD 20 billion in 2030. With a concerted international effort and an annual investment of about USD 15 billion, agroforestry could be expanded at a rate of about 19 million ha per year by 2030;
- *For forestry,* additional investment and financial flows are estimated at about USD 21 billion. An indicative estimate of the cost of reducing deforestation and forest degradation in non-Annex I Parties to zero in 2030 is USD 12 billion. The estimated investment and financial flows in 2030 to increased GHG removals by sinks through sustainable forest management is USD 8 billion and the estimated investment and financial flows needed for afforestation and reforestation is USD 0.1–0.5 billion;
- *For technology R&D and deployment,* additional investment and financial flows are estimated at about USD 35–45 billion. Government spending on energy R&D worldwide has stagnated, while private sector spending has fallen. Government budgets for energy R&D and support for technology deployment need to double, increased expenditures in 2030 are expected at USD 10 and 30 billion respectively.

Table IX-60. **Current and projected size of the international carbon markets**

Year	Market	Sales (2006 USD billion per year)	Quantity (Mt CO_2 eq)	Average price and range (2006 USD/t CO_2 eq)
		Trading activity		
2006	Clean development mechanism (CDM)	5	475	11 (6 – 27)
	Joint implementation (JI)	<1	16	9
	European Union emissions trading scheme allowances	24	1,101	22 (5 – 40)
		Compliance needs		
2010	Compliance by Parties to the Convention that are also Parties to the Kyoto Protocol with commitments inscribed in Annex B to the Kyoto Protocol (mainly CDM and JI)	10 – 15 (5 – 25)	400 – 600 excluding Canada	24 (14 – 34)
2030	Purchases by Parties currently included in Annex I to the Convention			
	Low estimate	10 – 15 (5 – 25)	400 – 600	24 (14 – 34)
	High estimate	100 (90 – 125)	4,000 – 6,000	24 (14 – 34)

Table IX-61. **Investment for energy supply under the reference and mitigation scenarios in 2030 (billions of United States dollars)**

	Global			Non-Annex I Parties		
Sector	Reference scenario	Mitigation scenario	Additional investment	Reference scenario	Mitigation scenario	Additional investment
Fossil fuel supply						
Coal	20	12	-8	13	8	-5
Oil	154	125	-29	85	69	-16
Natural gas	148	126	-22	58	47	-11
Total	322	263	-59	156	124	-32
Power supply						
Coal-fired generation	75	24	-51	40	13	-27
Oil-fired plants	2	1.5	-1	1	1	0
Gas-fired plants	39	36	-3	17	13	-4
Nuclear energy	15	40	25	3	14	11
Hydropower	37	59	22	28	46	18
Renewable	41	79	38	12	30	18
CO_2 capture and storage facility coal-fired plants	–	40	40	0	21	21
CO_2 capture and storage facility gas-fired plants	–	23	23	0	6	6
Transmission and distribution	231	130	-101	149	101	-48
Total	439	432	-7	251	245	-6

Abbreviations: Non-Annex I Parties = Parties not included in Annex I to the Convention

Table IX-62. **Additional investment for emission reductions under the mitigation scenario for related sectors in 2030 (billions of United States dollars)**

	Additional investment	
Sector	**Global**	**Non-Annex I Parties**
Industry		
Electrical equipment	10.8	3.8
Stationary fuel consuming equipment	8.7	3.1
CO_2 capture and storage	14.1	11.0
Non-CO_2 gases	2.0	1.2
Total	35.6	19.1
Buildings		
Electrical equipment	42	10.0
Stationary fuel consuming equipment	8.8	4.0
Total	50.8	14.0
Transportation		
Hybrid vehicles and efficiency improvement in vehicles	78.7	31.5
Biofuel	9.2	4.0
Total	87.9	35.5
Waste total	0.9	0.6

Abbreviations: Non-Annex I Parties = Parties not included in Annex I to the Convention
Note: Additional investments are calculated based on the capital costs of different measures to achieve the emission reductions projected for the mitigation scenario as compared with the reference scenario.

Table IX-63. **Additional investment and financial flows under the mitigation scenario for forestry and agriculture in 2030 (billions of United States dollars)**

Sector	**Global**	**Non-Annex I Parties**
Agriculture		
Non-CO_2 gases[a]	20	13
Agroforestry	15	N.A.[b]
Grassland management	N.A.	N.A.
Forestry		
Reduced deforestation[a,c]	12	12
Forest management[a,d]	8	8
Afforestation and reforestation	0.12 – 0.50	0.1 – 0.4

Abbreviations: Non-Annex I Parties = Parties not included in Annex I to the Convention
Note: Additional investments are calculated based on the capital costs of different measures to achieve the emission reductions projected for the mitigation scenario. Additional financial flows are calculated based on the marginal costs of the measures to achieve the emission reductions projected for the mitigation scenario.

[a] Financial flows, minimum investments required.
[b] Only global estimates are currently available.
[c] Reducing emissions from deforestation in developing countries as defined in SBSTA Agenda Item 5.
[d] Part of this investment might also be considered in Reduced deforestation.

Table IX-64. **GHG emission reductions and additional investment and financial flows**

	Global		Non-Annex I Parties			
	Emission Reduction Gt CO_2 eq	Additional investment and financial flows in 2030 USD billion	Emission Reduction Gt CO_2 eq	Additional investment and financial flows in 2030 USD billion	Per cent of global emission reduction	Per cent of global additional investment and financial flows
Power supply	9.4	148.5	5.0	73.4	53	49
Industry	3.8	35.6	2.3	19.1	60	54
Transport	2.1	87.9	0.9	35.5	42	40
Building	0.6	50.8	0.3	14.0	48	28
Waste	0.7	0.9	0.5	0.6	64	64
Agriculture	2.7	35.0	0.4	13.0	14	37
Forestry	12.5	20.7	12.4	20.6	100	99
Total	**31.7**	**379.5**	**21.7**	**176.2**	**68**	**46**

Note: The data should not be used to compare the cost per ton of CO_2e reduced by sector. The costs for reducing electricity use in buildings and industry are reported in those sectors, while the emission reductions are counted in the power supply sector. (see also TABLES IV-11 and -39).

736. *Mitigation actions are expected to be more cost-effective in non-Annex I Parties.* TABLE IX-64 shows that 68 per cent of the projected global emission reductions occur in non-Annex I Parties while only 46 per cent of the additional investment and financial flows are needed in non-Annex I Parties. This reflects mitigation opportunities associated with the rapid economic growth projected for large developing countries, the relatively inefficient energy use, and the prevalence of low cost mitigation opportunities in the forestry sector.

737. The *entities that make the investment decisions are different in each sector, and the policy and/or financial incentives needed will vary* accordingly. For example:

- Increased energy efficiency is best achieved through appropriate policies or regulations (the investments are internal and often incremental, and have short payback periods, but adoption is hampered by recognized barriers);
- Shifting investment in efficient motor vehicles needs incentives to:
  - Introduce hybrid vehicles such as vehicle purchase subsidies, regulatory standards and higher taxes on the least efficient vehicles;
  - Expand the use of biofuels such as larger R&D programmes and minimum requirements for biofuels in conventional fuel blends;
- Shifting investment in the power sector to CCS and low GHG emitting generation technologies will need both policies and financial incentives which make these technologies economically more attractive than high GHG emitting technologies. This requires large R&D programmes, incentives for large scale demonstration plants, national or international policy frameworks, such as carbon markets, renewable portfolio standards or higher feed-in tariffs, loan guarantees to reduce the cost of capital, financial penalties on carbon emissions;
- Financial incentives will be needed to achieve significant reductions in emissions through reduced deforestation and forest management.

738. Currently most of the investment in mitigation measures is domestic; however, ODA plays an important role in Africa and the LDCs. *With appropriate policies and/or incentives, a substantial part of the additional investment and financial flows needed could be covered by the current sources. However, there will be a need for new and additional external sources of funds dedicated to mitigation.*

739. The share of the *GEF, as an operating entity of the financial mechanism of the Convention,* of total multilateral and bilateral funding between 1997 and 2005 is 1.6 per cent.

740. The *carbon market* and policies to promote renewables are already playing an important role in shifting investment flows. This is indicative of how quickly investment flows can respond to changes in policies and incentives.

741. It is estimated that the CDM project activities that entered the pipeline in 2006 will generate investment of about USD 25 billion, of which approximately 50 per cent represents capital invested in unilateral projects by host

country project proponents. Renewable energy and energy efficiency projects account for 90 per cent of the overall investment.

742. The supply of Kyoto units will be abundant compared with the level of compliance demand for the period 2008–2012. The voluntary market could represent about 15 per cent of the total carbon market.

743. The low estimate of compliance demand by Annex I Parties in 2030 is a market of USD 5–25 billion per year, which is basically a continuation of the current flow of projects. The high estimate of compliance demand is a market of USD 100 billion per year; to meet this demand, a large fraction of the potential emission reductions, from all existing and some new categories of projects, would need to earn emission reduction credits.

744. All Parties need to adopt *climate change policies.* International coordination of policies in an appropriate forum is often effective. Areas where international coordination would be beneficial include:

- Technology R&D and deployment;
- Energy efficiency standards for internationally traded appliances and equipment.

745. Funding from external sources will play an important role in helping developing countries formulate and implement national policies.

9.2.3. KEY FINDINGS ON INVESTMENT AND FINANCIAL FLOWS NEEDED FOR ADAPTATION IN 2030

746. The global cost of adaptation to climate change is difficult to estimate, largely because climate change adaptation measures will be widespread and heterogeneous. More analysis of the costs of adaptation at the sectoral and regional levels is required to support the development of an effective and appropriate international response to the adverse impacts of climate change. Nevertheless it is clear that a large amount of new and additional investment and financial flows will be needed to address climate change adaptation.

747. Estimated overall *additional investment and financial flows needed for adaptation in 2030* amount to several tens of billion United States dollars (see TABLE IX-65). In particular:

- About USD 14 billion in investment and financial flows are estimated to be needed for *agriculture, forestry and fisheries* (AFF);
  - About USD 11 billion is estimated to be needed for production and processing, most of which is expected to be financed by domestic private sources;
  - About USD 3 billion is estimated to be needed for R&D and extension activities. Based on current trends, it can be expected that public sources of funding will need to cover a large part of this additional need.
- The additional investment needed in *water supply* infrastructure in 2030 is estimated at USD 11 billion, 85 per cent of which will be needed in non-Annex I Parties. About 90 per cent of the cost for all aspects of water resource use is currently covered by public domestic funding sources and 10 per cent by external public funding sources, and this pattern is unlikely to change significantly by 2030;
- The costs of treating the increased cases of *diarrhoeal disease, malnutrition and malaria* due to climate change are estimated at USD 5 billion in 2030. This need for additional financial flows will occur solely in developing countries and corresponds to the current annual ODA for health. The additional cost is likely to be borne mainly by the families of those affected. Where private individuals cannot cope with the additional cost of treatment, additional public financing will be necessary;
- The investment needed in 2030 for *beach nourishment and dykes* is estimated to be about USD 11 billion. About half of the global investment would be needed in non-Annex I Parties. Efforts to protect *coastal areas* from coastal storms and sea level rise are typically undertaken by governments. The necessary public resources for coastal zone adaptation are likely to be available in developed and some developing countries. However, deltaic regions, particularly the large coastal deltas in Asia and Africa as well as the small island developing States, may have significant problems in raising the required investment and financial flows to respond to sea level rise;
- The additional investment needed to adapt *new infrastructure* vulnerable to climate change is estimated at USD 8–130 billion, which is less than 0.5 per cent of global investment in 2030. The extra cost is likely to be met in the same manner as the overall infrastructure cost.

748. The change in investment and financial flows for adaptation that will need to occur in developed and developing countries varies by sector. *A significant share of the additional investment and financial flows will be needed in non-Annex I Parties (USD 28 – 67 billion).* See TABLE IX-65.

749. *Private sources* of funding can be expected to cover a portion of the adaptation costs in sectors (such as *AFF and infrastructure)* with privately owned physical assets, in particular in developed countries. However, public resources will be needed to implement policies or regulations to encourage the private investment of private resources in adaptation measures, especially in developing countries. Public domestic resources will be needed to cover adaptation costs related to climate change impacts on public infrastructure in all countries.

750. *Additional external public funding is likely to be needed for adaptation measures.* Such additional funding will be needed in particular for sectors and countries that are already highly dependent on external support, for example in the health sector in LDCs, or for coastal infrastructure in developing countries that are highly vulnerable to sea level rise. *Current mechanisms and sources of financing are limited and it is likely that new sources of funding will be required.*

751. The *funds managed by the GEF* that are available for adaptation projects, including the SPA of the GEF Trust Fund, the SCCF and the LDCF, amount to over USD 275 million. Since 2005 the GEF has provided USD 110 million for adaptation projects.

752. The *revenue received by the Adaptation Fund* under the Kyoto Protocol depends on the quantity of CERs issued and their price. Assuming annual sales of 300 – 450 million CERs and a market price of USD 24 (range USD 14 to 34), the Adaptation Fund would receive USD 80 – 300 million per year for the period 2008 – 2012. Funding for the Adaptation Fund post 2012 depends on the continuation of the CDM and the level of demand in the carbon market. Assuming a share of proceeds for adaptation of 2 per cent continues to apply post 2012, the level of funding could be USD 100 – 500 million per year in 2030 for a low demand by Annex I Parties for credits from non-Annex I Parties, and USD 1 – 5 billion per year for a high demand. This will still be less than the amount likely to be needed.

753. *Bilateral contributions* for adaptation are estimated to have been in the order of USD 100 million per year between 2000 and 2003.

754. *National policies* could play an important role in ensuring that the use of resources for adaptation purposes, both public and private, is optimized. In particular, there is a need for:

- Domestic policies that provide incentives for private investors to adapt new physical assets to the potential impacts of climate change;
- National policies that integrate climate change adaptation in key line ministries;
- Local government adaptation policies in key sectors.

755. Although the additional investment and financial flows needed for adaptation described above are significant, *the value of the climate change impacts that those expenditures would avoid could be larger.* This study does not estimate the total value of impacts avoided by adaptation to climate change, so it does not determine whether benefits of avoided damage exceed the adaptation costs. Existing estimates of the future damage caused by climate change vary substantially; however, available studies yield two important common findings:

Table IX-65. **Estimated additional investment and financial flows needed for adaptation in 2030 (billions of United States dollars)**

Sector	Global	Non-Annex I Parties
Agriculture, forestry and fisheries	14	7
Water supply	11	9
Human health	5	5
Coastal zones	11	5
Infrastructure	8 to 130	2 to 41

- Damage increases with the magnitude of climate change. The more that the climate changes, typically measured as the increase in global mean temperature, the greater the damage;
- Investment needs for adaptation would almost certainly increase substantially in the latter decades of the twenty-first century. They will be particularly high if no mitigation measures are implemented.

756. On average, developing countries suffer more damage as a percentage of their GDP than developed countries, which implies that damages and benefits are not distributed evenly.

9.2.4. PRIORITIES IDENTIFIED BY DEVELOPING COUNTRY PARTIES IN THE UNFCCC PROCESS

757. In addition to the needs identified above, when tailoring incentives for financial and investment flows it is important to take into account priority areas for climate change mitigation and adaptation identified by non-Annex I Parties under the Convention process. Although these priorities have been identified in various contexts and do not constitute a comprehensive view of non-Annex I Parties priorities and needs, they complement the discussion of investment and financing needs.

758. In their INCs two-thirds of non-Annex I Parties reported energy supply measures as a priority, and a majority of the mitigation project proposals in the energy sector submitted by Parties in their INCs involve switching to renewable sources of energy. Other mitigation measures identified as priorities include switching to less carbon intensive fuels, installing more efficient industrial boilers, improving cooking stoves for the residential/commercial sector, promoting electric and compressed natural gas vehicles, reducing waste generation at source, making changes in cattle management practices and promoting forest conservation and restoration.

759. Adaptation measures related to water supply were reported as a priority in all regions. Measures proposed in this sector are aimed at increasing water supply, improving water management and improving flood, drought, and water level monitoring. Other adaptation measures identified as priorities by Parties include the development of resistant crop and livestock varieties and salt-tolerant fish species. Measures related to the prevention of soil erosion and to the integrated management of coastal areas were also highlighted, along with the need for early warning systems for extreme events and measures for flood prevention. Development of health infrastructure and protection of tourism infrastructure were also identified as priorities. The need for an integrated approach to adaptation was emphasized by Parties.

760. With regard to the adverse impacts of response measures, measures prioritized by Parties include the development of low GHG emitting technologies, financial risk management such as commodity price hedging and economic shock funds, and the development of key infrastructure needed to diversify economic activity.

9.3. KEY FACTORS AND OPTIONS DETERMINING FUTURE INVESTMENT AND FINANCIAL FLOWS

761. The previous chapters illustrate that addressing climate change will require significant changes to in patterns of investment and financial flows. Such changes fall into three categories:

- *Shift investments and financial flows* made by private and public investors to more sustainable climate-friendly alternatives, for example, by redirecting investments from traditional energy supply sources and technologies to low GHG emitting ones;
- *Scale-up* international private and public capital dedicated to investments and financial flows in mitigation or adaptation activities or technologies, for example by expanding the carbon market, by increasing contributions from Annex II Parties or by identifying new sources of funding;
- *Optimize the allocation of the funds* available by spreading the risk across private and public investors, for example by providing incentives for private investment in the early deployment of new technologies or by improving the capacity of the insurance market.

9.3.1. SHIFT INVESTMENTS AND FINANCIAL FLOWS

762. Substantial shifts in investment patterns will be required to mitigate and adapt to climate change. About half of these shifts should occur in developing countries, which will require incentives and support for policy formulation and implementation.

763. Shifting investment is particularly important for the power supply. About USD 148 billion needs to be shifted from fossil-fired generation to renewables, CCS, nuclear energy and hydropower. Currently investment in the power sector is mostly domestic (about 70 per cent) with significant

international FDI and international borrowing in some regions. Shifting domestic investments into more climate-friendly alternatives may require national policies and/or financial incentives.

764. Investment in improved efficiency by energy consumers and biofuel (USD 158 billion) would reduce the investment required in energy supply by USD 67 billion in 2030. Such a shift will require appropriate policies to encourage consumers to implement energy efficiency measures.

765. Adaptation in the infrastructure and AFF sectors will require a shift in public- and private-sector investment patterns and associated production activities. In both sectors, investment in physical assets will need to be shifted towards assets that are less vulnerable to the adverse impacts of climate change. The shift can be characterized, for example, by a change in location, design, building material or primary input in the case of manufacturers. The optimal shift will occur only with adequate policies and incentives. In the case of poor populations, direct financial support may also be required.

766. Shifting investments into high-cost, low GHG emitting technologies poses additional challenges. Since the risks and costs are higher than those of conventional technologies, private investors need financial incentives or other arrangements to enable them to earn a comparable risk-adjusted return. This means it will be necessary, in particular in developing countries, to scale up funding (in the form of grants, concessional loans, promotional programmes, demonstration projects, etc.) to shift the investments (see CHAPTER IX.3.2 on scaling up funding).

9.3.1.1. SHIFTING PRIVATE INVESTMENTS AND FINANCIAL FLOWS

767. Private investors pursue opportunities to earn risk-adjusted returns that meet their investment preference. As a consequence of the increasing public and government attention to climate change, there has been an increase in private investment in the area – the opportunities to make a profit are clearer and more immediate. More attention is also being paid to the risks of climate change – the need to consider the impacts of climate change on the projected returns from proposed investments. While these shifts in private investment are most welcome, they are not sufficient to offset the much larger, continuing investments in traditional, long-lived, fossil fuel consuming, GHG emitting facilities.

768. *Governments* – primarily those at the national level – set the rules for the markets in which investors seek profits. If current market rules are failing to attract – or drive – private investors into lower GHG emitting, more climate-proof alternatives, there are a variety of steps governments can take to help address these market failures, including:

- *Overcoming policy-based barriers to entry* by:
  (1) requiring regulated, monopoly providers (such as electricity grids) to provide access to and purchase power from providers that use lower carbon sources of energy on financially attractive terms;
  (2) reducing or removing subsidies to dirtier, less efficient energy production and/or use (such as subsidies for fossil fuel consumption or production); and
  (3) reducing or removing standards that inhibit implementation of lower carbon solutions (such as the building codes and energy efficiency or zoning codes and higher density, mixed use developments);
- *Making the polluter pay (internalizing externalized costs)* by:
  (1) imposing GHG emission limits or performance standards on production operations and products (such as vehicle emission standards);
  (2) imposing taxes or other charges on GHG emissions or fossil fuel use (such as a tax on coal use); and
  (3) holding polluters liable for the climate damage they cause;
- *Paying the innovator (internalizing externalized benefits)* by:
  (1) creating tradable rights to reward investments in reducing GHG emissions (such as a cap and trade regime);
  (2) offering fiscal incentives for investing in lower carbon methods (such as production tax credits for renewable energy); and
  (3) providing direct public support for lower carbon activities (such as funding for research and development);
- *Filling information gaps* by:
  (1) requiring disclosure of data on GHG emissions from production operations or energy use by products;
  (2) supporting voluntary efforts to make such data available; and
  (3) directly providing data helpful to potential investors (such as on wind resources or investment incentives).

Box IX-16. Brazilian government initiatives to leverage private sector financing

PROINFA (the Brazilian Alternative Energy Sources Incentive Programme) was implemented in 2004 in order to diversify the Brazilian electricity generation portfolio. Phase A of the programme established a target 3.3 GW of installed capacity through wind, biomass and mini-hydro projects by the end of 2008. A further 3.3 GW is due to be added by 2012. The Brazilian National Bank for Social and Economic Development (BNDES) earmarked USD 2.5 billion to finance up to 80 per cent of the total cost of contracted projects through indirect and direct loans with a maximum 12-year tenor. Eletrobras (Public Electricity Utility) guarantees power purchase agreement contracts for 20 years for projects using alternative sources and established generous feed-in tariffs.

769. Such policy mechanisms are being adopted by governments around the world – at the international level (Kyoto Protocol – carbon markets), regional level (EU support for renewable energy), national level (China's renewable energy goal), state level (state and regional' GHG cap and trade programmes in the United States) and local level (municipal procurement requirements for cleaner buses). Examples of developing countries applying these approaches in the renewable energy sector are provided in TABLE 31-ANNEX V. These policy tools can also be used across many different sectors – as shown in TABLE 32-ANNEX V.

770. By using these policy mechanisms to tilt the playing field toward lower carbon, more climate-proof investments, governments can encourage private investors to shift their investments to attractive opportunities in more climate-friendly assets.

771. The carbon markets and policies to promote renewables are already playing an important role in shifting investment flows. This is indicative of how quickly investment flows can respond to changes in policies and incentives.

772. Some of the existing *funding sources under the Convention and its Kyoto Protocol* are already providing incentives for the development and implementation of climate change related policies. The financial mechanism of the Convention may be used to support the development of such policies. The programme of activities in the CDM has the potential to promote the implementation of policies to a larger number of investors. The potential of these mechanisms would need to be enhanced significantly to leverage the needed shifting from private sector investments. See BOX IX-17.

773. *Additional options* that could be considered at the intergovernmental process could include efforts to:

- Collect and disseminate the experience of governments, particularly those in developing countries, to use policies to increase private investment in climate-friendly approaches;
- Promote dialogue with investors on how policy approaches affect their investments and how they might be changed to increase their investment further.

774. *Multilateral Development Banks (MDBs)* can stimulate shifts of private investments in clean energy and more climate resilient development, for example, by providing guarantees for investment risks that private investors would not take. The IFC is developing "the Carbon Delivery Guarantee" to guarantee delivery of carbon credits from projects in developing countries, thus eliminating project delivery risk for buyers. Under the Clean Energy and Investment Framework, MDBs have been collaborating to develop proposals for partial risk (credit) guarantees to private lenders and bondholders to cover debt service payments for clean energy projects based on future carbon credit cash flows (World Bank, 2006).

775. MDBs can also promote demonstration projects or commercialization of new clean technologies.

776. As further elaborated below in the chapter on optimizing resources, sharing risks among private and public, domestic and external sources can also shift investment flows.

Box IX-17. **Example of projects by the GEF supporting shifts in private financing**

The **India Alternate Energy project** was started in 1991 by the World Bank and the GEF to promote commercialization of wind power and solar PV technologies in India. The project was designed to strengthen government policies to promote wind power through special tax incentives. In just a few years, 968 MW of wind farms were installed and operating in India, almost all commercial and privately operated. Highly favorable investment tax policies strongly influenced these commercial installations. The wind industry jumped from three companies to 26, many of them joint ventures. Technology development and exports accelerated and costs declined.

The GEF-sponsored **China Energy Conservation Project** implemented by the World Bank started in 1998 and established three pilot energy service companies (ESCOs) in Beijing, Liaoning, and Shandong to promote investments in energy efficiency projects through energy performance contracting. Currently the project is replicating the initial experience and promote the development of new ESCOs in China through the creation of a self-sustaining ESCO Association and by establishing a commercial loan guarantee program to provide partial risk guarantees to local financial institutions which lend to the ESCOs. By end of 2006, almost 1,500 energy efficiency projects had been completed, with total investments exceeding USD 550 million. These projects have resulted in the reduction of energy use by 2.8 million tons of coal equivalent a year. More importantly, the China Energy Conservation Project has been instrumental in promoting the market-based energy performance contracting mechanism in China and in creating an ESCO industry that has flourished rapidly. Membership in ESCO Association has grown rapidly and reached more than 200 by the end of 2006.

9.3.1.2. SHIFT OF PUBLIC INVESTMENTS AND FINANCIAL FLOWS

777. *Governments* also need to shift their own investments. Governments are responsible for 10 – 25 per cent of the investment in new physical assets. Most of those investments are driven by local development priorities, whether they are jobs, power, transport, education, health or other public benefits. For developing countries, in particular, shifting funding to climate change has to take social and development priorities into account.

778. The challenge is to shift more public investment into lower carbon, more climate-proof measures without sacrificing development priorities. Integrating climate change adaptation and mitigation considerations into national planning (such as considering investments in clean technology in energy planning or costs associated with climate change impacts in new infrastructure, such as bridges or roads) is part of the solution.

779. Targeted measures can also help shift public investment while contributing to development priorities, for example:

- Removing existing subsidies from fossil fuels and promoting cleaner and more efficient energy use;
- Removing existing subsidies from unsustainable land uses;
- Integrating energy efficiency into new government buildings and facilities.

See BOX IX-18.

Box IX-18. Examples of government funding to promote renewable energy

The government of China is supporting a wide range of renewable technologies, including small hydropower, biogas, solar hot water systems, photovoltaic and wind generation. It provides subsidies of about USD 125 million a year for household biogas systems, and is investing heavily in its Village Electrification Programme, aiming to provide electricity to 27 million people by 2010 at an estimated cost of USD 2.5 billion. India, too, has renewable energy programmes coordinated by the Ministry for New and Renewable Energy (MNRE). In 2005, the MNRE had a budget of USD 137 million, 35 per cent of which was destined for rural electrification. Egypt, Malaysia, Mexico, the Philippines, South Africa and Thailand also have government funding programmes for renewable energy. In December 2006, Thailand's Ministry of Natural Resources and Environment set up a USD 300 millions fund to support small renewable energy projects under the Very Small Power Producers Programme.

780. The mechanisms of *the Convention and its Kyoto Protocol* and carbon markets can also play an important role. The CDM can, for example, provide an opportunity for governments to implement GHG emissions mitigation projects. The financial mechanism can assist developing countries in integrating climate change adaptation and mitigation into long-term national planning. See example in BOX IX-19.

781. *Additional options* that could be considered in the intergovernmental process could include efforts to:

- Publicize examples of the co-benefits of investments in lower GHG emitting, more climate-proof projects;
- Shared experiences, particularly South – South, on the benefits and risks associated with shifting more investment into lower GHG emitting, more climate-proof projects.

782. *MDBs* can shift their own investments by integrating climate change risks and costs of adaptation and mitigation into their lending practices. The World Bank has estimated that 20 to 40 per cent of ODA and public concessional finance (USD 20 to USD 40 billion per year) is subject to climate risk and only a small portion of ODA takes this risk into account in project planning. The Bank is currently developing a climate risk assessment tool to assess development projects for their potential sensitivity to climate change.

783. Shifting MDB investment and financial flows to more climate-resilient and cleaner energy can complement and reinforce development goals. Examples of their recent initiatives include (World Bank, 2007):

- The African Development Bank is developing a Clean Energy Investment Framework that is to be combined with support to increase access to energy;
- The Asian Development Bank is supporting the development of sustainable transport systems in Asia and has developed a USD 1 billion annual Energy Efficiency Initiative through a proposed Asia Pacific Fund;
- The Inter-American Development Bank has launched a Sustainable Energy and Climate Change Initiative to promote renewable energy and energy efficiency, biofuels, access to carbon finance, and adaptation;
- The European Bank for Reconstruction and Development launched a Sustainable Energy Initiative to more than double its energy efficiency and cleaner energy investments to EUR 1.5 over the next three years;
- The European Investment Bank is supporting research, development and demonstration in renewable energy.

784. To promote further initiatives of this type from MDBs, it will be important to consider at the intergovernmental level means for:

- Developing country Party access to the new types of support being offered by the MDBs;
- MDBs to cover the additional costs of climate change in lending/support programmes to provide incentives for cleaner technologies and more climate-proof projects.

Box IX-19. Example of a clean development mechanism project activity implemented by a local government – São João Landfill Gas to Energy Project

The São João Landfill Gas to Energy is a project between the municipality of São Paulo and Biogás Energia Ambiental S.A. It is designed to explore the landfill gas produced in Aterro Sanitário "Sítio São João", which is one of the biggest landfills in Brazil. The annual average emission reductions over the crediting period is estimated 816,940 tonnes CO_2 eq emission reductions. The landfill is located in the metropolitan region of São Paulo, Brazil's biggest and heavily indebted city with liability today around USD 9,2 billion. The administration of the city has been seeking partnerships and new ways to boost investment and improve life quality in the area. As a participant in this project, the municipality will receive 50 per cent of revenues to be earned through emissions reductions commercialization, an income to be used for new investments in landfill installations and rubbish dumps recovery.

9.3.2. SCALE UP FUNDING

785. A significant increase (USD 248 – 381 billion) will be needed in investment and financial flows to mitigate and adapt to climate change. Much of this will be required for adaptation (USD 49 – 171 billion), but substantial amounts are also required for mitigation measures (such as technology development and deployment (USD 35 – 45 billion), forestry (USD 21 billion) and agriculture (USD 35 billion)).

786. The capacity of national governments, in developing countries in particular, to increase pools of financing is limited. For private investment and finance, expansion of the international carbon markets or provision of other economic incentives to invest more in specific sectors, particularly in developing countries, will therefore be needed. For public investment, expansion of the climate-focused funding from Annex II Parties (in accordance with Article 4, paragraph 3 of the Convention), as well other potential sources of funding to address climate change, will be needed.

9.3.2.1. EXPANDED INTERNATIONAL CARBON MARKET

787. Although the international carbon market has generated a large amount of investment (about USD 30 billion including CDM and JI) for cleaner technologies in a very short period, its scale would need to be increased considerably to finance the additional investments needs for mitigation (USD 200 – 210 billion) in 2030.

788. Proposals to expand the international carbon market should consider the following factors:

- The increase in the demand is largely determined by the aggregate emission reduction resulting from limits on GHG emissions established at the national and international level and by the national policies implemented to comply with these limits;
- The increase in the investment flows to developing countries is limited by the potential and costs of eligible mitigation measures in those countries and requirements to maintain the environmental integrity of the system (additionality, preventing double counting, etc.);
- The carbon market directs investment to mitigation measures for which the revenue from the sale of credits has the biggest impact on profitability. The investment flows stimulated will differ across mitigation measures. Stimulating specific types of mitigation measures may require complementary measures or different mechanisms, as explained in the CHAPTER IX.3.3 on optimizing investments and financial flows;
- Policy certainty is important for investors. A longer agreement increases the range of mitigation measures that are attractive investments.

789. Most proposals for expansion of the international carbon market for non-Annex I Parties focus on the CDM, increasing the supply of credits from countries with a non-binding target or none at all. The suggestions include both expansion of the types of projects eligible under the CDM and possible new mechanisms.

790. Suggestions for expansion of the CDM include:

- HFC-23 destruction projects at new HCFC-22 plants;
- CO_2 capture and storage;
- Tradable credits for reduced emissions from deforestation in developing countries (REDD);
- Tradable credits for sustainable development policies and measures (SD-PAMs);
- Sectoral CDM;
- Policy CDM.

791. Other options for REDD, SD-PAMs and sectoral targets propose financial or other incentives, rather than tradable credits.

792. Numerous new mechanisms, such as no lose targets, sectoral targets and REDD targets, have been proposed. The mechanisms would differ from the CDM in terms of the process for approving the target and/or issuing the tradable credits, or they would create tradable credits that are not fully fungible with CERs. The operational details of most of these proposed mechanisms remain to be developed. If Parties agree to any of these mechanisms, there would be a need for modalities to define baseline emissions and verify the actual emissions to determine the credits earned.

793. If the international market in 2030 involves an annual demand of 400–600 Mt CO_2 eq from non-Annex I Parties – the low estimate – the scope for expansion or new mechanisms is small.

794. If the international market in 2030 involves an annual demand of 4,000–6,000 Mt CO_2 eq from non-Annex I Parties – the high estimate – all of those options could be accommodated. To supply such a demand, a large fraction of the potential emission reductions, from all existing and some new categories of projects, would need to earn credits. It would probably require enhanced mechanisms to capture many of the reductions cost-effectively.

795. Experience with the CDM to date indicates that a market mechanism is very effective at identifying the most cost-effective mitigation measures. It is also clear that the stimulus provided by the market varies significantly across project types, owing to the inherent economics of, and the administrative, operational and management challenges raised by, each project type. For example, HFC-23 destruction projects have been more profitable and easier to implement than transportation efficiency projects.

796. Any market mechanism will provide a differential stimulus across eligible project types. Therefore there is merit in considering different mechanisms for different project types, whether reduced deforestation, CCS, SD-PAMs, or sectoral targets. That allows the methology and administrative process to be tailored to the needs of the projects. The disadvantage of adopting different mechanisms for different project types is possible fragmentation of the market.

797. A consultative event with private sector investors held in London on 21 June 2007 revealed that expansion of global carbon markets is constrained primarily by the absence of long-term political certainty over the existence and stringency of the GHG reduction targets to post 2012.

798. Among the options that the COP might consider for the international carbon market are the following:

- Taking a long-term perspective (i.e. adopting policies with 20–30 year time horizons) to stimulate investments with significant sustainable development benefits;
- Strengthening existing governance institutions by making them more independent of political processes and more attuned to the needs of private carbon market actors;
- Addressing technology and country risks by supporting the development of risk guarantees and other risk sharing mechanisms;
- Reducing the transaction costs associated with project-by-project approvals where possible.

9.3.2.2. ADAPTATION FUND

799. The revenue generated for the Adaptation Fund by the share of proceeds depends on the quantity of CERs issued and the price of CERs. Funding for the Adaptation Fund for post 2012 depends on the continuation of the CDM and the share of proceeds and the level of demand in the carbon market. Assuming that the share of proceeds for adaptation continues to apply post 2012, the level of funding could be of USD 100–500 million per year for a low demand by Annex I Parties in 2030 for credits from non-Annex I Parties and USD 1–5 billion per year for a high demand.

800. In either case, the revenue generated for the Adaptation Fund would be small in relation to the estimated needs for adaptation. The Adaptation Fund could be further expanded with additional sources of funding.

9.3.2.3. FINANCIAL MECHANISM OF THE CONVENTION

801. The role of financial mechanisms as a source of funding has been mainly as a catalyst for adaptation and mitigation actions. While the funding for the climate change focal area in the GEF Trust Fund and in the LDCF and SCCF is small relative to the other sources of public investment in climate change, they have demonstrated the ability to catalyse larger investments (about 5 times as large). Other GEF focal areas (biodiversity, land degradation and international waters) also play an important catalytic role in financing adaptation and mitigation activities, such as the protection of ecosystems.[133]

802. Funding from the GEF is available as a grant and can be used for higher risk, longer term projects (such as the commercialization of new technology) and project development costs for which other sources of funding are typically very difficult to obtain. The GEF can also play an important role in promoting capacity-building on the ground.

803. As mentioned in CHAPTER VIII, replenishment of the GEF depends on voluntary contributions from donors and, in the case of the Convention, on how much Annex II Parties allocate to the financial mechanism in accordance with their obligations under Article 4, paragraph 3, of the Convention. The fourth review of the financial mechanism should start at COP 13 and as part of this review, the COP is expected to make an assessment of the amount of funds necessary to assist developing countries and provide an input to GEF 5.[134]

804. If the funding available to the financial mechanism remains at its current level and continues to rely mainly on voluntary contributions, it will not be sufficient to address the future financial flows estimated to be needed for adaptation and mitigation. In that context, in addition to addressing the need for increased resources it will be key to define what role the GEF as financial mechanism of the Convention should play.

9.3.2.4. EXPANDED CLIMATE FUNDS FROM DONOR COUNTRIES

805. In addition to increasing their contributions to the financial mechanism of the Convention, Annex II Parties can increase their bilateral aid and contributions to multilateral funds to address climate change. According to information available in the fourth national communications of Annex II Parties, about USD 11.5 billion was made available to multilateral funds and USD 8.5 billion to bilateral funds between 2001 and 2003.[135]

806. While ODA investments were only 0.23 per cent of global investment in year 2000, ODA plays an important role in countries with little capacity to leverage domestic and international private investments (rising to over 2 per cent in Africa and over 6 per cent in LDCs) and for technologies or project types where risks are still high for private sector investments (for example in sectors such as health, coastal zones and water supply, most of the financial flows needed for adaptation cannot consist of simple shifts of investment flows and will need to rely on additional external sources of financial flows).

807. Increased financial flows from bilateral donors and multilateral lenders to governments in developing countries for policy development and implementation in sectors that can mitigate and adapt to climate change is also important. Data on ODA, official aid and other lending to developing countries and countries in transition for policy and administration is summarized in TABLE 34-ANNEX V. Funding for policies in the agriculture and energy alone accounts for half of the total flow to all nine sectors. Asia received over two-third of the total ODA for policy development and administration, while Africa and Latin America received 23 per cent and 31 per cent respectively.

[133] Please refer to CHAPTERS IV.2.5 and V.2.4 of this paper.

[134] Decision 2/CP.12.

[135] Because the information in the national communication reports of Annex II Parties is limited, the exact amount of multilateral and/or bilateral contributions oriented to climate change activities is difficult to estimate. Detailed information can be found in the upcoming compilation and synthesis report of fourth national communications of Annex II Parties (in preparation).

9.3.2.5. OTHER POTENTIAL SOURCES OF FINANCIAL FLOWS

808. Other potential options to generate additional funds to address climate change could be considered, including possibilities originally suggested for other purposes (see TABLE IX-66). Brief descriptions of the options are provided in ANNEX IV.

809. Any of these options would, of course, require further analysis and agreement at the intergovernmental level. The main value of this list is to illustrate the availability of possible new sources of funds to address climate change that could generate revenues commensurate with the additional needs. Negotiations on a future regime could consider, inter alia, new commitments, new funding options, and needs that would be funded by the Convention.

9.3.3. OPTIMIZE THE ALLOCATION OF THE FUNDS

810. In addition to shifting and scaling up funding, the allocation of available resources needs to be optimized. How the available funds are allocated across different projects depends on three major factors:

- *The sources of investment,* as public and private investors differ in their preference for risk and return over time;

Table IX-66. **Illustrative options for raising additional revenue for addressing climate change**

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

Abbreviations: CDM = clean development mechanism, ERU = emission reduction units, AAU = assigned amount units, *RMU = removal units, IMF = International Monetary Fund*

- *The technology/project* into which the investment is going, as opportunities vary in the risks they present, both generally (technology risk) and specifically (project risk);
- *The host country* of the investment, as countries vary in their attractiveness to investors (country risk).

811. Understanding the interplay among these factors and their implications with regard to how different sources of capital can be used to cover the risks facing different investments is critical to optimizing the use of the available funds.

9.3.3.1. OPTIMIZING SOURCES OF INVESTMENTS – OPPORTUNITIES FOR PARTNERSHIPS

812. Each type of investor – public or private – has its own preference for risk and reward over time. Each investment involves technology, project (sector and location), country and other risks. Different private investors are prepared to bear these risks if the expected return is commensurate. If the risks are too high or the returns are too low, public investment or financial support may be needed. Major differences in preferences for risk and return over time are shown in TABLE IX-67.

813. Allocating investment risks across the parties/sources most willing and able to manage them is a key feature of successful investment in any sector. For example, an investment in a wind farm in a developing country could involve equity investment coming from privately held or publicly listed companies; debt financing from the banks or bond markets; export credits and other insurance from public or private sources, and possibly public grants.

814. Investment partnerships to distribute the risks to the entities best able to bear them while providing each with a reasonable return over time is the key to optimizing the use of the funds available.

815. Some risks are best borne by the private investors involved (e.g. commercial risks). Some can be addressed by governments through the policy and investment frameworks they set. Still others can be taken by MDBs and other sources of public money.

816. The large number of different sources of capital, with varying preferences for risk and return, creates opportunities to bring different sources of capital together to cover the cost of any particular investment, in particular using the public sector's focus on social returns to attract private investors to activities that generate both social and financial returns.

817. Understanding these drivers will be key in defining what new mechanisms need to be developed under the Convention and how existing mechanisms can better complement each other.

Table IX-67. **Investment preferences**

		Grants		Debt		Equity	
Investor capacity/preference	**Direct public investment**	**Public**	**Private**	**Public**	**Private**	**Public**	**Private**
Total pool	Large	Small	Small	Medium	Large	Small	Large
Returns sought							
Social	High	High	High	High	Low	High	Low
Financial	None	None	None	Low	Medium	Medium	High
Risks taken							
Project	Yes	Yes	Yes	Some	Little	Some	Yes
Technology	Little	Yes	Yes	Some	No	Yes	Yes
Country	Yes	Yes	Yes	Some	Some	Yes	Some
Duration of investment	1-100+ years	1 to 5 years	1 to 3 years	1 to 100+ years	1 to 10+ years	1 to 100+ years	3 to 7 years

Source: Gentry, B. 2007.

9.3.3.2. OPTIMIZING SOURCES TO TECHNOLOGIES AND PROJECTS

TECHNOLOGIES

818. While many of the *technologies* needed to help mitigate climate change are already available, new technologies still need to be developed, and both existing and new technologies will have to be installed in new locations. The risks associated with the state of development of a technology (technology risk) and the specific risks facing the project that deploys a technology (project risk) need to be addressed.

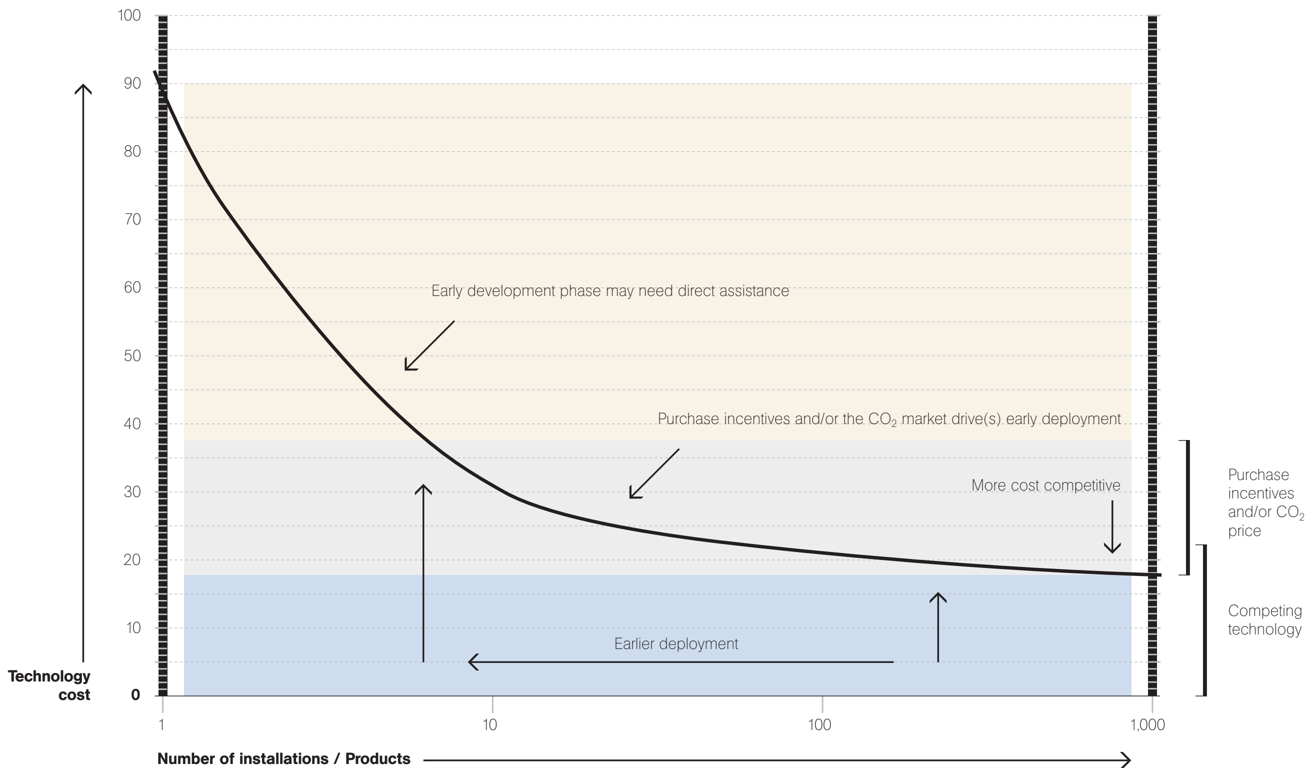
819. Each technology presents different risks at different points in its lifecycle. As shown in FIGURE IX-41, early stage technologies often require some form of public R&D funding before a private venture capitalist may step in for commercialization. Even proven technologies require purchase incentives to overcome the higher costs during early deployment.

820. *The process and financing of innovation varies radically across sectors.* For information technology and pharmaceuticals, for instance, the rapid technological change is largely financed by the private sector. However, private investors may not consider research into treatments for diseases whose prevalence may be increased by climate change to be a priority. Public funding might then be required for research into the treatment of such diseases.

821. *Public* funding makes a significant contribution to energy R&D. Since the early 1990s, private sector funding for energy R&D has declined, while public funding declined and then recovered to roughly the same level. Much higher levels of energy R&D will be needed to develop the technologies needed to mitigate GHG emissions.

822. Research for the agriculture sector also involves a mix of public and private investment. Governments provide more than 90 per cent of the funds in developing countries and less than half of the funds in developed countries.

Figure IX-41. **Technology cost and financing curve**



Source: Kirkman A *et al.*, 2007.

823. The risks facing any particular technology change as it moves through its *lifecycle* – from research to development, demonstration and deployment. The sources of investment also change according to the life cycle. The returns to public investment in a technology shift from entirely social to both social and financial as it moves closer to commercialization and the private investment share of research investment typically increases.

PROJECTS

824. Efforts to install and operate a technology will face risks associated with the sector and the location (project risk).

825. *Different sectors* present different risks at the project level, for example:

- The major obstacles to private investment in water supplies include: the low rates of return; the capital-intensive nature of the sector; and the political sensitivity of the sector. Renewable energy projects linked to the electricity grid need long-term agreements for the purchase of their output;
- Although energy efficiency measures can be financed from the energy savings through performance contracts, most efficiency improvements are financed internally by the industry or building owner. As a result implementation of energy efficiency measures must overcome barriers related to the initial financial and availability of the appropriate technologies;
- Most of the abatement opportunities from methane capture in developing countries still face barriers related to lack of awareness of, and experience with, alternative technologies; poor economics at smaller landfills; and limited infrastructure for use of the captured gas use in some regions. Over 100 landfill gas projects have been proposed under the CDM, but the emission reductions achieved have been far lower than projected;
- Before large-scale implementation of CCS can occur, further technology development is required, mainly in CO_2 capture. Public funding will be needed for early installations to help reduce costs. Finally, the long-term liability issues will need to be resolved. The expectation is that the CO_2 will remain in the reservoir for thousands of years. The legal responsibility of entities operating CCS reservoirs must be clearly defined if they are to be able to attract the required investment.

826. *Vulnerable locations:* As the impacts of climate change become more obvious, particularly through extreme weather events, more investors are starting to ask how those risks can be shared. The damage caused by climate related events can be financed in various ways, from within the country or internationally. Funds can be provided by public finances, or the private sector, and within those through contractual arrangements like insurance, or informally through charitable relief. In the last resort, the damage may be taken as a loss of assets or income by the victims.

827. The increased risks due to climate change have led insurers to make major modifications to their risk profiling and coverage strategies. Catastrophic risk insurance has been treated as a yearly business, with premiums being reviewed every year based on the most recent experience. Insurers have also withdrawn from high-risk zones or areas recently struck by catastrophic events. Increasing insurance costs and declining coverage have led to protests by consumers and political interventions on their behalf.

828. As a result, interest is growing among *governments and MDBs* in using a wider range of risk management instruments, particularly catastrophe bonds and weather derivatives, to help address the macro-economic financial impact of disasters. This is because it has become clear that ex-post financing is inefficient for several reasons (e.g. tardiness, impact on other projects, uncertainty), while insurance also has some deficiencies, principally lack of continuity of coverage and terms. A particular example of this new approach is the Caribbean Climate Risk Insurance Facility (CCRIF) (see BOX IX-20).[136]

829. As exemplified by the CCRIF, a public-privat partnership seems to be an appropriate model for insuring climate risk in many developing countries – as public resources are limited and there are significant barriers to private investment. The most important attractions for the private sector are the prospects for a positive profit margin and scale.

[136] Dlugolecki A. 2007.

Box IX-20. **Caribbean Catastrophe Risk Insurance Facility**

The Caribbean Catastrophe Risk Insurance Facility (CCRIF) is being established under the coordination of the World Bank to provide member states with index-based insurance (cat bonds) against government losses caused by natural disasters.
It represents an important shift from disaster response to ex-ante disaster management and mitigation. Governments will purchase catastrophe coverage to provide them with a cash payment within one month after a major hurricane or earthquake. These funds are intended to meet a portion of the immediate liquidity problems that face governments in the aftermath of a disaster.

Pooling risk among 15 countries has enabled the premiums to be reduced by about 50 per cent from the aggregate value of the individual premiums, due to the benefit of non-correlated risks, even within a relatively small area like the Caribbean. The Facility will be created with the premiums from participating countries and substantial assistance from donors (USD 47 million). For poorer countries, the fees will be subsidized or contributed by donors. For tax efficiency, CCRIF will be domiciled in the Cayman Islands.

9.3.3.3. OPTIMIZING SOURCES BY HOST COUNTRY CAPACITY

830. Country risks play a major role in investment decisions by foreign investors and lenders. Different regions vary dramatically in the types of investment capital they attract and the returns expected. Many of these differences can be explained by the characteristics of the national investment markets involved. UNCTAD has developed an investment compass to help countries understand how they rate on factors relevant to investment decisions by foreign direct investors.[137]
The key variables include:

- Resource assets, including human and natural (raw materials, resources) capital, as well as market size;
- Infrastructure, including both basic (transport, water, power) and telecommunications;
- Operating costs, reflecting items such as wages, rents and electricity tariffs;
- Economic performance and governance, including economic growth rates, current account balance, unemployment, country debt rating, rule of law and political stability;
- Taxation types and levels, along with investment incentives;
- Regulatory framework for foreign investors, including entry, operating and exit requirements.

831. A similar analysis by Ernst & Young ranks countries according how attractive they are to investors in renewable energy projects (Ernst & Young, 2007). The ranking criteria include measures of both natural and social capital, such as:

- The “Renewables Infrastructure Index”, covering items such as: electricity market regulatory risk; planning and grid connection issues; and access to finance;
- “Technology Factors”, including:
  power off-take attractiveness; tax climate; grant/soft loan availability; market growth potential; current installed base; resource quality; and project size.

832. Similarly, the mitigation or adaptive capacity of countries is now being measured by factors such as: economic resources; technology; information and skills; infrastructure; institutions; and equity. Such factors are increasingly being considered by private investors as they choose locations for their projects, as well as by national governments as they review their development and adaptation goals. Such differences in institutional structures and basic infrastructure increase the difficulties of adapting to climate change in many poor communities.

833. The result is a spectrum across countries, from those able to attract substantial investment from the global capital markets to those more dependent on domestic capital and ODA. A country that can tap a range of investment sources has many more options for financing a large clean power generating facility.

834. This spectrum of capacity means different roles for public and private capital across different countries. Countries with good access to global capital markets can focus public investment on priority areas and attract private capital for other investments. Countries with little or no access to private capital – locally or globally – need to use domestic and international public capital for a much wider range of investments.

Box IX-21. Example of possible assistance by MDBs in addressing country risks – The Multilateral Investment Guarantee Agency

As a member of the World Bank Group, the Multilateral Investment Guarantee Agency (MIGA) mission is to promote FDI into developing countries to help support economic growth, reduce poverty, and improve people's lives. Concerns about investment environments and perceptions of political risk often inhibit foreign direct investment, with the majority of flows going to just a handful of countries and leaving the world's poorest economies largely ignored. MIGA addresses these concerns by providing three key services: political risk insurance for foreign investments in developing countries, technical assistance to improve investment climates and promote investment opportunities in developing countries, and dispute mediation services to remove possible obstacles to future investment. Since its inception in 1988, MIGA has issued nearly 850 guarantees worth more than USD 16 billion for projects in 92 developing countries. MIGA specializes in facilitating investments in high-risk, low-income countries – such as in Africa and conflict-affected areas.

9.3.3.4. WHAT CAN BE DONE TO IMPROVE THE COMPLEMENTARITY OF AVAILABLE FUNDS

835. As shown in this chapter it is important to optimize allocation of funding and factor in various preferences by different sources of funding for risks and returns. Some can be addressed by governments through the policy and investment frameworks they set and some can be taken by IFIs and other sources of public money.

836. *Governments* can increase the diversity of the sources of capital available through the policy and investment frameworks they establish. Attracting more private (domestic and foreign) investment to climate mitigation and adaptation projects means that they require less government funding, and ODA in developing countries can then be redirected to social needs. Policy and investment frameworks that can attract more private capital include:

- Tailored policies for different types of projects, such as secure access with fair prices for renewables supplying the electricity grid and mandatory energy efficiency standards for buildings, appliances and equipment;
- Policies that promote diversification of the domestic financial market; and
- Measures to make the country more attractive to foreign private investors.

837. In considering how to enhance existing sources of funding and what new sources could be developed, it will be important that *Parties:*

- Understand what roles different sources can play and how they can best complement each other. The sources of funding in the Convention and its Kyoto Protocol could be better focused and made more effective by considering where:
  - The investment markets are failing to deliver sufficient public and private investment; and
  - The global structure of the COP and the Convention provides a comparative advantage.
- Support and participate in the efforts to bring government officials, investors and NGO representatives together to find new financing and policy approaches to bringing more investment to addressing climate issues.

838. *MDBs* can play also play an important role in layering- in funding in areas where risks are likely not to be taken by other sources.

[137] <http://compass.unctad.org/Page1.egml?country1=&country2=®ion=&sessioncontext=202061216&object=SC.app.objects.methodology> (accessed July 19, 2007).

9.4. CONCLUSIONS

839. In developing options for long-term cooperative action for improving the potential of investments and financial flows to address climate change, it will be important to consider that:

- Future actions to address climate change have to consider measures to increase global investment and financial flows. This increase is large compared with the existing funding in the Convention and its Kyoto Protocol but is small compared with global GDP (0.3 – 0.5 per cent) and investments (1.1 – 1.7 per cent) in 2030;
- Needs for future investment and financial flows to address climate change are very different across sectors and regions. Solutions to provide the necessary incentives to address needs will require better use and complementarities of sources of available investment and financial flows;
- Changes in patterns in future investments and financial flows need a combination of actions by the intergovernmental process (including under the UNFCCC process and under other processes such as International Financial Institutions), national governments and private sector (including corporations and households);
- Solutions will also require a combination of:
  - Policy frameworks, national and international, that increase the economic and financial attractiveness of investments in clean energy technologies and emission reduction measures, such as carbon markets or feed in tariffs;
  - Incentives and assistance to developing countries in establishing environments to change investment and financial flows towards addressing climate change;
  - Policy frameworks, national and international, that regulate GHG emissions and promote their reduction;
  - Options for scaling up additional financial flows, from existing and new sources, that allow adequate and sustainable financing of developing country needs, in particular in areas such as adaptation, forestry and technology deployment;
- Collaborative efforts in R&D on low GHG emitting technologies and better understanding the costs and opportunities of adaptation and mitigation measures.

840. As the first ever effort to collect and present data on projected, climate-related investments under reference and mitigation scenarios, it is not surprising that this study encountered many gaps in the existing data. The questions of whether and how to fill any of these gaps should also be considered by the Parties.

841. The results of this analysis present the complexity of the systems involved – across investors, sectors, technologies, locations and other factors. This is to be welcomed, as a more nuanced view of the opportunities and barriers facing investments in a more sustainable climate future is important to making progress.

842. At the same time, Parties cannot be expected to engage in detailed investment analyses when negotiating the post-2012 climate agreement. Parties could negotiate an international framework that enhances international mechanisms, such as the international carbon market, the financial mechanisms of the Convention and its Kyoto Protocol, and other sources of funding, and encourages Parties to develop and implement national policies that shift private and public investment and financial flows toward lower GHG emitting and more climate proof options.

843. While it is important for the Parties to be aware of and consider the implications of these complexities in their deliberations, it is even more critical that some widely supported, relatively simple and actionable themes be developed around which the structure of the post-2012 agreement can be shaped. Doing so will give the investment community both the rules it needs to predict risks and returns, as well as the room it needs to innovate for realizing both financial and social returns.

ANNEX

ANNEX I
REGION DEFINITIONS[1]

AFRICA
Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libyan Arab Jamahiriya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, SouthAfrica, Saint Helena, Sudan, Swaziland, United Republic of Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.

DEVELOPING ASIA
Afghanistan, American Samoa, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Chinese Taipei, Cook Islands, Democratic Peoples' Republic of Korea, Fiji, French Polynesia, Guam, Hong Kong (China), India, Indonesia, Kiribati, Lao Peoples' Democratic Republic, Macau (China), Malaysia, Maldives, Marshall Islands, Micronesia, Mongolia, Myanmar, Nauru, Nepal, New Caledonia, Niue, Northern Mariana Islands, Pakistan, Palau, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Sri Lanka, Thailand, Timor-Leste, Tokelau, Tonga, Vanuatu, Viet Nam, Wallis and Futuna.

LATIN AMERICA
Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Islas Malvinas), Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, Tuvalu, Uruguay, Venezuela, British Virgin Islands.

MIDDLE EAST
Bahrain, Islamic Republic of Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestinian Administrative Areas, Qatar, Saudi Arabia, Syrian Arab Rebublic, United Arab Emirates, West Bank and Gaza, Yemen.

OECD EUROPE
Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, Turkey, the United Kingdom of Great Britain and Northern Ireland.

OECD NORTH AMERICA
Canada, Mexico, the United States of America.

OECD PACIFIC
Australia, Japan, New Zealand, Republic of Korea.

OTHER EUROPE
Andorra, Channel Islands, Faroe Islands, Greenland, Isle of Man, Liechtenstein, Monaco, San Marino.

TRANSITION ECONOMIES
Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Estonia, Georgia, Gibraltar, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Malta, Republic of Moldova, Montenegro, Romania, Russian Federation, Serbia, Slovenia, Tajikistan, The former Yugoslavia Republic of Macedonia, Turkmenistan, Ukraine, Uzbekistan.

PARTIES INCLUDED IN ANNEX I TO THE CONVENTION
Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom of Great Britain and Northern Ireland, the United States of America.

PARTIES NOT INCLUDED IN ANNEX I TO THE CONVENTION
Afghanistan, Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Burkina Faso, Burundi, Cambodia, Cameroon, Cape Verde, Central African Republic, Chad, Chile, China, Colombia, Comoros, Congo, Cook Islands, Costa Rica, Côte d'Ivoire, Cuba, Cyprus, Democratic Peoples' Republic of Korea, Democratic Republic of the Congo, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Ethiopia, Fiji, Gabon, Gambia, Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, India, Indonesia, Islamic Republic of Iran, Israel, Jamaica, Jordan, Kazakhstan, Kenya, Kiribati, Kuwait, Kyrgyzstan, Lao Peoples' Democratic Republic, , Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta,

Marshall Islands, Mauritania, Mauritius, Mexico, Micronesia, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nauru, Nepal, Nicaragua, Niger, Nigeria, Niue, Oman, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Qatar, Republic of Korea, Rwanda, Samoa, San Marino, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia and Montenegro, Seychelles, Sierra Leone, Singapore, Solomon Islands, South Africa, Sri Lanka, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Sudan, Suriname, Swaziland, Syrian Arab Republic, Tajikistan, Tanzania, Thailand, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkmenistan, Tuvalu, Uganda, United Arab Emirates, Uruguay, Uzbekistan, Vanuatu, Venezuela, Viet Nam, Yemen, Zambia, Zimbabwe.

LEAST DEVELOPED COUNTRIES[2]

Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Cape Verde, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Laos, Lesotho, Liberia, Madagascar, Malawi, Maldives, Mali, Mauritius, Mozambique, Myanmar, Nepal, Niger, Rwanda, Samoa, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, Sudan, Tanzania, Timor-Leste, Togo, Tuvalu, Uganda, Vanuatu, Yemen, Zambia.

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[1] The list of countries and territories was created based on World Bank World Development Indicator 2006 and OECD, Creditor Reporting System online database 2007. Regional groupings are primarily based on IEA World Energy Outlook 2006. For countries, territories and administrations not included in the World Energy Outlook regional groupings, the Central Intelligence Agency's World Fact Book was used.

[2] Based on United Nations classification, UNSTAT 2006.

ANNEX II DESCRIPTION OF DATA AND DATA SOURCES

This annex describes the data and estimation procedures used to calculate current investment flows. All data are for 2000 unless otherwise specified.

2.1. GROSS DOMESTIC PRODUCT

Gross domestic product (GDP) at purchaser's prices is the sum of the gross value added by all resident producers in the economy plus any product taxes and less any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current USD. USD figures are converted from domestic currencies using single year official exchange rates.

Data sources: World bank (2006a) and UNSTAT (2006). The UNSTAT data were used for those countries for which there was no data in the WDI report.

2.2. GROSS FIXED CAPITAL FORMATION

Gross fixed capital formation (GFCF) includes land improvements (fences, ditches, drains, etc.); plant, machinery and equipment purchases; and the construction of roads, railways, schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. According to the 1993 System of National Accounts prepared by the Inter-Secretariat Working Group on National Accounts, net acquisitions of valuables are also considered capital formation. Data are in constant 2000 USD.

Data sources: World Bank (2006a) database and UNSTAT(2006). The UNSTAT data were used for those countries for which there was no data in the WDI report.

A total GFCF value was not available for 91 countries. Missing values were estimated using a regression equation. Regression analysis was conducted using the observed values of GFCF with GDP as the explanatory variable. The equation was estimated using data for countries comparable in terms of GDP and population to the countries with missing GFCF values. The 90th percentile values for population (= 22 million) and GDP (= USD 18 billion) were determined for the 91 countries lacking data on GFCF. The sample of countries used to estimate the regression equation was limited to countries with a population of less than 22 million and GDP of less than USD 18 billion. The estimated regression equation is:

$$\mathbf{GFCF_i = 26.869 + 0.1959\ GDP_i}$$
$$\mathbf{(R^2 = .89,\ t\text{-}test = 27.242)}$$

The median ratio of predicted GFCF: GDP is 0.2096.

The predicted GFCF values for Kiribati, Marshall Islands, Nauru and Tuvalu appeared to be implausible outliers. To estimate the GFCF for those countries the sample was restricted to nine very small countries (population no greater than 200,000) for which GFCF data were available. The ratio of observed GFCF: GDP for those nine countries has a median value of 0.2746 (75th percentile = 0.42) and no value greater than 0.493. Thus, the GFCF estimate for Kiribati, Marshall Islands, Nauru and Tuvalu is estimated at 27,46 per cent of GDP.

2.3. GROSS FIXED CAPITAL FORMATION BY ECONOMIC SECTOR

The economic sectors for which GFCF data are available are:

1. Agriculture, hunting and forestry; fishing;
2. Mining and quarrying;
3. Manufacturing;
4. Electricity, gas and water supply;
5. Construction;
6. Transport, storage and communications;
7. Financial intermediation; real estate, renting and business activities;
8. Wholesale retail trade, repair of motor vehicles, motorcycles, etc.; hotels and restaurants;
9. Public administration and defence; compulsory social security;
10. Education; health and social work; other community, social and personal services.

Data source: UNSTAT (2006). Data in the national currency were converted to USD using the 2000 exchange rates from the International Financial Statistics (IFS) database of the International Monetary Fund (IMF).

GFCF data by economic sector were available for only 53 countries, but they accounted for 87.8 per cent of total GFCF. GFCF by sector was estimated for the remaining countries as follows:

Type 1 countries provide a complete set of data for deriving the regression model. There are 35 countries in this category, representing 21.4 per cent of global GFCF. A best-fit model was derived by carrying out regression analyses for the share of GFCF for each sector ('sector share') against the corresponding sector value added (also in share terms), for 2000 and lagged values for 1998 and 1995, per capita GDP and per capita GDP squared. The estimation was constrained so that the sector shares add up to 1.0.

Type 2 countries provide complete sector GFCF data but could not be used in the regression model because of missing data for some explanatory variables. There are 18 countries in this category, representing 66.4 per cent of global GFCF.

Type 3 countries are those for which the regression model was used to predict the sector shares. Predicted sector shares were then multiplied by the total GFCF to estimate the predicted sector GFCF. There are 69 countries in this category, representing 4.6 per cent of global GFCF.

Type 4 countries are those for which the regression model predicted some negative sector shares. Sector GFCFs in such instances were set equal to zero. Setting the negative sector shares to zero results in a sum for the remaining shares that is greater than 1.0. The remaining positive sector shares were scaled to equal 1.0. This resulted in a small adjustment to the GFCF sector values of those countries. There were 39 such countries in this category, representing 5.7 per cent of global GFCF.

Type 5 countries are those for which information on the explanatory variables is missing, making it impossible to predict sector shares using the regression model. Sector GFCFs for those countries were predicted by applying the mean sector share of countries for which such information is available. There were 51 countries in this category, representing 1.3 per cent of global GFCF.

Details of the statistical analysis will be made available upon request.

2.4. GROSS FIXED CAPITAL FORMATION BY SOURCE

The GFCF sources for which data were available are as follows:

1. Household (including non-profit institutions serving households);
2. Corporations (financial and non-financial);
3. Government.

Data source: UNSTAT (2006). Data in the national currency were converted to USD using the 2000 exchange rates from the IFS database of the IMF.

GFCF data by sources was available for only 48 countries, but they accounted for 89.1 per cent of total GFCF. GFCF by source was estimated for the remaining countries as follows:

Type 1 countries provide a complete set of data for deriving the regression model. There are 48 countries in this category, representing 89.1 per cent of global GFCF. A best-fit model was derived to estimate the unobserved values. GFCF by source was regressed against per capita GDP and a set of regional dummy variables (with the North America set as the base category). The estimation procedure was constrained to ensure that the total source shares add up to 1.0.

Type 2 countries have source GFCF data but were used in the regression model because of missing explanatory variables. Only six countries, representing 0.4 per cent of global GFCF, fell into this category.

Type 3 countries are those for which the regression model was used to predict source shares of GFCF. Predicted source shares were multiplied by total GFCF to determine predicted GFCF by source GFCF. This category included 77 countries representing 6.9 per cent of the world GFCF.

Type 4 countries are those for which the regression model predicted some negative source shares. The negative source shares were set to zero and the remaining positive values were scaled to add up to 1.0. The adjusted source shares were multiplied by total GFCF to determine GFCF by source. This category included 63 countries, representing 3.4 per cent of global GFCF.

Type 5 countries are those for which information on per capita GDP is missing, making it impossible to predict source shares using the regression model. Source GFCF for such countries was predicted by applying the mean source

share of countries for which such information was available. This category includes 18 countries, representing 0.1 per cent of global GFCF.

Details of the statistical analysis will be made available upon request.

2.5. POPULATION

Data source: World Bank (2006a).

2.6. FOREIGN DIRECT INVESTMENT, NET INFLOWS

Foreign direct investment (FDI) is the net inflows of investment to acquire a lasting management interest (10 per cent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital and short-term capital as shown in the balance of payments.

Data sources: World Bank (2006a), World Bank (2006b) and ADB (2006).

2.7. FOREIGN DIRECT INVESTMENT BY ECONOMIC SECTOR

Data source: UNCTAD (2006a).

2.8. INTERNATIONAL DEBT SECURITIES BY RESIDENCE OF ISSUER BY SOURCE AND SECTOR, NET ISSUES

The Bank for International Settlements (BIS) definition of international securities (as opposed to domestic securities) is based on three major characteristics of the securities: the location of the transaction, the currency of issuance and the country of residence of the issuer. International issues comprise all foreign currency issues by residents and non-residents in a given country and all domestic currency issues launched in the domestic market by non-residents. In addition, domestic currency issues launched in the domestic market by residents are also considered international issues if they are specifically targeted at non-resident investors. However, due to the lack of information from commercial data providers, notes and money market instruments issued by non-residents in a domestic market in the currency of that market (foreign issues) are not included.

Data source: BIS (2007a).

The *country of residence of issuer* geographical classification distinguishes borrowers according to their geographical location; this is consistent with the approach taken in the BIS locational banking statistics and, more generally, with balance of payments methodology.

In the *sectoral breakdown,* “governments” comprise central governments, other governments and central banks. “Financial institutions” comprise commercial banks and other financial institutions. The international debt securities data include “repackaged securities”, for example the new global issues of Argentina, resulting from the April 2005 exchange offer. Repackaged securities that are exclusively domestically targeted are allocated to the domestic debt securities database. For the Republic of Korea, new data series have been taken into account.

Data source: BIS (2007b).

2.9. INVESTMENT IN INFRASTRUCTURE PROJECTS BY COMMERCIAL BANKS

Only projects with financial closure during the specified year were considered.

Data source: Dealogic Ltd (2007).

2.10. CROSS-BORDER MERGERS AND ACQUISITIONS BY SELLER/PURCHASER

FDI is a balance-of-payments concept involving the cross-border transfer of funds. Cross-border merger and acquisition (M&A) statistics shown in the paper are based on information reported by Thomson Financial. In some cases, these include M&A between foreign affiliates and firms located in the same host economy. Such transactions conform to the FDI definition as far as the equity share is concerned. However, the data also include purchases via domestic and international capital markets, which should not be considered FDI flows. Although it is possible to distinguish types of financing used for M&A (e.g. syndicated loans, corporate bonds and venture capital), it is not possible to trace the origin or source countries of the funds used. Therefore, the data used in the paper include the funds not categorized as FDI.

FDI flows are recorded on a net basis (capital account credits less debits between direct investors and their foreign affiliates) in a particular year. In contrast, M&A data are expressed as the total transaction amount of particular deals, rather than differences between gross acquisitions

and divestment abroad by firms from a particular country. Transaction amounts recorded in the UNCTAD M&A statistics are those at the time of closure of the deals, not at the time of announcement. The M&A values are not necessarily paid out in a single year. Cross-border M&A is recorded in both directions of transactions; that is, when cross-border M&A takes place, it is registered as a sale in the country of the target firm and as a purchase in the home country of the acquiring firm (see for example Annex tables B.4 and B.5 in UNCTAD 2006b). Data showing cross-border M&A activities on an industry basis are also recorded as sales and purchases. Thus, if a food company acquires a chemical company, this transaction is recorded in the chemical industry in the columns on M&A by industry of seller and in the food industry in the columns on M&A by industry of purchaser.

Data source: UNCTAD (2006b).

2.11. PRIVATE INVESTMENT IN ENERGY, TRANSPORT AND WATER

Private investment in energy covers infrastructure projects in energy (electricity and natural gas transmission and distribution) that have reached financial closure and directly or indirectly serve the public. Movable assets and small projects such as windmills are excluded. The types of project included are: operations and management contracts; operations and management contracts with major capital expenditure; greenfield projects (in which a private entity or a public-private joint venture builds and operates a new facility); and divestitures. Data are in current USD.

Data source: World Bank (2007).

2.12. OFFICIAL DEVELOPMENT ASSISTANCE

Net official development assistance (ODA) consists of disbursements of loans made on concessional terms (net of repayments of principal) and grants by official agencies of the members of the Development Assistance Committee (DAC) of the Organisation for Economic Co-operation and Development, by multilateral institutions and by non-DAC countries. The aim of ODA is to promote economic development and welfare in countries and territories in part I of the DAC list of recipients.[3] It includes loans with a grant element of at least 25 per cent (calculated at a rate of discount of 10 per cent). Net official aid refers to aid flows (net of repayments) from official donors to countries and territories in part II of the DAC list of recipients: more advanced countries of Central and Eastern Europe, the countries of the former Soviet Union, and certain advanced developing countries and territories. Official aid is provided under terms and conditions similar to those for ODA.

Only infrastructure-related ODA flows in different sectors defined in the Creditor Reporting System database of the OECD were considered for capital investment analysis.

Data source: OECD (2007).

2.13. TOTAL RESERVES (FOREIGN EXCHANGE)

Total reserves comprise holdings of monetary gold, special drawing rights, reserves of IMF members held by the IMF and holdings of foreign exchange under the control of monetary authorities. The gold component of these reserves is valued at year-end (December 31), London prices. Data are in current USD.

Data source: World Bank (2006a).

[3] The list is available at: <http://www.oecd.org/document/45/0,3343,en_2649_34447_2093101_1_1_1_1,00.html>.

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ANNEX III WORLD HEALTH ORGANIZATION REGIONS

Region grouping used for the analysis of the climate change impact on health	WHO Region and mortality stratum	Description	Broad grouping	Member states
Africa				
Africa	Afr-D	Africa with high child and high adult mortality	High-mortality developing	Algeria, Angola, Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Comoros, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Madagascar, Mali, Mauritania, Mauritius, Niger, Nigeria, San Tome and Principe, Senegal, Seychelles, Sierra Leone, Togo
	Afr-E	Africa with high child and very high adult mortality	High-mortality developing	Botswana, Burundi, Central African Republic, Congo, Cote d'Ivoire, Democratic Republic of Congo, Eritrea, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, Namibia, Rwanda, South Africa, Swaziland, Uganda, United Republic of Tanzania, Zambia, Zimbabwe
Americas				
America-A	Amr-A	Americas with very low child and very low adult mortality	Developed	Canada, Cuba, United States of America
America-B	Amr-B	Americas with low child and low adult mortality	Low-mortality developing	Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela
South-East Asia				
South-East Asia-A	Sear-B	South-East Asia with low child and low adult mortality	Low-mortality developing	Indonesia, Sri Lanka, Thailand
South-East Asia-B	Sear-D	South-East Asia with high child and high adult mortality	High-mortality developing	Bangladesh, Bhutan, Democratic People's Republic of Korea, India, Maldives, Myanmar, Nepal, Timor-Leste

(continued)

Region grouping used for the analysis of the climate change impact on health	WHO Region and mortality stratum	Description	Broad grouping	Member states
Europe				
Europe	Eur-A	Europe with very low child and very low adult mortality	Developed	Andorra, Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden, Switzerland, United Kingdom
	Eur-B	Europe with low child and low adult mortality	Developed	Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Georgia, Kyrgyzstan, Poland, Romania, Serbia and Montenegro, Slovakia, Tajikistan, The former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Uzbekistan
	Eur-C	Europe with low child and high adult mortality	Developed	Belarus, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine
Eastern Mediterranean				
Eastern Mediterranean	Emr-B	Eastern Mediterranean with low child and low adult mortality	Low-mortality developing	Bahrain, Islamic Republic of Iran, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates
	Emr-D	Eastern Mediterranean with high child and high adult mortality	High-mortality developing	Afghanistan, Djibouti, Egypt, Iraq, Morocco, Pakistan, Somalia, Sudan, Yemen
Western Pacific				
Western Pacific-A	Wpr-A	Western Pacific with very low child and very low adult mortality	Developed	Australia, Brunei Darussalam, Japan, New Zealand, Singapore
Western Pacific-B	Wpr-B	Western Pacific with low child and low adult mortality	Low-mortality developing	Cambodia, China, Cook Islands, Fiji, Kiribati, Lao People's Democratic Republic, Malaysia, Marshall Islands, Micronesia (Federated States of), Mongolia, Nauru, Niue, Palau, Papua New Guinea, Philippines, Republic of Korea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, Viet Nam

ANNEX IV POSSIBLE SOURCES OF EXPANDED FUNDING

4.1. EXTENSION OF THE SHARE OF PROCEEDS TO THE JOINT IMPLEMENTATION AND INTERNATIONAL EMISSIONS TRADING MECHANISMS

The Adaptation Fund receives a 'share of proceeds' equal to 2 per cent of the number of certified emission reductions (CERs) issued for a clean development mechanism project. These are to be used to assist non-Annex I Parties that are particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation.

The idea of expanding the same concept to other Kyoto Protocol mechanisms (joint implementation and international emissions trading) was tabled by some Parties during negotiations on the Marrakesh Accords and recently considered further in some proposals for a post-2012 agreement, including the São Paulo Proposal and the Future Actions Dialogue from the Centre of Clean Air Policy.

TABLE 1-ANNEX IV presents estimates of applying 2 per cent of the share of proceeds to international transfers of emission reduction units (ERUs), removal units (RMUs) and assigned amount units (AAUs) for different periods based on the projections for the carbon markets presented in CHAPTER VII of the paper.

During the Kyoto Protocol commitment period, the share of proceeds is projected to contribute annual revenue of 2006 USD 80–200 million to the Adaptation Fund. If the revenue from extending the share of proceeds is projected to contribute annual revenue of 2006 USD 80 – 200 million to the Adaptation Fund. If the revenue from extending the share of proceeds to international transfers of ERUs, AAUs and RMUs were contributed to the Adaptation Fund, its revenue would be increased by 10 – 25 per cent.

The estimate of the revenue raised by the existing share of proceeds after 2012 depends on the number of Parties that adopt commitments, the types of commitment adopted and the stringency of the commitments. The international sales of CERs could be worth 2006 USD 5 – 25 billion (low estimate) or 2006 USD 90 – 125 billion (high estimate) per year, and the corresponding revenues generated by a 2 per cent share of proceeds could be 2006 USD 100 – 500 million or 2006 USD 1.8 – 2.5 billion per year.

Trade among Parties with commitments depends on the commitment adopted by each country relative to the cost-effective mitigation measures available domestically. The post-2012 commitments of Parties would necessarily be arbitrary assumptions, so the revenue generated by extension of the share of proceeds is not estimated.[4]

[4] For background information please refer to the literature from the Centre for Clean Air Policy (2007) and BASIC (2006).

Table 1. **Possible levels of funding for a 2 per cent share of proceeds**

Period	Share of proceeds of CERs issued	Potential share of proceeds of international transfers of ERUs, AAUs and RMUs
2010		
Units (million/year)	300 – 450	40 – 100
Market value (2006 USD million/year)	4,000 – 15,000	500 – 2,250
Share of proceeds (2006 USD million/year)	80 – 300	10 – 50
2030		
Low estimate		Not available. Depends on commitments adopted relative to cost-effective mitigation measures
Market value (2006 USD million/year)	5,000 – 25,000	
Share of proceeds (2006 USD million/year)	100 – 500	
High estimate		
Market value (2006 USD million/year)	50,000 – 250,000	
Share of proceeds (2006 USD million/year)	1,000 – 5,000	

Abbreviations: Abbreviations: AAUs = assigned amount units, CERs = certified emission reductions, ERUs = emission reduction units, RMUs = removal units.

4.2. AUCTION OF ALLOWANCES FOR INTERNATIONAL AVIATION AND MARINE EMISSIONS

The European Commission has proposed including CO_2 emissions from international aviation in the European Union emissions trading scheme. The São Paulo Proposal suggests that allowances for international bunkers could be auctioned.

Greenhouse gas emissions associated with international air and marine transport are rising rapidly and are currently not regulated. CO_2 emissions from fuel used for international air and marine transport could be regulated by the Conference of the Parties (COP) in conjunction with relevant agencies, such as the International Civil Aviation Organization and the International Maritime Organization. Aircraft and ship operators would need to provide allowances equal to their CO_2 emissions. An allocation of AAUs or equivalent allowances could be established by the COP to cover these emissions. The allowances could be sold by auction.

Emissions from international aviation are projected to grow at a rate of 4.5 per cent per year from 2000 through 2030 and those from international marine transport are projected to grow at a rate of 2.4 per cent per year. A requirement to hold allowances for the emissions would promote the adoption of emission reduction measure by aircraft and ship operators and encourage development of more energy efficient aircraft and vessels, which could reduce aviation emissions by about 15 per cent and marine emissions by about 20 per cent by 2030 (Kahn and Kobayashi, 2007).

The total allowance allocation for each sector should be less than the projected emissions after implementation of the reduction measures. Participants would purchase CERs, ERUs or other units to cover the balance of their emissions. Auctioning allowances equal to the projected international aviation and marine emissions could generate revenue of USD 22 billion in 2010, rising to USD 35 billion in 2030. The COP can decide how to use the revenue from the auctioned allowances.

Table 2. **Estimate of potential revenue from an auction of greenhouse gas emission allowances for international aviation and marine bunkers**

	2010	2020
BAU international aviation emissions (Mt CO_2)	450	725
Potential emission reductions (Mt CO_2)	–	75
Total (Mt CO_2)	**450**	**650**
BAU international marine emissions (Mt CO_2)	500	625
Potential emission reductions (Mt CO_2)	–	75
Total (Mt CO_2)	**500**	**550**
Price (2006 USD/t CO_2 eq)	23.60	23.60
Aviation revenue (2006 USD billion)	10	15
Marine revenue (2006 USD billion)	12	13
Total revenue from international bunkers (2006 USD billion)	22	28

Sources: Den Elzen *et al.*, 2007; Kahn and Kobayashi, 2007.
Abbreviation: BAU = business as usual.

4.3. INTERNATIONAL AIR TRAVEL LEVY

As mentioned above, emissions associated with international air transport are rising rapidly and are currently not regulated. Müller and Hepburn (2006) suggest that these emissions be addressed through an international air travel adaptation levy (IATAL) or an emissions trading scheme with auction revenues hypothecated for adaptation. Here the focus is on the amount of revenue that might be raised rather than how the funds would be used.

The IATAL is a charge based on the (per capita) flight emissions levied on the flight ticket price. IATAL would reduce emissions where demand is price elastic[5] and raise revenue where demand is not elastic. Müller and Hepburn estimate that a low levy (such as the charges introduced by France of 5 per cent on first and business class tickets to raise funds for fighting HIV/Aids and other pandemics) would yield EUR 3 – 6 billion annually; they estimate the social cost of aviation emissions at EUR 25 billion annually.

Müller and Hepburn suggest that the IATAL levy reflect a combination of revenue-raising and emission-reducing objectives and be set at an average EUR 5 (USD 6.5) per passenger per flight, to generate EUR 10 billion (USD 13 billion) annually.

4.4. FUNDS TO INVEST FOREIGN EXCHANGE RESERVES

In the *Report of the Eminent Persons Group to The President of the Asian Development Bank* (ADB, 2007) it is suggested that Asian countries consider alternative strategies for investing their foreign exchange reserves since their current strategies could be costing them revenue.

Currently, most foreign exchange reserves are invested in government, mainly American, treasury bills with low yield and significant exchange risk. "Some analysts estimate that in local (appreciating) currency terms, the returns from these reserves are close to zero. Given the large reserves-to-GDP ratio of many Asian countries, the current investment strategies could be costing the countries between 1.5 and 2 per cent of GDP each year." (ADB, 2007)

Countries could transfer a small part of their foreign exchange reserves to the care of funds, similar to carbon funds, which would invest in energy efficiency, renewable energy and other mitigation measures. As in the case of carbon funds, a fund could invest reserves contributed by a single country or by several countries. The investor(s) would establish the policies of the fund such as eligibility of investments and target return on investment.

With an appropriate mix of investments it should be possible to maintain the value of the reserves contributed and earn a small return. A fund would provide some diversification in the foreign exchange reserve investments, but would be less liquid than treasury bills. Liquidity is important for foreign exchange reserves, so only a small part of the total, less than 5 per cent, could prudently be contributed to such funds.

Global foreign exchange reserves at the end of 2004 totalled 2004 USD 3,941 billion. Contributing 5 per cent of the reserves to funds would provide capital of 2004 USD 197 billion.[6]

[5] Demand for a good or service is "elastic' if it declines by more than 1% due to a 1% price increase. Demand is inelastic if it declines by less than 1% due to a 1% price increase. A price increase for a good or service with an inelastic demand increases the total revenue.

[6] For background information, please refer to World Development Indicators 2006 (World Bank, 2006).

4.5. ACCESS TO RENEWABLES PROGRAMMES IN DEVELOPED COUNTRIES

A number of developed countries have programmes to promote renewable energy, including feed-in tariffs, renewables obligations and targets with renewable energy certificates. One motivation for these programmes is the environmental benefits of renewable energy. Reduction of GHG emissions is one such benefit.

Recognizing that the climate change mitigation benefits of GHG emissions reductions do not depend on the location of reductions, such programmes could allow a share, say 5 per cent, of the renewable energy supply to be met by sources in developing countries that meet the programme requirements. Specifically verified deliveries of power by eligible renewable sources in developing countries would receive certificates. Entities with compliance obligations under a renewables programme could purchase certificates to a maximum of 5 per cent of their compliance obligation. A five per cent share of the renewable energy programmes in Annex I Parties in 2005 would have provided approximately USD 500 million for renewable energy technologies in non-Annex I Parties.

Eligibility could be extended to include coal- or gas-fired generation with carbon dioxide capture and storage.

Further research is needed to estimate the value of the different renewable energy programmes.

4.6. TOBIN TAX

James Tobin proposed a currency transaction tax as a way to enhance the efficacy of national macroeconomic policy and reduce short-term speculative currency flows. Owing to the large volume of international currency transactions, even a low tax would generate substantial revenue.

Whether such a tax would reduce or increase exchange rate volatility has been debated in the literature. While this issue is not resolved, there appears to be consensus that the tax rate should be 0.1 per cent or lower to minimize the loss of liquidity and adverse impacts on the trade volume and market structure.

Although a currency transaction tax is widely accepted as being technically feasible, how it could best be implemented and enforced is still debated. However, the biggest barrier to implementation of a currency transaction tax is the global political consensus needed for universal adoption.

There are numerous estimates of the revenue that a currency transaction tax could generate. They vary widely owing to differences in the assumed tax rate, in the proposals for how the tax would be implemented (e.g. all transactions or end-of-day open positions) and in the estimated change in trade volumes due to introduction of the tax. The estimates range from less than USD 50 billion to almost USD 200 billion.

Nissanke (2003) assumes that the tax rate would need to be low for both political reasons (i.e. to achieve universal adoption) and technical reasons (i.e. to minimize market disruption and tax evasion). She estimates that a tax of 0.01 per cent applied to wholesale transactions would generate revenue of 2003 USD 15–20 billion while a tax of 0.02 per cent would generate annual revenue of 2003 USD 30–35 billion.

4.7. SPECIAL DRAWING RIGHTS

In the run-up to the 2002 United Nations International Conference on Financing for Development, George Soros of Soros Fund Management and Joseph Stiglitz of Columbia University proposed that the International Monetary Fund (IMF) authorize a new form of special drawing rights (SDRs) to meet a share of the estimated USD 50 billion needed for the United Nations Millennium Development Goals (MDGs). SDRs are a form of intergovernmental currency provided by the IMF to serve as a supplemental form of liquidity for its member countries.

Under the proposal, the IMF would allocate new SDRs to all member countries. Under the assumption that developed countries do not need the additional liquidity, they would be expected to make their new SDRs available to approved international non-governmental organizations (NGOs) to distribute to meet specific MDGs. For the first time, these pre-approved international NGOs would be permitted to hold SDRs that they could convert to hard currencies. They would be responsible for distributing the hard currencies to other NGOs to implement MDG projects at the local and national levels. The proposal received considerable attention during the conference, prompting a number of OECD (Organisation for Economic Co-operation and Development) countries to commission studies and policy papers on the idea.
A modification of the proposals from Soros and Stigliz (2002) might be envisaged to incorporate climate mitigation and adaptation. The IMF board could propose to member states that a new issuance of SDRs to recognized NGOs, particularly in concert with a post-2012 agreement, would

be consistent with the requirements for stability in the international economic markets. The proposal could be implemented in two stages. First, a special SDR issu of USD 27 billion authorized by the IMF in 1997 would be released, of which approximately USD 18 billion would be donated. The second stage is annual issues of SDRs, of which some would be donated.

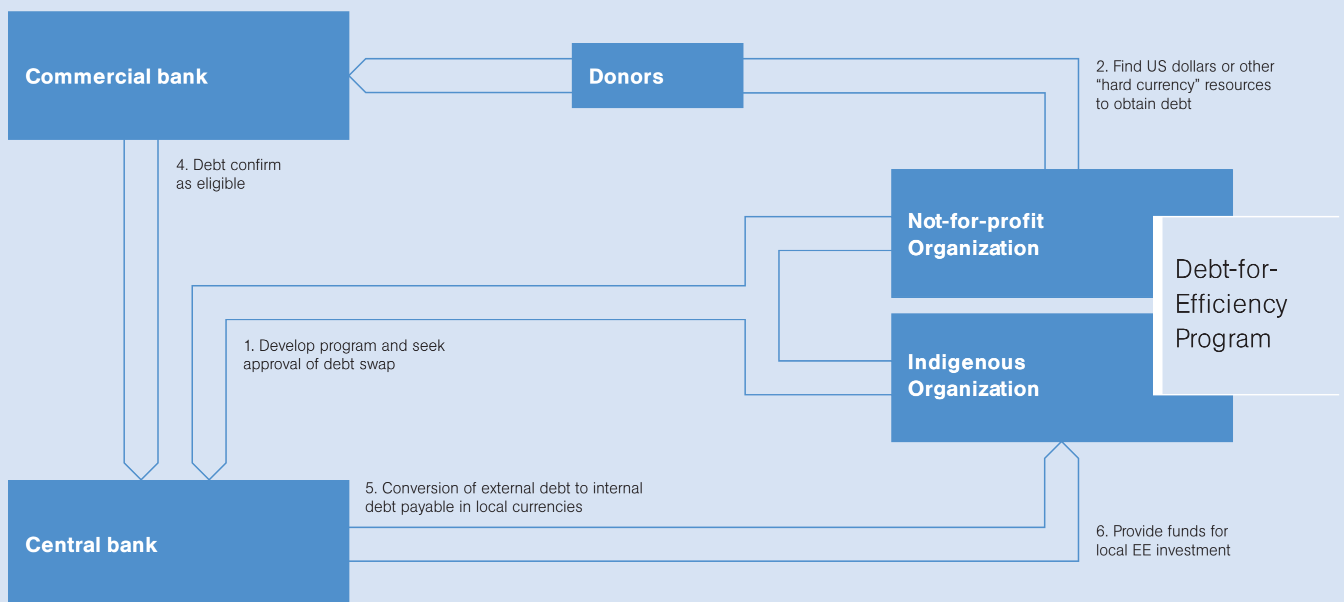
4.8. DEBT-FOR-EFFICIENCY SWAP: CONVERTING NON-PERFORMING DEBT TO RENEWABLE ENERGY AND ENERGY EFFICIENCY INVESTMENT

The development by the multilateral development banks (MDBs) of debt swap programmes between donor countries and developing countries could become an important new source of funding for public or semi-public renewable energy (RE) and energy efficiency (EE) projects, as shown in FIGURE 1-ANNEX IV.

Under debt swap programmes, creditors negotiate agreements whereby a portion of the debt owed to them is cancelled in exchange for a commitment by the debtor government to convert the cancelled amount into local currency for investment in clean energy projects. The positive impact of debt reduction at low cost, combined with increased investment in priority sectors such as RE and EE, makes such debt conversion programmes attractive. Since proceeds from debt swaps are in local currencies, they would not qualify for payment of imported products.

Where other sources of financing can be found to pay for imported clean energy technologies, proceeds from debt-swap programmes implemented by MDBs could potentially be used to finance recurring local costs, such as salaries, project operation and maintenance, or costs associated with locally-produced hardware. Likewise, proceeds could be used as collateral to secure domestic bank financing of clean energy projects, thus increasing available sources of funding to undercapitalized project developers.

Figure 1. **Structure of a Debt Swap for Energy Efficiency or Renewable Energy**



Source: Pratt, 2007.

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ANNEX V SUPPLEMENTARY TABLES AND FIGURES[1]

Table 1. **Investment through commercial banks by different sectors in 2000 and 2005**

Sectors	2000				2005	
	GFCF, 2000 USD million	Investment, 2000 USD million	Investment as a percentage of GFCF	Debt/equity	Investment USD million	Debt/equity
Agriculture, hunting, forestry; fishing	155,322	N.A.	N.A.	N.A.	N.A.	N.A.
Mining and quarrying	123,726	10,550	8.53	80/20	12,683	83/17
Manufacturing	1,153,976	14,821	1.28	81/19	38,087	73/27
Electricity, gas and water supply	228,236	66,174	28.99	83/17	58,345	85/15
Wholesale retail trade, repair of motor vehicles, motorcycles, etc.; hotels and restaurants	551,284	N.A.	N.A.	N.A.	N.A.	N.A.
Construction	388,732	N.A.	N.A.	N.A.	N.A.	N.A.
Transport, storage and communications	788,368	112,064	14.21	82/18	47,894	84/16
Financial intermediation; real estate, renting and business activities	2,316,125	1,034	0.04	75/25	195	100/0
Public administration and defense; compulsory social security	552,059	3,776	0.68	88/12	5,138	92/8
Education; health and social work; other community, social and personal services	617,391	1,208	0.20	94/6	3,533	91/9
Total	6,875,219	209,628	3.05	82/18	165,875	85/15

Data Sources: Dealogic (2007).
Note: No data available for 2005 GFCF at the time of study.
Abreviation: GFCF = Gross Fixed Capital Formation.

[1] All figures are expressed in 2005 United States dollars unless otherwise stated.

Table 2. **Investment through commercial banks by regions in 2000, percentage of GFCF**

Region	Mining and quarrying	Manufacturing	Electricity, gas and water supply	Transport, storage and communications	Total including other sectors
Africa	0.97	0.27	0.17	1.39	2.92
Developing Asia	0.03	0.65	0.80	2.33	3.99
Latin America	2.19	0.39	1.77	3.21	7.62
Middle East	0.00	2.29	1.70	1.57	5.55
OECD Europe	0.03	0.05	0.75	3.50	4.53
OECD North America	0.07	0.20	1.35	0.59	2.21
OECD Pacific	0.05	0.03	0.61	0.34	1.06
Other Europe Total	0.00	0.00	0.00	23.23	23.23
Transition economies	0.05	0.23	0.14	0.10	0.51
World total	0.15	0.22	0.96	1.63	3.05
Annex I Parties	0.05	0.09	0.92	1.54	2.69
Non-Annex I Parties	0.52	0.48	1.08	1.02	3.14
Least Developed Countries	1.93	0.00	0.18	0.19	2.31

Source: Dealogic (2007).
Abbreviations: Annex I Parties = Parties included in Annex I to the Convention, Non-Annex I Parties = Parties not included in Annex I to the Convention, OECD = Organisation for Economic Co-operation and Development.

Table 3. **Sources of investment by regions in 2000**

Investments	Africa	Dev Asia	LA	Mid East	OECD Europe
Total investment, USD billion	118	804	332	140	2,067
Households (percentage)					
Total investment	19.24	16.91	21.55	25.34	28.29
Domestic	19.24	16.91	21.55	25.34	28.29
Corporations[a] (percentage)					
Total investment	54.81	72.78	66.92	64.22	59.23
Domestic	45.59	54.15	13.67	57.55	-19.52
Debt	0.48	0.01	25.57	1.09	31.87
FDI	8.75	18.61	27.68	5.58	46.87
FDI adjusted	5.41	17.90	36.81	4.84	34.29
Domestic adjusted	40.18	36.25	-23.14	52.70	-53.81
Government (percentage)					
Total investment	25.95	10.32	11.52	10.44	12.48
Domestic	23.25	8.67	3.32	7.40	11.12
Debt	0.38	0.31	7.48	2.81	1.33
ODA bilateral	1.41	0.80	0.59	0.19	0.01
ODA multilateral	0.91	0.54	0.14	0.05	0.01
Total ODA	2.32	1.34	0.73	0.24	0.02
Total (percentage)					
Total investment	100.0	100.0	100.0	100.0	100.0
Domestic	88.07	79.72	38.55	90.28	19.90
FDI	8.75	18.61	27.68	5.58	46.87
Domestic adjusted	91.41	80.44	29.41	91.02	32.48
FDI adjusted	5.41	17.90	36.81	4.84	34.29
Debt	0.86	0.33	33.04	3.90	33.21
ODA	2.32	1.34	0.73	0.24	0.02

Data Source: UNSTAT, *National Accounts Database;* BIS, 2007; World Bank, 2006, *World Development Indicator;* OECD, CRS.
Abbreviations: Dev Asia = Developing Asia, FDI = Foreign direct investment, LA = Latin America, Mid East = Middle East, OECD = Organization for Economic Co-operation and Development, OECD NA = OECD North America, TE = Transition Economies, AI Parties = Parties included in Annex I to the Convention, NAI Parties = Parties not included in Annex I to the Convention, LDC = Least Developed Countries.

[a] Combined financial and non-financial corporations.

OECD NA	OECD Pacific	Other Europe	TE	World	AI Parties	NAI Parties	LDC
2,488	1,695	2	105	7,750	6,014	1,654	40
33.34	20.51	19.43	15.90	26.38	28.52	18.69	17.92
33.34	20.51	19.43	15.90	26.38	28.52	18.69	17.92
54.44	60.86	66.10	73.18	59.99	59.99	57.45	69.11
13.84	58.44	66.10	60.38	20.78	20.78	13.26	57.28
22.27	0.13	0.00	0.61	16.81	16.81	20.20	0.02
18.33	2.29	0.00	12.19	22.40	22.40	23.99	11.81
27.49	3.14	-12.75	15.06	22.46	22.46	23.65	13.96
-13.65	55.29	78.86	45.32	-1.68	-1.68	-10.39	43.32
12.22	18.62	14.47	10.93	13.62	14.04	12.20	21.14
12.50	18.63	14.39	-15.98	12.37	13.29	9.05	15.26
-0.28	-0.01	0.00	26.28	1.03	0.74	2.12	-0.39
0.00	0.00	0.08	0.48	0.14	0.00	0.65	3.17
0.00	0.00	0.00	0.15	0.08	0.00	0.38	3.09
0.01	0.00	0.08	0.63	0.23	0.00	1.03	6.26
100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
59.68	97.58	99.92	60.29	59.54	55.07	85.02	82.05
18.33	2.29	0.00	12.19	22.40	23.99	11.81	12.00
50.52	96.74	112.67	57.42	59.48	55.41	82.87	79.45
27.49	3.14	-12.75	15.06	22.46	23.65	13.96	14.61
21.99	0.12	0.00	26.89	17.84	20.94	2.14	-0.32
0.01	0.00	0.08	0.63	0.23	0.00	1.03	6.26

Table 4. **Current and projected investment across sectors by region (percentage)**

Region	Year	World total	Total, USD billion	Agriculture, hunting, forestry; fishing	Mining and quarrying	Manufacturing	Electricity, gas and water supply
World Total	2000	100	7,750	2.3	1.8	16.8	3.3
	2030	100	22,270	1.2	0.8	15.5	1.7
Africa	2000	1.5	118	8.2	11.2	13.2	4.0
	2030	2.2	498	9.0	7.3	16.4	3.2
Developing Asia	2000	10.4	804	3.9	2.2	30.2	3.9
	2030	28.6	6,369	1.4	0.8	22.7	1.3
Latin America	2000	4.3	332	4.8	5.3	17.9	5.8
	2030	3.0	678	4.7	2.0	15.4	2.5
Middle East	2000	1.8	140	4.4	14.5	9.9	2.6
	2030	3.7	813	1.5	2.7	13.0	1.1
OECD Europe	2000	26.7	2,067	3.0	1.5	15.1	3.6
	2030	22.2	4,933	0.8	0.3	11.2	1.4
OECD NA	2000	32.1	2,488	1.0	0.8	16.3	1.9
	2030	26.8	5,970	0.6	0.4	12.4	1.5
OECD Pacific	2000	21.9	1,695	1.2	0.6	13.8	4.1
	2030	13.6	3,038	0.6	0.4	13.9	2.6
Other Europe	2000	0.0	3	4.6	4.3	16.1	5.6
	2030	0.3	56	0.6	0.1	12.3	1.4
TE	2000	1.3	103	5.0	8.8	16.0	5.4
	2030	2.0	448	1.6	2.9	14.4	1.8
NAI Parties	2000	21.3	6,014	4.1	4.2	26.8	4.1
	2030	40.9	12,918	2.1	1.5	21.0	1.4
AI Parties	2000	77.6	1,654	1.7	1.1	14.1	3.1
	2030	58.0	9,114	0.6	0.4	11.5	1.8
LDCs	2000	0.5	40	10.6	7.7	10.6	7.1
	2030	N.A	N.A.	N.A	N.A	N.A	N.A

Data Source: UNSTAT, National Accounts Database; World Bank, 2006, World Development Indicator; OECD, ENV-Linkages Model.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, Dev Asia = Developing Asia, OECD = Organization for Economic Co-operation and Development, OECD NA = OECD North Amercia, TE = Transition Economies, N-AI Parties = Parties not included in Annex I to the Convention, LDCs = Least Developed Countries.

[a] Aggregated data for the three sectors.

Transport, storage and communications	Financial intermediation; real estate, renting and business activities	Construction	Wholesale retail trade, repair of motor vehicles, motorcycles, etc.; hotels and restaurants	Public administration and defense; compulsory social security	Education; health and social work; other community, social and personal services	Total
8.0	**5.7**	**11.5**	**33.7**	**8.0**	**9.0**	**100**
19.1	**12.4**	**9.5**		**39.9[a]**		**100**
4.4	6.7	12.5	15.9	19.6	4.3	100
24.9	7.9	4.9		26.3[a]		100
5.0	14.2	16.7	11.6	7.7	4.7	100
23.3	8.9	12.1		29.5[a]		100
9.1	5.5	16.2	19.8	8.3	7.4	100
16.9	14.8	12.2		31.4[a]		100
6.4	1.3	16.3	24.2	10.2	10.0	100
24.2	1.0	14.3		42.2[a]		100
8.3	3.0	11.2	37.9	6.8	9.5	100
19.8	9.6	8.9		48.1[a]		100
11.0	6.5	10.4	32.5	9.1	10.5	100
15.3	16.7	5.9		47.2[a]		100
4.9	3.9	9.4	46.4	7.1	8.7	100
15.0	20.5	9.1		37.9[a]		100
7.5	6.0	13.3	25.5	9.6	7.5	100
19.9	0.04	9.6		56.1[a]		100
7.6	4.8	15.1	21.3	7.8	8.2	100
15.4	6.6	19.0		38.3[a]		100
4.7	12.6	15.0	14.0	8.8	5.7	100
23.5	7.5	11.8		31.1[a]		100
8.9	3.7	10.5	39.1	7.8	9.9	100
15.7	15.8	7.8		46.3[a]		100
5.5	9.7	11.9	16.8	15.1	5.0	100
N.A	N.A	N.A	N.A	N.A	N.A	N.A

Table 5. **Total emissions by sectors and years under the reference and mitigation scenario (Gt CO_2 eq)**

Scenario	Sector	2000	2005	2010	2015	2020	2025	2030
Reference scenario	Power Generation	10.22	10.73	12.31	13.99	15.18	16.35	17.48
	Industry	4.34	5.51	6.25	6.96	7.35	7.72	8.08
	Transport	5.63	6.47	7.09	7.71	8.33	8.96	9.58
	Others	3.23	4.08	4.40	4.71	4.94	5.17	5.38
	Industrial Process	0.83	1.00	1.18	1.35	1.52	1.70	1.87
	Non-CO_2	8.82	9.46	10.28	10.50	12.06	12.46	13.34
	LULUCF/Forestry	5.80	5.80	5.80	5.80	5.80	5.80	5.80
	Total	**38.87**	**43.05**	**47.31**	**51.02**	**55.19**	**58.14**	**61.52**
Mitigation scenario	Power Generation	10.22	10.61	11.44	12.04	11.42	10.04	8.08
	Industry	4.34	5.45	5.95	6.41	6.43	6.26	6.08
	Transport	5.63	6.42	6.75	7.03	7.21	7.34	7.44
	Others	3.23	4.06	4.29	4.50	4.58	4.65	4.71
	Industrial Process	0.83	0.97	1.11	1.25	1.38	1.52	1.66
	Non-CO_2	8.82	9.46	7.49	7.74	8.78	9.29	9.94
	LULUCF/Forestry including agroforestry	5.80	5.22	4.30	2.85	0.56	-3.07	-8.80
	Total	**38.87**	**42.18**	**41.33**	**41.81**	**40.35**	**36.04**	**29.11**

Abbreviations: LULUCF = land use, land use change and forestry.

Table 6. **Difference in investment between the reference and mitigation scenario in 2030 (billions of United States dollars)**

Region/Country	Energy supply		Power Generation		
	TD	Fossil fuels supply	Fossil fuel generation	CCS	Nuclear and renewable
World	-101.29	-59.05	-54.44	63.19	85.31
OECD	-48.32	-16.91	-18.42	34.68	30.30
OECD North America	-24.74	-10.19	-3.85	27.06	13.29
United States	-20.35	0.00	-1.69	26.14	10.96
Canada	-2.79	0.00	-1.53	0.03	1.69
Mexico	-1.59	0.00	-0.64	0.88	0.63
OECD Pacific	-5.05	-1.92	-1.99	1.91	6.39
Japan	-2.29	0.00	-0.89	0.40	3.25
Korea	-1.50	0.00	-1.31	0.63	1.47
Australia and New Zealand	-1.26	0.00	0.21	0.88	1.67
OECD Europe	-18.54	-4.79	-12.57	5.70	10.62
Transition Economies	-5.30	-9.67	-4.30	1.68	8.50
Russia	-0.99	-6.80	-1.73	1.19	4.40
Other EIT	-4.30	-2.88	-2.57	0.49	4.10
Developing Countries	-47.67	-32.47	-31.73	26.83	46.52
Developing Asia	-33.82	-8.87	-24.28	22.08	35.92
China	-18.03	-3.35	-10.97	17.10	19.12
India	-6.73	-0.63	-7.14	3.19	10.61
Indonesia	-1.24	-0.73	-0.83	1.43	0.72
Other Developing Asia	-7.82	-4.16	-5.34	0.37	5.48
Latin America	-6.99	-7.87	-3.03	0.57	2.15
Brazil	-2.68	-2.68	0.11	0.12	-1.23
Other Latin America	-4.31	-5.19	-3.14	0.45	3.38
Africa	-3.58	-7.80	-3.12	0.73	7.05
Middle East	-3.28	-7.93	-1.31	3.45	1.39

Abreviation: OECD = Organization for Economic Co-operation and Development, EIT = Economies in transition, TD = transmission and distribution, CCS = carbon di-oxide capture and storage.

Industry			Building and waste		Transport		
Energy efficiency	CCS in industry	Non-CO_2	Energy efficiency	Non-CO_2	Energy efficiency	Bio fuel	Total
19.50	**14.13**	**2.04**	**50.80**	**0.94**	**78.70**	**9.20**	**109.02**
11.50	**2.05**	**0.49**	**24.20**	**0.25**	**41.90**	**5.20**	**66.92**
7.45	0.63	0.32	11.52	0.16	25.30	2.40	49.34
2.95	0.56	0.13	9.64	0.10	21.10	2.30	51.84
0.55	0.05	0.02	1.28	0.02	1.80	0.10	1.22
3.96	0.02	0.17	0.60	0.04	2.40	0.00	6.47
1.65	0.80	0.07	3.45	0.03	5.20	0.10	10.63
0.05	0.55	0.00	1.99	0.01	2.50	0.00	5.57
0.20	0.18	0.01	0.93	0.01	1.50	0.00	2.11
1.40	0.07	0.06	0.53	0.01	1.20	0.00	4.77
2.40	0.63	0.10	9.23	0.06	11.30	2.70	6.84
1.92	**0.80**	**0.37**	**3.99**	**0.08**	**5.30**	**0.00**	**3.38**
0.81	0.26	0.16	2.31	0.03	3.60	0.00	3.24
1.10	0.54	0.21	1.68	0.06	1.70	0.00	0.14
6.08	**11.27**	**1.18**	**22.61**	**0.60**	**31.50**	**4.00**	**38.73**
3.59	10.69	0.69	14.40	0.36	18.90	1.60	41.27
2.19	8.62	0.42	6.82	0.14	10.60	0.80	33.46
0.80	0.98	0.15	4.06	0.12	2.00	0.20	7.62
0.21	0.21	0.04	1.11	0.03	1.70	0.20	2.86
0.39	0.87	0.08	2.41	0.07	4.70	0.40	-2.56
0.65	0.28	0.13	1.75	0.09	4.60	2.00	-5.67
0.11	0.20	0.02	0.57	0.04	2.20	2.00	-1.22
0.54	0.08	0.10	1.18	0.05	2.50	0.00	-4.35
1.13	0.27	0.22	4.45	0.09	3.60	0.30	3.34
0.72	0.02	0.14	2.01	0.07	4.30	0.00	-0.41

Table 7. **Economic value of energy subsidies in the twenty non-OECD countries with the largest primary energy consumption (billions of United States dollars), 2005**

Country	Oil products	Natural gas	Electricity	Coal	Total
Viet Nam	0.63	0.00	0.56	0.00	1.18
Nigeria	1.54	0.00	0.33	0.00	1.87
Thailand	1.74	0.48	0.86	0.33	3.40
Malaysia	3.23	0.00	0.32	0.00	3.55
South Africa	0.01	0.00	3.87	0.00	3.87
Pakistan	1.66	2.73	0.00	0.00	4.39
Argentina	0.89	4.20	1.49	0.00	6.58
Kazakhstan	1.19	3.60	0.69	1.35	6.84
Venezuela	8.10	0.00	1.13	0.00	9.22
Egypt	9.16	1.24	1.77	0.00	12.17
Ukraine	0.29	12.40	2.38	0.34	15.41
Indonesia	14.11	0.01	1.60	0.42	16.15
India	7.04	2.06	10.08	0.00	19.19
Saudi Arabia	10.07	4.27	5.40	0.00	19.74
China	6.74	3.89	6.67	7.69	24.99
Iran	24.43	9.41	2.72	0.00	36.56
Russia	0.21	25.36	14.80	0.00	40.37
Total	91.04	69.65	54.66	10.14	225.49

Source: IEA, 2006.
Notes: Subsidies in Brazil, the Philippines and Chinese Taipei are not shown, as they amount to less than USD 1 billion in each case. The aggregated results are based on net subsidies only for each country, fuel and sector. Results are converted to US dollars at market exchange rates.

Table 8. **The impact of the removal of all energy consumption subsidies in selected non-OECD countries**

Country	Average rate of subsidy (per cent of market price)	Annual economic efficiency gain (per cent of GDP)	Reduction in energy consumption (in per cent)	Reduction in CO_2 emissions (in per cent)
China	10.9	0.4	9.4	13.4
Russia	32.5	1.5	18.0	17.1
India	14.2	0.3	7.2	14.1
Indonesia	27.5	0.2	7.1	11.0
Iran	80.4	2.2	47.5	49.4
South Africa	6.4	0.1	6.3	8.1
Venezuela	57.6	1.2	24.9	26.1
Kazakhstan	18.2	1.0	19.2	22.8
Total sample	21.1	0.7	12.8	16.0
Total world	N.A.	N.A.	3.5	4.6

Source: IEA, 1999.

Table 9. **Baseline emissions for non-CO_2 GHG in agriculture sector by region in 2000 – 2030**

Country/region	2000	2005	2010	2015	2020	2025	2030
Africa	301	332	364	398	431	464	496
Annex I	1,258	1,244	1,230	1,263	1,297	1,331	1,364
Australia/NZ	104	107	109	110	111	112	113
Brazil	249	271	292	310	327	347	366
Canada	28	31	35	39	43	47	51
China	789	790	791	834	876	919	961
Eastern Europe	86	89	93	96	99	102	106
EU-15	313	304	296	299	303	307	310
India	417	429	441	461	480	496	512
Japan	65	57	49	49	50	51	51
L. America/Caribbean	210	228	246	262	278	295	312
Mexico	57	62	67	70	74	78	82
Middle East	37	42	47	50	53	57	61
Non-EU Europe	21	21	22	23	23	24	24
Non-OECD Annex I	282	268	254	264	274	284	294
OECD	1,018	1,022	1,026	1,053	1,080	1,107	1,134
OPEC	538	451	363	373	384	395	405
Russia	237	219	201	208	215	222	229
South & SE Asia	1,141	991	842	870	898	926	954
South Korea	24	23	22	23	24	25	26
Turkey	45	48	51	54	56	59	62
Ukraine	23	25	27	29	32	34	36
United States	338	345	351	361	370	378	386
World	4,563	4,490	4,417	4,619	4,822	5,025	5,227

Abbreviations: EU = European Union, GHG = greenhouse gases, NZ = New Zealand, OECD = Organisation for Economic Co-operation and Development, OPEC = Organization of the Petroleum Exporting Countries, SE = South East

Table 10. **Current/recent greenhouse gas emissions and removals in the forest sector**

		WGIII/AR4[a]	CAIT[b,g]	FAO[d]	Other sources[f]	WGIII/AR4	CAIT
Year	**UN-ECE 2000**	**Flux in 1990s (various sources reported in WGIII/AR4)**	**2000**	**2000**	**2000 – 2005 per year (average)**		
		Mt CO_2 yr^{-1}					
Unit/Region	**Mt CO_2 yr^{-1}**	**Models**	**Land observations**	**Mt CO_2**	**Forest area (x1000 ha)**	**Forest area lost (x1000 ha)**	**Forest area lost and degraded**
Asia				-3,957.1	566,562	1,003	
South America				-2,053.9	852,796	-4,251	
Central America and Caribbean				-303.2	29,543	-231	
Caribbean					5,706	54	
Central America					23,837	-285	
Oceania				-153.8	208,034	-356	
Sub-Saharan Africa			-576 (+235) -440 (+110) -1,283 (+733)	-1,398.8			
Middle East & N. Africa				-52.2			
Africa					655,613	-4,040	
Europe	316	495 (+752)	0 (+733) and 513	-32.6	998,091	661	
North America	CAN 340 USA 610	1,833 (+2,200)		338.3	677,971	-101	
World		4,767 (+5,500) 2,567 (+2,933) 4,913 9,516	-7,993 (+2,933) -4,000 -5,800 -8,485	-7,618.6	3,988,610 (In 2005 3,952,000)	-7,317[c,e]	Gross deforestation was 13.1 million ha/year in 1990s (net loss 8.9 million ha/year) 12.9 million ha/year between 2000 and 2005 (net loss 7.3 million ha/year) 2.4 million ha/year in 1990s forest degradation (FAO, 2006)

Abreviation: AR4 = IPCC Fourth Assessment Report, CAIT = Climate Analysis Indicators Tool, FAO = Food and Agriculture Organization of the United Nations, WG = Working Group, UN-ECE = United Nations Economic Commission for Europe.

[a] The table above is from the WGIII/AR4 provides annual fluxes in Mt CO_2 yr^{-1} from the UN-ECE for the year 2000 the table is contained in table 8;
[b] The CAIT database also provides Mt CO_2 yr^{-1} for 2000. In addition, the WGIII/AR4 table provides estimates for annual carbon fluxes during the 1990s based on models and on land observations;
[c] Please note the sign reversal: WGIII/AR4 indicates a sink as a positive value, whilst the CAIT tool reports emissions. For comparison reasons, the sign of the CAIT values has been changed: emissions are reported as negative values (like the WGIII/AR4 values);
[d] The dataset of the FAO for forest area and forest area lost remains the most complete data set available. FAO, 2006;
[e] According to FAO (2005) equalling 4,000 Mt CO_2 yr^{-1};
[f] No other datasets are available to compare area estimates. The lowest level of disaggregation that can be presented and compared is on the regional level but not all regions can be compared due to different groupings of countries and/or sub-regions;
[g] Most of the CAIT groupings differ from those used in section 9 from WGIII/AR4, but the estimate for sub-Saharan Africa from CAIT corresponds with the highest estimate based on land observations reported by WGIII/AR4. Most likely because both CAIT and WGIII/AR4 are using the same underlying data source from Houghton (2003). Values for the Caribbean and Central and South America of CAIT also correspond with the estimates of WGIII/AR4: the total for those regions corresponds to the lower estimate of inversion of atmospheric transport models and the highest estimate based on land observations. In general it has to be noted that the estimates vary strongly. This was concluded by the section 9 authors of the WGIII/AR4 as well.

Table 11. **Selected estimates of carbon exchange of forests and other terrestrial vegetation with the atmosphere (in Mt CO_2 per year)**

Regions	Annual carbon flux based on international statistics: UN-ECE, 2000	Annual carbon flux during 1990s: Based on inversion of atmospheric transport models	Annual carbon flux during 1990s: Based on land observations
			Mt CO_2 yr^{-1}
OECD North America		1,833 ± 2,200[i]	0 ± 1,100[e]
Separately: Canada	340	2,090 ± 3,337[b]	293 ± 733[a]
Separatedly: USA	610		
OECD Pacific	224		0 ± 733[a]
Europe	316		0 ± 733[a]
		495 ± 752[f]	513[k]
Countries in Transition	1,726	3,777 ± 3,447[b]	1,100 ± 2,933[i]
			1,181 ± -1,588[g]
Separately: Russia	1,572	4,767 ± 2,933[i]	1,907 ± 469[h]
Northern Africa		623 ± 3,593[b]	
Sub-Saharan Africa			-576 ± 235[c]
			-440 ± 110[d]
			-1,283 ± 733[a]
Caribbean, Central and South		2,310 ± 3,887[b]	-1,617 ± 972[c]
America			-1,577 ± 733[d]
			-2,750 ± 1,100[a]
Separately: Brazil			0 ± 733[l]
Developing Countries of South		-2,493 ± 2,713[b]	-3,997 ± 1,833[a]
and East Asia and Middle East			-1,734 ± 550[c]
			-1,283 ± 550[d]
Separately: China		2,273 ± 2,420[b]	-110 ± 733[a]
			128 ± 95[m]
			249[n]
Global total		**4,767 ± 5,500[i]**	**-7,993 ± 2,933[a]**
		2,567 ± 2,933[j]	**-3,300 ÷ 7,700[e]**
		4,913[b]	**-4,000[o]**
		9,516[q]	**-5,800[p]**
			-8,485[r]
Annex I Parties			
(excluding Russian Federation)			1,300[s]

Source: Nabuurs G J, IPCC, 2007c.
Abbreviations: OECD = Organisation for Economic Co-operation and Development, UN-ECE = United Nations Economic Commission for Europe, Annex I Parties = Parties included in Annex I to the Convention.
Notes: Positive values represent the sink of carbon, negative values represent source sign "÷" indicates a range of values; sign "±" indicates error term.

[a] Houghton 2003 (flux from changes in land use and land management based on land inventories).
[b] Gurney *et al.* 2002 (inversion of atmospheric transport models, estimate for Countries in Transition applies to Europe and boreal Asia; estimate for China applies to Temperate Asia).
[c] Achard *et al.* 2004 (estimates based on remote sensing for tropical regions only).
[d] De Fries 2002 (estimates based on remote sensing for tropical regions only).
[e] Potter *et al.* 2003 (NEP estimates based on remote sensing for 1982–1998 and ecosystem modeling, the range reflects interannual variability).
[f] Janssens *et al.* 2003 (combined use of inversion and land observations; includes forest, agricultural lands and peat lands between Atlantic Ocean and Ural Mountains, excludes Turkey and Mediterranean isles).
[g] Shvidenko and Nilson, 2003 (forests only, range represents difference in calculation methods).
[h] Nilsson *et al.* 2003 (includes all vegetation).
[i] Ciais *et al.* 2000 (inversion of atmospheric transport models, estimates for Russia applies to Siberia only).
[j] Plattner *et al.* 2002 (revised estimate for 1980's is 400 /700.
[k] Nabuurs *et al.* 2003 (forests only).
[l] Houghton *et al.* 2000 (Brazilian Amazon only, losses from deforestation are offset by regrowth and C sink in undisturbed forests).
[m] Fang *et al.* 2005.
[n] Pan *et al.* 2004.
[o] FAO 2006a (global net loss of biomass resulting from deforestation and regrowth).
[p] IPCC AR4, WG I, (estimates of loss of biomass from deforestation).
[q] IPCC AR4, WG I, (Residual terrestrial carbon sink).
[r] EDGAR database for agriculture and forestry (see Chapter 1, Figure 1.3a/b (Olivier *et al.* 2005)). These include emissions from bog fires and delayed emissions from soils after land use change.
[s] Olivier *et al.* 2005.

Table 12. **Global Environment Facility funding for forestry sector (millions of current United States dollars)**

	Forest conservation		Sustainable use of forests		Sustainable forestry management		
Region	**Allocated GEF funds**	**Leveraged co-financing**	**Allocated GEF funds**	**Leveraged co-financing**	**Allocated GEF funds**	**Leveraged co-financing**	**Total GEF funding**
Eastern and Southern Africa	69,655	351.27	15.12	43.33	69,872	255,904	154,647
Northern Africa	5.65	17.30			11.09	112.06	30.60
Western and Central Africa	80,085	191.37	5,841	119,347	41.79	180,251	127,716
Africa	246,775	559.94	20,961	162,677	123,752	548,355	312,963
East Asia	35.93	51.85			13.21	31.42	49.14
South and Southeast Asia	79,089	153,993	16,707	20,315	46,845	94.87	212,964
Western and Central Asia	31,865	33,485	5.56	59.46	11,435	25.73	48.86
Asia	146,884	239,328	22,267	79,775	71.49	152.02	310,964
Europe	27,051	27,189	8.14	36.24	37,482	52.80	72,673
Caribbean	2,145	11,291	0.19	0.20	0.99	0.972	3,325
Central America	80.83	193,686	13.40	57,525	49.26	212,112	143.49
North America	20.79	77.63	31,837	140,297	15,905	28,615	68,532
North and Central America	145,345	282,607	45,472	198,022	66,155	241,699	256,927
Oceania			17.55	38.75	5.09	2.20	22.64
South America	153,948	212,713	22,837	18,514	47,732	101,178	224,517
Global	1.00	4.16			45.04	59.96	
World	721,003	1,326,387	137,182	533,978	396,741	1,158,212	1,254.93

Data Sources: GEF Project Database.
Abreviation: GEF= Global Environment Facility.

Table 13. **Bilateral and multilateral Official Development Assistance in forestry policy and administrative management: Forestry development, Fuel wood, Forestry education and training, Forestry research and forestry services in 1990, 1995, 2000 and 2005 (millions of United States dollars)**

	1990			1995		2000		2005	
Region	**Bilateral**	**Multilateral**	**Other flows[a]**	**Bilateral**	**Multilateral**	**Bilateral**	**Multilateral**	**Bilateral**	**Multilateral**
Africa	217.5	25.5	134.3	47.9	6.5	85.3	39.2	61.0	86.7
AI Parties	–	–	–	–	–	–	–	0.2	–
Central Asia	–	–	–	0.2	–	2.9	–	0.5	30.0
Developing Asia	100.6	474.0	75.0	122.9	193.0	148.4	37.6	359.2	1.0
Latin America	51.4	0.0	5.8	119.3	4.0	44.9	6.0	19.6	–
Middle East	1.1	–	–	–	–	0.2	–	0.6	–
North Africa	–	7.5	84.1	0.2	–	43.9	–	0.4	–
OECD North America	0.4	–	–	4.3	–	0.5	–	0.3	–
Transition Economies	–	–	–	0.6	–	5.2	–	6.7	37.0
Developing Countries[b]	370.7	499.5	215.1	290.1	203.6	278.6	82.8	440.5	87.7

Sources: CD, Creditor Reporting System.
Abreviations: OECD = Organization for Economic Co-operation and Development.

[a] Other flows includes lending from multlilateral development institutions.
[b] Africa, Developing Asia, Latin America and Middle East.

Table 14. **Official Development Assistance by region for agriculture, forestry and fisheries with extension and research components broken out in 2000 and 2005 (millions of United States dollars)**

Region	Research 2000	Extension 2000	Total 2000	Research 2005	Extension 2005	Total 2005
Asia	13.5	46.9	1,341.4	20.5	26.6	3,475.5
Latin America and the Caribbean	9.0	10.6	2,101.4	65.8	44.7	905.7
Pacific	0.7	0.1	73.2	0.3	0.1	53.4
Europe	0.5	0.2	24.6	0.6	2.4	112.7
Africa	29.3	28.0	1,604.0	58.1	44.7	1,911.4
Others	0.0	0.0	0.2	0.0	0.0	0.9
Total	52.9	85.7	5,990.1	145.2	118.8	6,459.8

Sources: OECD, Creditor Reporting System

Table 15. **Official Development Assistance by region in water sector (infrastructure only) in 2000 and 2005 (millions of United States dollars)**

Region	Total bilateral 2000	Total multilateral 2000	Total bilateral 2005	Total multilateral 2005	Total ODA 2000	Total ODA 2005
Africa	515	367.1	489.2	749.6	780.5	1,182.5
Developing Asia	1,631.8	653	2,384	735.4	2,022.1	2,845.2
Latin America	967.9	194.1	164.7	151.6	1,028.3	297.4
Middle East	115.8	20	1,051.5	229.6	120.1	1,160.2
OECD Europe	0.6	43.8	0.1	274.4	39.4	274.5
Transition Economies	155.8	36.3	106.2	42.5	170	136.4
World Total	3,387	1,314.4	4,195.7	2,183	4,160.5	5,896.2
NAI Parties	3,311.8	1,249.9	3,353.4	1,893.5	4,037	4,861.2
Least Developed Countries	262	275.5	509.4	373.8	475.6	824.5

Sources: OECD, Creditor Reporting System.
Abbreviations: NAI Parties = Parties not included in Annex I to the Convention, OECD = Organization for Economic Co-operation and Development.

Table 16. **Official Development Assistance in health sector in 2000 and 2005 (millions of United States dollars)**

Region	Bilateral 2000	Multilatera 2000	Bilateral 2005	Multilatera 2005	Total ODA 2000	Total ODA 2005
South Asia	288.9	575.9	667.4	564.2	864.8	1,231.6
Southwest Asia	71.5	4.1	316.1	17.8	74.7	333.9
South East Asia	137.4	164.3	264.1	209.3	301.8	473.3
Central Asia	7.9	7.7	50.5	66.1	15.6	116.4
East Asia	51.2	6.8	45.0	35.1	57.9	80.0
LAC	271.5	451.2	343.1	301.9	722.9	645.0
Pacific	15.7	11.6	58.4	5.1	27.2	63.5
Europe	62.8	22.9	59.2	40.4	85.7	99.6
Africa	610.6	551.0	1,304.6	1,154.5	1,149.7	2,459.2
Others	4.1				4.1	
Total	**1,521.6**	**1,795.4**	**3,108.4**	**2,394.2**	**3,304.5**	**5,502.5**

Sources: OECD, Creditor Reporting System
Abbreviations: LAC = Latin America and the Caribbean, ODA = Official Development Assistance.

Table 17. **Official Development Assistance in infrastructure in 2000 and 2005 (millions of United States dollars)**

Region	Total bilateral 2000	Total multilateral 2000	Total bilateral 2005	Total multilateral 2005	Total ODA 2000	Total ODA 2005
South Asia	366.3	1,883.1	1,251.9	2,448.2	2,249.3	3,700.0
Southwest Asia	129.7	198.0	1,417.1	201.1	327.8	1,618.2
South East Asia	1,844.1	338.4	1,681.3	416.3	2,182.5	2,097.5
Central Asia	183.1	22.5	70.8	47.9	201.9	118.7
East Asia	832.3	1,084.4	267.7	1,556.1	1,916.7	1,823.8
LAC	1,295.4	709.9	327.3	1,554.6	2,005.2	1,882.1
North America	0.0	0.0	0.0	0.0	0.0	0.0
Pacific	65.7	9.0	27.1	50.6	74.7	77.7
Europe	71.7	68.0	279.1	54.1	139.5	333.2
Africa	1,018.3	881.8	1,474.9	1,885.6	1,900.1	3,360.6
Others	0.3	0.0	0.0	0.0	0.3	0.0
Total	**5,806.8**	**5,195.0**	**6,797.4**	**8,214.5**	**10,998.1**	**15,011.7**

Sources: OECD, Creditor Reporting System
Abbreviations: LAC = Latin America and the Caribbean, ODA = Official Development Assistance.

Table 18. **Overview of existing carbon markets**

Market	Start date	Number of projects or participants	Emissions limit 2006 Mt CO_2 eq	Volume traded during 2006 Mt CO_2 eq	Average price 2006 USD/Mt CO_2 eq
Kyoto Protocol					
CDM CER primary market	2000	1,478[a]	521[a]		10.70
CDM CER secondary market		94[b]	24[b]	450	17.75
JI ERU market	2008	146[a]	25[a]	25	8.80
Emissions trading	2008	–	–	16	–
Protocol Parties				0	
European Union ETS Phase I	2005	1,500	2,088		19.50[f]
European Union ETS Phase II	2008	N.A.[c]	N.A.[c]	820	23.00[f]
Norway	2005	51	7	280[c]	–
United Kingdom[d]	2002	32[d]	30 to 20[d]	–	4.10[e]
Non-Party systems				2[e]	
New South Wales – Australian Capital Territory	2003	33	53	20	11.25
Chicago Climate Exchange	2002	237	230	10	3.80
Voluntary market					
Voluntary	1995			20+	10

Sources: Capoor and Ambrosi, 2006; Capoor and Ambrosi, 2007; Ellis and Tirpak, 2006; Fenhann, 2006; Enviros, 2006.
Abbreviations: CDM = Clean Development Mechanism, CER = Certified emission reductions, ERU = Emission reduction unit, ETS = Emissions trading scheme, JI = Joint Implementation.

[a] Number of projects in the pipeline at the end of 2006 and the estimated annual emission reductions for those projects.
[b] Number of projects with issued CERs and the quantity of CERs issued.
[c] Some national allocation plans for Phase II have not yet been approved, but the number of participants will be higher, and the emissions limits will be about 8 per cent lower, than for Phase I. Contracts for Phase II allowances are already trading.
[d] As discussed in CHAPTER VII.2, this reflects the Direct Entry component of the scheme, which accounted for most of the allowance allocation and trading activity.
[e] During the first nine months of 2006.
[f] Estimated.

Table 19. **Estimated capital invested for Clean Development Mechanism (CDM) projects registered and projects that entered the pipeline during 2006 (millions of current United States dollars)**

Country	Estimated capital invested in projects registered during 2006	Estimated capital invested in unilateral projects registered during 2006	Estimated capital invested in projects that entered the pipeline during 2006	Estimated capital invested in unilateral projects that entered the pipeline during 2006	ODA for energy policy and renewable energy projects 2005	Private investment in renewable energy and energy efficiency 2006
Argentina	54	12	0	0	0	0
Armenia	9	3	25	0	2	0
Bangladesh	3	0	0	0	0	11
Bolivia	0	0	60	58	1	0
Brazil	1,037	601	981	290	0	410
Cambodia	14	0	0	0	–	0
Chile	287	274	70	0	0	34
China	1,270	93	12,130	3,793	132	3,098
Colombia	76	6	50	0	200	0
Costa Rica	2	0	31	9	0	0
Cuba	0	0	55	0	6	0
Cyprus	0	0	47	47	–	0
Dominican Republic	79	0	92	13	0	0
Ecuador	99	15	42	0	0	0
Egypt	13	0	328	0	274	0
El Salvador	108	0	50	0	0	0
Equatorial Guinea	0	0	324	324	–	0
Georgia	0	0	2	0	0	0
Guatemala	57	21	302	160	1	0
Guyana	0	0	12	12	196	0
Honduras	15	7	42	13	101	0
India	1,239	944	7,534	5,998	–	2,238
Indonesia	530	27	445	11	–	0
Israel	3	0	41	39	–	6.5
Côte d'Ivoire	0	0	30	0	–	0
Jamaica	34	0	0	0	–	0
Kyrgyzstan	0	0	2	0	0	0

Table 19. **Estimated capital invested for Clean Development Mechanism (CDM) projects registered and projects that entered the pipeline during 2006 (millions of current United States dollars)** (continued)

Country	Estimated capital invested in projects registered during 2006	Estimated capital invested in unilateral projects registered during 2006	Estimated capital invested in projects that entered the pipeline during 2006	Estimated capital invested in unilateral projects that entered the pipeline during 2006	ODA for energy policy and renewable energy projects 2005	Private investment in renewable energy and energy efficiency 2006
Lao PDR	0	0	1	0	0	0
Malaysia	431	14	455	0	–	15.3
Mexico	435	138	1,097	589	9	0
Republic of Moldova	8	0	2	4	4	0
Mongolia	31	31	68	31	37	0
Morocco	5	5	1	1	166	0
Nepal	3	0	8	0	–	75
Nicaragua	177	15	0	0	–	0
Nigeria	206	0	554	332	–	0
Pakistan	2	0	69	67	–	0
Panama	18	11	118	106	–	0
Papua New Guinea	161	161	0	0	–	0
Peru	48	47	334	328	0	0
Philippines	85	–	160	0	0	413.6
Qatar	0	0	200	200	0	0
South Africa	49	39	271	261	–	11.6
Republic of Korea	180	46	141	84	–	176
Sri Lanka	2	2	63	30	1	0
Tajikistan	0	0	16	16	0	0
United Republic of Tanzania	0	0	3	3	–	0
Thailand	0	0	85	0	4	0
Tunisia	22	0	22	0	–	0
Uruguay	–	0	8	1	5	0
Viet Nam	94	0	93	74	0	20
Total	6,886	2,512	26,465	12,894	1,226	6,509

Source: OECD, Creditor Reporting System; UNEP Risoe Database, NEF, Private Sector Investment Database.
Abbreviations: ODA = Official Development Assistance
Note: ("–") means less than USD 0.5 million. Capital invested is estimated using capital cost/thousand t CO_2 eq of estimated annual emission reduction for different project types estimated by the World Bank and from data in PDDs. ODA includes both bilateral and multilateral assistance.

Table 20. **Estimated capital invested for CDM projects registered and projects that entered the pipeline compared to Private Investment and ODA for Renewable energy and Energy efficiency in 2006 (millions of current United States dollar)**

Total including other sectors	Estimated capital invested in projects registered during 2006	Estimated capital invested in unilateral projects registered during 2006	RE&EE investment for registered projects in 2006
Argentina	54	12	17
Armenia	9	3	0
Bangladesh	3	0	0
Bolivia	0	0	0
Brazil	1,037	601	692
Cambodia	14	0	14
Chile	287	274	246
China	1,270	93	1,243
Colombia	76	6	42
Costa Rica	2	0	2
Cuba	0	0	0
Cyprus	0	0	0
Dominican Republic	79	0	79
Ecuador	99	15	95
Egypt	13	0	2
El Salvador	108	0	102
Equatorial Guinea	0	0	0
Georgia	0	0	0
Guatemala	57	21	57
Guyana	0	0	0
Honduras	15	7	15
India	1,239	944	1,173
Indonesia	530	27	442
Israel	3	0	0
Côte d'Ivoire	0	0	0
Jamaica	34	0	34
Kyrgyzstan	0	0	0
Lao People's Democratic Republic	0	0	0
Malaysia	431	14	429
Mexico	435	138	232
Republic of Moldova	8	0	8
Mongolia	31	31	31
Morocco	5	5	5
Nepal	3	0	3
Nicaragua	177	15	177
Nigeria	206	0	0

Estimated capital invested in projects that entered the pipeline during 2006	Estimated capital invested in unilateral projects that entered the pipeline during 2006	RE&EE investment for projects entered in pipeline in 2006	ODA for energy policy and renewable energy projects 2005	Private investment in renewable energy and energy efficiency 2006
0	0	0	0	0
25	0	10	2	0
0	0	2	0	11
60	58	60	1	0
981	290	968	0	410
0	0	0	–	0
70	0	28	0	34
12,130	3,793	11,549	132	3,098
50	0	3	200	0
31	9	31	0	0
55	0	55	6	0
47	47	47	–	0
92	13	92	0	0
42	0	39	0	0
328	0	316	274	0
50	0	50	0	0
324	324	0	–	0
2	0	0	0	0
302	160	303	1	0
12	12	12	196	0
42	13	42	101	0
7,534	5,998	7,410	–	2,238
445	11	450	–	0
41	39	38	–	6.5
30	0	0	–	0
0	0	0	–	0
2	0	0	0	0
1	0	1	0	0
455	0	450	–	15
1,097	589	913	9	0
2	4	0	4	0
68	31	68	37	0
1	1	0	166	0
8	0	8	–	75
0	0	0	–	0
554	332	0	–	0

Table 20. **Estimated capital invested for CDM projects registered and projects that entered the pipeline compared to Private Investment and ODA for Renewable energy and Energy efficiency in 2006 (millions of current United States dollar)** (continued)

Total including other sectors	Estimated capital invested in projects registered during 2006	Estimated capital invested in unilateral projects registered during 2006	RE&EE investment for registered projects in 2006
Pakistan	2	0	2
Panama	18	11	18
Papua New Guinea	161	161	161
Peru	48	47	48
Philippines	85	–	83
Qatar	0	0	0
South Africa	49	39	46
Republic of Korea	180	46	180
Sri Lanka	2	2	2
Tajikistan	0	0	0
United Republic of Tanzania	0	0	0
Thailand	0	0	0
Tunisia	22	0	0
Uruguay	–	0	0
Viet Nam	94	0	1
Total	**6,886**	**2,512**	**5,681.935**

Data Source: OECD, Creditor Reporting System; UNEP Risoe Database, NEF, Private Sector Investment Database.
Abbreviations: EE = Energy efficiency, ODA = Official Development Assistance, RE = Renewable energy.
Notes: ("–") means less than USD 0.5 million. Capital invested is estimated using capital cost/thousand CO_2 eq of estimated annual emission reduction for different project types estimated by the World Bank and from data in project design documents (CDM-PDDs). ODA includes both bilateral and multilateral assistance.

Estimated capital invested in projects that entered the pipeline during 2006	Estimated capital invested in unilateral projects that entered the pipeline during 2006	RE&EE investment for projects entered in pipeline in 2006	ODA for energy policy and renewable energy projects 2005	Private investment in renewable energy and energy efficiency 2006
69	67	69	–	0
118	106	118	–	0
0	0	0	–	0
334	328	331	0	0
160	0	157	0	414
200	200	0	0	0
271	261	253	–	12
141	84	72	–	176
63	30	63	1	0
16	16	16	0	0
3	3	0	–	0
85	0	85	4	0
22	0	0	–	0
8	1	1	5	0
93	74	93	0	20
26,465	12,894	24,201.12	1,226	6,509

Table 21. **Technology Transfer and Investment in/through CDM Projects in 2006**

Project type	Number of projects	No technology transfer	Equipment only	Knowledge only	Knowledge and equipment	Average investment (USD/thousand of CO_2 eq/year)
Afforestation	0	–	–	–	–	–
Agriculture	91	18.5	0.6	35.9	45	137.39[a]
Biogas	32	43.2	0.9	12.1	38.4	33.12
Biomass energy	194	61.6	15.3	2.8	7.5	261.68
Cement	22	100	–	–	–	137.39[a]
Coal bed/mine methane	2	99.6	–	–	0.4	38.65
Energy distribution	2	7.2	–	92.8	–	137.39[a]
Energy efficiency households	4	7.6	41.1	–	51.3	160.80[b]
Energy efficiency industry	109	81.6	8.5	9.5	0.3	160.80[b]
Energy efficiency service	10	80.5	19.5	–	–	160.80[b]
Fossil fuel switch	32	92	8	–	–	377.65
Fugitive	7	85	4	11.1	–	137.39[a]
Geothermal	6	57.4	–	18	24.6	577.83
HFCs	13	15	62.6	1.6	20	0.29
Hydro	145	81	9.7	1.4	7	306.48
Landfill gas	74	36.2	17.3	23.2	22.2	31.90
N_2O	3	–	92.9	–	7.1	1.47
Reforestation	2	30.9	–	–	–	113.62
Solar	5	1	99	–	–	137.39[a]
Tidal	1	–	–	–	100	137.39[a]
Transport	1	100	–	–	–	137.39[a]
Wind	99	38.2	30.9	5.1	25.9	640.36
Total	**854**	**34.5**	**41.2**	**6.6**	**16.1**	

Data Source: Haites, *et al.*, 2006, Table 7. Average investment from Philippe Ambrosi of the World Bank and Stephen Seres by personal communication.
Abbreviations: HFC = Hydrofluorocarbon, N_2O = Nitrous Oxide
Notes: Based on the estimated annual emission reductions. Per centages in a row may not sum to 100 per cent due to exclusion of “other” technology transfer.

[a] The average for all CDM project types is used when capital cost data for the specific project type is not available;
[b] Average capital cost calculated for all types of energy efficiency projects.

Table 22. **Revenue and Investments in Joint Implementation projects compared to Private investments in renewable energy and energy efficiency in 2006**

Country	Number of projects that entered the pipeline during 2006	Estimated annual emission reductions of those projects ERUs in thousand	Estimated annual revenue (USD million) USD 8.80/ERU (primary market)	USD 17.18/ERU (secondary market)	Estimated capital invested in 2006 projects (USD million)	Private investment in renewable energy and energy efficiency 2006 (USD million)
Bulgaria	11	960	8	17	680	0
Czech Republic	2	45	–	1	118	0
Estonia	2	145	1	3	169	0
Germany	1	87	1	2	21	4,044
Hungary	2	42	–	1	180	0
Lithuania	3	123	1	2	62	0
Poland	3	192	2	3	177	33.6
Romania	7	1,194	11	21	561	0
Russian Federation	19	12,086	106	215	3,810	0
Ukraine	3	988	9	18	491	0
Total	**53**	**14,976**	**132**	**266**	**6,269**	**4,473**

Data Source: UNEP Risoe Database; NEF, private sector investment database.
Note: Capital invested estimated using the factors for clean development mechanism projects shown in TABLE 19-ANNEX V.
Abreviations: ERU = emission reduction unit

Table 23. **Annual increase in secured capital by carbon funds**

Year	Cumulative secured capital (in million EUR)	Annual increase in secured capital In million EUR	Annual increase in secured capital In million USD	Estimated value of market transactions emission reductions (in million USD)
2000	351	351	324	50
2001	701	350	313	50
2002	1,111	410	386	100
2003	1,930	819	925	300
2004	2,977	1,047	1,301	600
2005	3,835	858	1,066	2,700
2006	5,492	1,657	2,079	5,000

Source: ICF International, 2007.
Note: The market value of emission reductions includes reductions for the voluntary market as well as reductions intended to earn certified emission reductions (CERs) and emission reduction units (ERUs).

Table 24. **Estimates of the demand for Kyoto Units in 2010 (Mt CO_2 eq)**

	Point Carbon	Capoor and Ambrosi	ICF International mid-demand[c]	ICF International range[c]
Annex I governments	140	–	318	289 to 349
European Union 15 governments	–	90	–	–
European Union ETS governments	217[a]	228	260	211 to 322
Japan, public and private	40	70	–	–
Other governments	–	12	–	–
Estimated demand excluding Canada	397	400[b]	578	500 to 671
Canada	–	260[e]	5d	0 to 187
Estimated demand	**–**	**660**	**583**	**500 to 858**

Abbreviations: Annex I = Parties included in Annex I to the Convention, ETS = Emission trading scheme, ICF = Consulting group.

[a] Point Carbon, CDM/JI supply: Will there be enough for everyone? 14 May 2007, converted to annual averages for 2008 to 2012. EU ETS demand is the overall limit on the use of CERs and ERUs for 21 countries based on approved national allocation plans, Carbon Market Europe, 18 May 2007. Point Carbon, Carbon 2007 – A new climate for carbon trading, March 2007, Figure 2.2 suggests a demand of about 140 Mt CO_2e for Canada and 410 Mt CO_2e for other Annex B Parties;
[b] Capoor and Ambrosi, 2007, Table 4, converted to annual averages. Over 45 per cent of the demand excluding Canada has already been contracted;
[c] ICF International, 2007, Table 2;
[d] This reflects the April 2007 policy announcement that the government will not purchase Kyoto units, but that firms in the emissions trading system that will begin in 2010 may use CERs for up to 10 per cent of their compliance needs;
[e] Distance to target as estimated by other sources reported by Capoor and Ambrosi (2007).

Table 25. **Estimates of the supply of Kyoto Units in 2010 (Mt CO_2 eq)**

Source	Point Carbon[a]	Capoor and Ambrosi[b]	ICF International mid-supply[c]	ICF International range[c]
Clean Development Mechanism				
April 2007 pipeline	460	–	–	–
Additional projects	270	–	–	–
Projected reductions	700	–	–	–
Estimated CERs issued	330	300[b]	–	–
Joint Implementation				
April 2007 pipeline	46	–	–	–
Additional projects	55	–	–	–
Projected reductions	101	–	–	–
Estimated ERUs issued	60	40	–	–
Sub-total CERs and ERUs	**390**	**340**	**340**	**220 to 450**
Surplus AAUs				
Russia	950[d]	640	–	–
Ukraine	300[d]	440	–	–
Other	400[d]	340	–	–
Sub-total AAUs	**1,650**	**1,420**	**400[c]**	**240 to 600[c]**
Total	**2,040**	**1,785**	**740**	**460 to 1,050**

Abbreviations: AAUs = assigned amount units, ERUs = emission reduction units, CERs = certified emission reductions.

[a] Point Carbon, CDM/JI supply: Will there be enough for everyone? 14 May 2007, converted to annual averages for 2008 to 2012;
[b] Capoor and Ambrosi, 2007, Table 4, converted to annual averages. CERs are based on the March 2007 CDM Pipeline (Fenhaan) adjusted for observed yields and no allowance for additional projects;
[c] ICF International, 2007, table 2, AAUs are only units sold through Green Investment Schemes and are converted to annual averages;
[d] Point Carbon, Carbon 2007 – A new climate for carbon trading, March 2007, Figure 2.2 converted to annual averages;
[e] Point Carbon and Capoor and Ambrosi project the supply of CERs and ERUs from the projects in the pipeline in early 2007. They discount the project estimates of emission reductions to calculate the CERs and ERUs issued. Point Carbon adds CERs and ERUs from projects in its database that have not yet released a project design document (PDD). That increases its estimate of the supply of CER/ERU supply to 390 Mt CO_2 eq per year compared with 340 Mt CO_2 eq for Capoor and Ambrosi and ICF International.

Table 26. **Model estimates of the maximum demand in 2030**

Model	Market size[a] (Mt CO_2 eq/year)	Market price[b] (2000 USD billion)	Annual purchases[c] (2000 USD billion)	Annex I and/or B commitment[d] (percentage below 1990)
AIM	4,648	28.09	131	20
AMIGA	5,233	60.00	314	43
EDGE	4,700	3.54	17	7
EPPA	12,126	19.49	236	-81
FUND	16,920	109.61	1,855	105
GEMINI	7,856	11.03	87	31
GRAPE	3,262	5.89	19	5
GTEM	13,176	43.93	579	76
IMAGE	6,402	19.00	122	31
IPAC	6,287	13.64	86	38
MERGE	1,645	3.69	6	-17
MiniCAM	6,455	14.30	92	31
PACE	986	0.53	0.5	31
POLES	5,806	26.24	152	32
SGM	10,369	21.50	223	49
WIAGEM	10,450	5.38	56	55
Median[e]	**6,345**	**16.65**	**107**	**31**

Data Source: Links to websites with results for the individual models are provided at <http://www.stanford.edu/group/EMF/projects/group21/EMF21ReportingResults.pdf>.
Abbreviations: AIM = Asian-Pacific Integrated Model, AMIGA = All Modular Industry Growth Assessment, EDGE = European Dynamic Equilibrium Model,
EPPA = Emission Projection and Policy Analysis Model, FUND = Climate Framework for Uncertainty, Negotiation and Distribution,
GEMINI = General Equilibrium Model of International Interaction for Economy-Energy-Environment, GRAPE = Global Relationship Assessment to Protect the Environment,
GTEM = Global Trade and Environment Model, IMAGE = Integrated Model to Assess The Global Environment, IPAC = Integrated Projection Assessments for China,
MERGE = Model for Evaluating Regional and Global Effects of GHG Reductions Policies, MiniCAM = Mini-Climate Assessment Model, PACE = Policy Analysis With Computable Equilibrium,
POLES = Prospective Outlook on Long-Term Energy Systems, SGM = Second Generation Model, WIAGEM = World Integrated Applied General Equilibrium Model.

[a] The market size is calculated as the emissions of non-Annex I Parties under the reference scenario less the emissions of non-Annex I Parties under the multi-gas mitigation scenario. In other words non-Annex I Parties are assumed to sell all potential emission reductions with a marginal cost below the market price. Or equivalently, the models equate the MACs of mitigation across countries, between at home reductions in Annex I Parties and offsetting in developing ctries;
[b] The market price is the marginal abatement cost reported for the multi-gas mitigation scenario;
[c] Annual purchases is the market size multiplied by the market price;
[d] The Annex I commitment is the emissions of Annex I Parties under the multi-gas mitigation scenario less the market size (purchases from non-Annex I Parties) expressed as a reduction from 1990 Annex I emissions. A negative value indicates the commitment is higher than the 1990 emissions;
[e] When values can not be symmetrically distributed as in this case – market size and price can not be less than zero – the median (half of the values above and below) is a better indicator of the central value than the average.

Table 27. **Maximum annual emission reduction potential in Parties not included in Annex I to the Convention, in 2030**

	Estimated annual emission reductions in current CDM pipeline (Mt CO_2 eq)	Maximum annual emission reduction potential in non-Annex I Parties in 2030 (Mt CO_2 eq)
Biofuels	30	250[b]
Coal bed/mine methane	20	–
Energy efficiency and fuel switching	55	2,000[b]
HFC/PFC destruction	81	0[c]
N_2O destruction	42	65[d]
Reforestation	1	1,300[e]
Renewable energy	52	900[b]
Other (mainly landfill gas)	52	–
Reduced deforestation	–	2,000[e]
CO_2 capture and storage	–	1,200[b]
Total	333	7,715

Abbreviations: HFC = Hydrofluorocarbon, PFC = Perfluorocarbon, N_2O - Nitrous Oxide, CO_2 = Carbon oxide.

[a] CDM Pipeline, 31 May 2007;
[b] Difference between reference scenario and beyond alternative policies scenario;
[c] Phase out of ozone depleting substances will largely eliminate waste HFCs/PFCs by 2030;
[d] Most reductions are at adipic acid plants and four of the six plants in non-Annex I Parties are already registered. The rest, about 13 Mt CO_2e, is at plants producing nitrate for fertilizers;
[e] Calculated from Table 9.3 in the report by Eveline Trines for reductions at a cost of less than USD 20/t CO_2.

Table 28. **Projects approved under the Special Climate Change Fund Adaptation Portfolio**

Country / Region	Project Title	IA/EA	Expected SCCF Grant (USD million)	Expected Co-financing (USD million)	Expected Total Financing (USD million)
Ecuador	Adaptation to CC through effective water governance	UNDP	3.65	6	9.65
Ethiopia	Coping with drought and CC	UNDP	1.08	1.87	2.95
Guyana	Conservancy Adaptation Project	World Bank	4.14	16.2	20.3
Kenya	Adaptation to CC in arid lands (KACCAL)	World Bank/UNDP	7.40	44.84	52.24
Mozambique	Coping with drought and CC	UNDP	1.04	0.93	1.97
Regional (Bolivia, Equador, Peru)	Design and implementation of pilot CC adaptation measures in the Andean region	World Bank	8.16	20.1	28.26
Tanzania	Mainstreaming CC in integrated water resources management in the Pangani river basin	UNDP	1.09	1.57	2.66
Zimbabwe	Coping with drought and CC	UNDP	1.07	1.16	2.22
Total			27.63	92.67	120.32

Sources: Information is provided by the GEF Secretariat.
Abbreviations: CC = Climate Change, EA = Executing Agency, IA = Implementing Agency, SCCF - Special Climate Change Fund, UNDP = United Nations Development Programme.

Table 29. **Projects in the pipeline of the Special Climate Change Fund Adaptation Portfolio**

Country/region	Project Title	IA/EA	Expected SCCF grant (USD million)	Expected co-financing (USD million)	Expected total financing (USD million)
China	Mainstreaming adaptation to CC into water resources management and rural development	World Bank	5.85	50	55.8
Philippines	CC adaptation project	World Bank	5.88	50	55.8
Regional (Cook Islands, Micronesia, Fiji, Nauru, Papua New Guinea, Samao, Solomon Islands, Tongo, Tuvalu, Vanuatu)	Pacific Islands Adaptation to CC project (PACC)	UNDP	12.64	70.8	83.4
Total			24.37	170.8	195

Abbreviations: CC = Climate Change, EA = Executing Agency, IA = Implementing Agency, PACC = Pacific islands adaptation to climate change project, SCCF = Special Climate Change Fund, UNDP = United Nations Development Programme.

Table 30a. **Project in the pipeline of the Least Developed Countries Fund Adaptation Program, as of August 2007**

Country	RegioProject Titlen	IA/EA	Expected LDCF Grant (USD million)	Expected Co-financing (USD million)	Expected Total Financing (USD million)
Bangladesh	Strengthening adaptive capacities to address climate change threats on sustainable development strategies for coastal communities in Bangladesh	UNDP	3.4	6.22	9.62
Bhutan	Reduce climate change-induced risks and vulnerabilities from glacial lake outbursts in the Punakha-Wangdi and Chamkhar Valleys	UNDP	3.96	3.50	7.49
Malawi	Climate Adaptation for Rural Livelihoods and Agriculture (CARLA)	AfDB	3.55	24.39	27.95
Mauritania	Reducing vulnerability of arid oasian zones to climate change and variability through improved watershed management	UNEP	1.83	1.41	3.24
Niger	Implementing NAPA priority interventions to build resilience and adaptive capacity of the agriculture sector to climate change in Niger	UNDP	2.3	4.27	6.57
Samoa	Integrated Climate Change Adaptation in Samoa (ICCAS)	UNDP	2.29	2.01	4.3
Total			17.33	41.8	59.13

Abbreviations: AfDB = African Development Bank, CC = Climate Change, EA = Executing Agency, IA = Implementing Agency, NAPA = National Adaptation Programmes of Action, UNDP = United Nations Development Programme, UNEP = United Nations Environment Programme

Table 30b. **Three Project Identification Forms ready for submission to the Least Developed Counrties Fund Adaptation Programme**

Country	RegioProject Titlen	IA/EA	Expected LDCF Grant (USD million)	Expected Co-financing (USD million)	Expected Total Financing (USD million)
Cambodia	Building capacities to integrate water resources planning in agricultural development	UNDP	2.14	2.01	4.15
Eritrea	Integrating climate change risks into community based livestock management in the northwestern lowlands of Eritrea	UNDP	3	3.4	6.4
Djibouti	Reducing impacts and vulnerability of coastal productive systems in Djibouti	UNEP	2.27	1.97	4.24
Total			7.81	7.38	15.20

Note: Information is provided by the GEF Secretariat.
Abbreviations: EA = Executing Agency, IA = Implementing Agency, UNDP = United Nations Development Programme, UNEP = United Nations Environment Programme.

Table 31. **Renewable Energy Policies and Government Support in Developing Countries**

Country	Policy name	Policy type	Technology	Renewable energy target
Brazil	The Brazilian Renewable Energy Incentive Programme (PROINFA)	– Guaranteed prices/feed-in – Obligations – Tradeable certificates – Third Party finance	– Onshore wind – Bioenergy – Hydropower	Additional 3,300 MW from wind, small hydro, biomass by 2016; 15 per cent of primary energy supply by 2020
	National Programme for Energy Development of States and Municipalities (PRODEEM)	– Rural electrification	– All technologies simultaneously	
	National Rural Electrification Programme	– Rural electrification	– All technologies simultaneously	
China	Brightness Programme	– Capital grants	– On-shore wind – Solar photovoltaics	
	The People's Republic of China Renewable Energy Law	– General energy policy – Guaranteed prices/feed-in – Obligations – R&D and Development – Regulatory and administrative rules	– All technologies simultaneously	3.3 GW by 2006 from wind, biomass and mini-hydro. To reach 120 GW of RE by 2020. 10 per cent of energy from RE by 2010, 16 per cent by 2020. – Wind: 30 GW by 2030 – Solar PV: 300 MW by 2010, 1.8 GW by 2030
	Reduced VAT and Income Tax	– Excise tax exemptions – Sales tax rebates – Tax credits	– Onshore wind	
	Wind Power Concessions Programme	– Bidding systems – Guaranteed prices/feed-in	– Onshore wind	
	Energy Efficiency	– Non-mandatory targets: energy intensity to fall by 20 per cent and major pollutants discharge by 10 per cent during the 11th Five Year Plan (2006 to 2010)	– All/energy efficiency	
India	Policy and Economic Incentives for Investment in Renewable Energy Sources (Model Renewable Energy Law in planning)	– FDI & joint ventures – Depreciation allowance – Income tax holiday – Excise & customs incentives – Planning exemptions – Loans – Feed-in tariffs due to be introduced for wind and solar (announced May 2007)	– All technologies simultaneously	10 per cent of additional electricity capacity by 2012 (excluding large hydro): increasing to 20 per cent by 2020, 10 GW RE by 2012

Table 31. **Renewable Energy Policies and Government Support in Developing Countries** (continued)

Country	Policy name	Policy type	Technology	Renewable energy target
India	Incentives for Investment in Wind Power Generation	– Concessional import duties – Accelerated depreciation – Sales tax & excise duty relief – Soft loans – Income tax holiday – Wheeling charges – Buy-back facility – 5 per cent annual tariff escalation – Financial incentives for demonstration projects	– Wind	
	Incentives for Investment in Small Hydro Power Generation	– Survey & investigation subsidies – Project development subsidies – Renovation, modernisation & capacity upgrade financial support – Term loans	– Small hydro power	
Mexico	Accelerated Depreciation for Environmental Investment (Renewable Energy Law in Congress – not yet implemented)	– Investment tax credits – Tax credits	– All technologies simultaneously	
	Grid Interconnection Contract for Renewable Energy	– Regulatory & administrative affairs	– Hydropower – Offshore wind – Onshore wind – Solar photovoltaics – Solar concentrating power	
	Project of Bill to Promote Renewable Energy	– General energy policy	– All technologies simultaneously	
	Project of Ecological Norm for Wind Farms	– Regulatory & administrative affairs	– Onshore Wind	
	Project of Electricity Reform in Connection with Renewable Energy	– Regulatory & administrative affairs	– All technologies simultaneously	
	Public Electricity Services Law	– General energy policy	– All technologies simultaneously	
	Methodology to Establish Service Charges for Transmission of Renewable Energy	– Regulatory & administrative affairs	– All technologies simultaneously	
	Wheeling Service Agreement for Electricity from Renewable Energy Sources	– Regulatory & administrative affairs	– All technologies simultaneously	

Table 31. **Renewable Energy Policies and Government Support in Developing Countries** (continued)

Country	Policy name	Policy type	Technology	Renewable energy target
Thailand	Strategic Plan for Renewable Energy Development	– General energy policy – Machinery import duty exemptions – Corporate income tax exemption	– Solar – Wind – Biomass – Biogas – Hydro – Biofuels – Geothermal – Fuel cells – Energy efficiency	8 per cent of primary energy by 2011 (excluding rural biomass)
Turkey	Electricity Market Licensing Regulation	– Capital grants	– All technologies simultaneously	Targeted 2 per cen of electricity from wind by 2010
	Law on Utilisation of Renewable Energy Resources for the Purpose of Generating Electrical Energy – No. 5346	– General energy policy	– All technologies simultaneously	
	Project of Ecological Norm for Wind Farms	– Regulatory & administrative affairs	– Onshore wind	
	Project of Electricity Reform in Connection with Renewable Energy	– Regulatory & administrative affairs	– All technologies simultaneously	
	Public Electricity Services Law	– General energy policy	– All technologies simultaneously	
	Methodology to Establish Service Charges for Transmission of Renewable Energy	– Regulatory & administrative affairs	– All technologies simultaneously	

Source: Greenwood C. *et al.*, 2007.
Abbreviations: FDI = Foreign direct investment, R&D = Research & Development, RE = Renewable energy, VAT = Value added tax.

Table 32. **Summary of Major Policy Recommendations Across Mitigation and Adaptation Sectors**

	Mitigation/Industry	Mitigation/Forestry	Mitigation/Agriculture	Investment in RE/EE
Information gaps				
Required disclosure	Product labeling			
Voluntary reporting	EE certification Green building standards	Wood certification	Agriculture product certification	
Government provided information	EE performance/options	Sustainable management	Sustainable management	Incubator support (info/networks)
Policy barriers to entry				
Monopoly regulation	Utility EE investment			Leveling field Feed-in tariffs
Perverse subsidies	↓for energy use	↓for forest clearance		
Perverse standards	Building codes Zoning for density			Expedited permitting
Externalized costs				
Civil liability				
Command & control	EE performance standards	Bans on illegal logging	Farming practices/ inputs/emissions	Portfolio standards Fuel standards
Taxes/charges	Energy pricing			Carbon tax
Externalized benefits				
Tradable rights	White tags	REDD/For. mitigation Afforesta/reforesta Energy/structural products	Reduced tillage Increased storage Animal wastes Bioenergy crops	Carbon market expansion
Government incentives	Early retirement EE equipment purchase	Sustainable land management/ecosystem services	Land restoration EE equipment	RE/EE technologies & projects Retail fin models
Government provision	R&D on EE technologies Public buildings	Protected areas Procurement	Procurement	R&D on new technologies Public procurement
		Forest Financing Mechanism: grants		
Other comments on sector, policies and markets	– Hugely decentralized sector – Split incentives builders/occupants – Need integrated approach to building EE – Much investment from retained earnings	– Land tenure a major issue in tropics – Most investment not related to climate – Most from private sector – Need devolve authority/funds	– Need understand global agriculture markets – Lots of energy in agriculture production/ transport – No baseline/mitigation scenarios	– Mainstream EE/RE – Policy-driven market – Lacking projects, not finance

Table 32. **Summary of Major Policy Recommendations Across Mitigation and Adaptation Sectors** (continued)

	Mitigation/Transport	Adaptation/Infrastructure	Adaptation/Ecosystems	Adaptation/Water
Information gaps				
Required disclosure	Fuel use for autos	In EIAs for buildings		Water use efficiency
Voluntary reporting		Green buildings		
Government provided info	Transport options	Adaptation plans Warnings/responses to weather events	Value of ecosystems	Weather forecasts Climate awareness Drought management plans
Policy barriers to entry				
Monopoly regulation				
Perverse subsidies	↓ for energy use, highways, sprawl	↓ for buildings in low areas	↓ for agriculture expansion, energy, transport, drainage, water	↓ for inefficient water use
Perverse standards	Land use/sprawl	Building codes	Land use/sprawl	Building codes
Externalized costs				
Civil liability			For damage to ecosystems	
Command & control	Vehicle standards Fuel standards Land use controls	Storm water collection Limits on building locations Building standards	Pollution/land use/ species controls	Efficiency/reuse standards Watershed land management standards
Taxes/charges	Congestion charges Fuel taxes	For new developments in low areas	On forest conversion	For water use; income support
Externalised benefits				
Tradable rights	Fleet efficiency		For ecosystem services/REDD	Water banking/trading
Government incentives	EE transit technologies	Insurance products	For habitat restoration/ protection	Efficiency/reuse investments
Government provision	Mass transit R&D in technologies	Responses to weather events	Protected areas	Desalination Reservoirs/networks Forested watersheds
Other comments on sector, policies and markets		– Capacity/willingness to act (national/local): adaptation deficit – Need mainstream – Durban Adaptation Strategy: across city – International > local costings – Need local studies		– Mostly public domestic sources – Long-lived assets, major investment risks – Intensely political

Table 32. **Summary of Major Policy Recommendations Across Mitigation and Adaptation Sectors** (continued)

	Adaptation/Agriculture	Adaptation/Health	Energy Subsidies	
Information gaps				
Required disclosure				
Voluntary reporting				
Government provided information	Disaster mitigation/ adaptation/land use planning/modeling Climate forecasts Pest/disease tracking Training/cap building	Promote health programs	Communications regarding changes in subsidy programs	
Barriers to entry				
Monopoly regulation			Allow access to grid, pricing	
Perverse subsidies	Excessive water use		Eliminate for fossil fuels	
Perverse standards			Reduce trade restrictions	
Externalized costs				
Civil liability				
Command & control	Ban illegal logging Controls on land use Product storage requests		RE portfolio standards	
Taxes/charges	Excessive water use		Carbon taxes	
Externalized benefits				
Tradable rights	Water rights			
Government incentives	Efficient water use Transition support		Add for RE/EE	
Government provision	R&D on methods/ crop lines Protected areas Climate insurance	Immunizations Water supply & sanitation	Direct income support Shift R&D to RE/EE	
Other comments on sector, policies and markets	Adaptation actions not in response to climate alone – need mainstream Adaptive cap varies Land tenure an issue in tropics		Phasing/timing of subsidies key	

Source: Adapted from review of sectoral papers prepared on mitigation and adaptation for the background paper (see list of references of the sectoral papers).
Abbreviations: EE = Energy efficiency, EIAs = Environment Impact Assessments, RE = Renewable energy, REDD = Reducing emissions from deforestation in developing countries, R&D = Research&Development.

Table 33. **Gross fixed capital formation by region in Agriculture, forestry and fisheries sectors (millions of United States dollars)**

Region	Agriculture 2005	Forestry 2005	Fishery 2005	Total 2005	Agriculture 2030	Forestry 2030	Fishery 2030	Total 2030
South Asia	18.8	5.6	1.3	25.7	48.5	17.6	2.0	68.1
Southwest Asia	4.9	1.2	0.4	6.5	15.2	13.4	0.7	29.3
Southeast Asia	3.9	4.2	0.5	8.5	9.6	11.1	0.8	21.5
Central Asia	4.8	0.5	0.2	5.5	13.7	2.0	0.3	16.0
East Asia	70.6	46.7	4.4	121.6	145.9	119.4	6.1	271.3
LAC	42.3	10.4	0.9	53.6	84.6	29.1	1.3	115.0
North America	87.7	71.3	0.5	159.5	140.1	102.0	0.7	242.8
Pacific	6.8	3.1	0.1	10.0	12.0	4.9	0.1	17.0
Europe	78.8	41.1	3.0	122.9	145.6	78.2	3.8	227.0
Africa	22.7	6.5	1.1	30.3	50.3	21.9	2.2	74.5
Total	**341.2**	**190.6**	**12.3**	**544.1**	**665.5**	**399.6**	**18.1**	**1083.2**
Developing countries	132.3	51.1	6.7	190.1	298.1	172.1	11.1	481.2
High income countries	208.9	139.5	5.6	354.0	367.5	227.5	7.1	602.0

Source: OECD, ENV-Linkage model
Abrevitation: LAC = Latin America and Caribbean.

Table 34. **Official Development Assistance for policy development and administration in 2000 by economic sector and region (millions of United States dollars)**

Region	Africa	Asia	Latin and Central America	West Asia	Transition economies	Other areas	Total
Energy policy and administration	205.7	870.6	218.5	41.1	37.7	1.1	1,374.6
Of which multilateral, per cent	64.9	89.7	98.8	27.8	10.8	–	83.3
Agricultural policy and administration	621.7	856.9	1 254.5	42.4	76.9	4.3	2,856.8
Of which multilateral, per cent	50.6	94.0	88.7	4.9	61.7	–	79.9
Environmental policy and administration	98.1	764.1	337.0	3.0	30.5	0.0	1,232.7
Of which multilateral, per cent	23.7	89.4	89.9		5.8	–	82.1
Fishing policy and administration	10.1	10.3	26.1	8.0	1.5	0.1	56.1
Of which multilateral, per cent	7.3	61.8	21.6	–	–	–	22.7
Forestry policy and administration	51.0	11.1	25.2	7.2	3.9	19.9	118.3
Of which multilateral, per cent	44.6	–	16.0	–	–	62.7	33.2
Health policy and administration	563.3	365.8	142.8	16.4	24.4	22.5	1,135.2
Of which multilateral, per cent	73.7	89.1	68.7	–	42.6	50.1	75.8
Industrial policy and administration	6.2	0.4	0.1	–	0.0	–	6.7
Of which multilateral, per cent	–	–	–	–	–	–	–
Transport policy and administration	324.9	340.3	221.3	2.5	120.2	0.3	1,009.6
Of which multilateral, per cent	83.5	87.7	86.7	–	98.4	–	87.2
Water Resources policy and administration	74.1	43.7	421.4	269.1	2.5	6.2	817.0
Of which multilateral, per cent	2.3	60.3	93.5	60.7	–	103.1	72.5
TOTAL	1,955.0	3,263.3	2,646.9	389.8	297.6	54.5	8,607.1
Of which multilateral, per cent	60.5	89.7	87.9	45.4	61.1	55.3	79.3

Source: OECD Creditor Reporting System

Table 35. **Investment flows by the economy sectors (percentage)**

Table 35.1 **Agriculture, hunting, forestry and fishing**

Region	World GFCF	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	Bilateral ODA	Multilateral ODA	Total	Total GFCF (USD billions)
Africa	5.51	96.16	0.97	0.00	1.79	1.07	100.0	10
Developing Asia	17.95	96.02	2.53	0.00	0.88	0.56	100.0	31
Latin America	9.02	98.53	1.04	0.00	0.39	0.04	100.0	16
Middle East	3.49	99.95	0.00	0.00	0.05	0.00	100.0	6
OECD Europe	35.18	84.79	0.13	15.08	0.00	0.00	100.0	62
OECD North America	13.67	98.52	1.43	0.05	0.00	0.00	100.0	24
OECD Pacific	12.10	98.58	0.81	0.62	0.00	0.00	100.0	21
Other Europe	0.05	100.00	0.00	0.00	0.00	0.00	100.0	0
Transition Economies	3.02	97.60	0.85	0.00	0.23	1.32	100.0	5
Global Total	**100.00**	**93.14**	**0.97**	**5.39**	**0.30**	**0.20**	**100.0**	**175**
NAI Parties	38.65	96.88	1.72	0.19	0.76	0.45	100.0	68
AI Parties	59.64	91.05	0.04	8.91	0.00	0.00	100.0	104
Least Developed Countries	2.42	92.02	2.48	0.00	2.95	2.55	100.0	4

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

Table 35.2 **Mining and quarrying**

Region	World GFCF	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	Bilateral ODA	Multilateral ODA	Total	Total GFCF (USD billions)
Africa	9.49	86.25	12.34	0.00	0.97	0.44	100.0	13
Developing Asia	12.40	90.76	9.04	0.00	0.20	0.00	100.0	17
Latin America	12.67	55.65	43.76	0.05	0.54	0.00	100.0	18
Middle East	14.58	100.00	0.00	0.00	0.00	0.00	100.0	20
OECD Europe	22.95	56.41	43.28	0.31	0.00	0.00	100.0	32
OECD North America	13.68	12.26	87.16	0.57	0.00	0.00	100.0	19
OECD Pacific	7.58	70.34	29.66	0.00	0.00	0.00	100.0	11
Other Europe	0.05	100.00	0.00	0.00	0.00	0.00	100.0	0
Transition Economies	6.59	81.21	18.75	0.00	0.04	0.00	100.0	9
Global Total	**100.0**	**66.44**	**33.18**	**0.16**	**0.19**	**0.04**	**100.0**	**139**
AI Parties	48.5	98.87	0.82	0.31	0.00	0.00	100.0	68
NAI Parties	49.78	81.79	17.75	0.00	0.38	0.09	100.0	69
Least Developed Countries	2.19	87.27	6.87	0.00	3.96	1.90	100.0	3

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

Table 35.3 **Manufacturing**

Region	World GFCF	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	Bilateral ODA	Multilateral ODA	Total	Total GFCF (USD billions)
Africa	1.20	89.18	6.36	3.34	1.07	0.05	100.0	16
Developing Asia	18.66	81.35	18.02	0.56	0.07	0.00	100.0	243
Latin America	4.56	80.46	15.53	3.84	0.13	0.04	100.0	59
Middle East	1.07	75.24	24.75	0.00	0.01	0.00	100.0	14
OECD Europe	24.04	62.92	25.35	11.73	0.00	0.00	100.0	313
OECD North America	31.15	55.01	36.57	8.42	0.00	0.00	100.0	405
OECD Pacific	18.00	99.25	0.05	0.70	0.00	0.00	100.0	234
Other Europe	0.02	-175.61	0.00	275.61	0.00	0.00	100.0	0
Transition Economies	1.29	85.80	14.03	0.05	0.12	0.00	100.0	17
World Total	**100.00**	**71.93**	**22.09**	**5.95**	**0.03**	**0.00**	**100.0**	**1,301**
NAI Parties	34.03	84.14	15.29	0.46	0.09	0.01	100.0	443
Least Developed Countries	0.33	75.45	11.61	12.27	0.67	0.00	100.0	4

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

Table 35.4 **Electricity, gas and water supply**

Region	World GFCF	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	Bilateral ODA	Multilateral ODA	Total	Total GFCF (USD billions)
Africa	1.83	80.04	0.00	0.00	12.37	7.59	100.0	5
Developing Asia	12.28	75.59	8.57	3.61	7.51	4.72	100.0	32
Latin America	7.46	39.42	28.80	26.71	3.64	1.43	100.0	19
Middle East	1.40	93.29	0.00	0.00	5.88	0.82	100.0	4
OECD Europe	29.23	47.35	15.42	37.18	0.00	0.05	100.0	75
OECD North America	18.85	65.46	22.46	11.54	0.48	0.05	100.0	48
OECD Pacific	26.71	96.97	0.71	2.32	0.00	0.00	100.0	69
Other Europe	0.04	-752.29	0.00	852.29	0.00	0.00	100.0	0
Transition Economies	2.20	92.12	2.95	0.72	3.43	0.78	100.0	6
World Total	**100.00**	**68.81**	**12.19**	**16.44**	**1.67**	**0.88**	**100.0**	**257**
AI Parties	72.49	81.41	0.04	18.52	0.03	0.01	100.0	186
NAI Parties	26.07	77.72	12.63	5.76	0.60	3.29	100.0	67
Least Developed Countries	1.10	63.48	6.28	0.00	12.16	18.09	100.0	3

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

Table 35.5 **Wholesale retail trade, repair of motor vehicles, motorcycles, etc.; hotels and restaurants**

Region	World GFCF	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	Bilateral ODA	Multilateral ODA	Total	Total GFCF (USD billions)
Africa	0.84	96.57	3.43	0.00	0.00	0.00	100.0	5
Developing Asia	6.47	68.57	27.80	3.64	0.00	0.00	100.0	40
Latin America	4.86	80.07	9.33	10.60	0.00	0.00	100.0	30
Middle East	1.44	97.49	2.51	0.00	0.00	0.00	100.0	9
OECD Europe	27.61	60.36	15.04	24.61	0.00	0.00	100.0	172
OECD North America	44.18	56.40	25.95	17.65	0.00	0.00	100.0	275
OECD Pacific	13.31	88.03	9.19	2.78	0.00	0.00	100.0	83
Other Europe	0.02	-397.71	0.00	497.71	0.00	0.00	100.0	0
Transition Economies	1.28	77.71	22.29	0.00	0.00	0.00	100.0	8
World Total	100.00	64.74	19.44	15.82	0.00	0.00	100.0	621
AI Parties	86.12	63.53	19.23	17.24	0.00	0.00	100.0	535
NAI Parties	12.51	87.15	10.66	2.18	0.00	0.00	100.0	78
Least Developed Countries	0.35	98.74	1.26	0.00	0.00	0.00	100.0	2

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

Table 35.6 **Construction**

Region	World GFCF	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	Bilateral ODA	Multilateral ODA	Total	Total GFCF (USD billions)
Africa	1.80	99.72	0.28	0.00	0.00	0.00	100.0	8
Developing Asia	26.01	98.46	1.54	0.00	0.00	0.00	100.0	114
Latin America	4.14	98.76	0.97	0.28	0.00	0.00	100.0	18
Middle East	0.42	49.79	3.87	46.34	0.00	0.00	100.0	2
OECD Europe	14.36	87.43	3.25	9.32	0.00	0.00	100.0	63
OECD North America	36.94	99.09	0.17	0.74	0.00	0.00	100.0	162
OECD Pacific	15.16	97.95	0.93	1.12	0.00	0.00	100.0	66
Other Europe	0.02	100.00	0.00	0.00	0.00	0.00	100.0	0
Transition Economies	1.14	97.35	2.65	0.00	0.00	0.00	100.0	5
World Total	100.00	96.85	1.16	1.99	0.00	0.00	100.0	438
AI Parties	51.31	95.56	1.28	3.16	0.00	0.00	100.0	225
NAI Parties	47.71	98.93	0.75	0.33	0.00	0.00	100.0	209
Least Developed Countries	0.88	98.80	1.20	0.00	0.00	0.00	100.0	4

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

Table 35.7 **Transport, storage and communications**

Region	World GFCF	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	Bilateral ODA	Multilateral ODA	Total	Total GFCF (USD billions)
Africa	1.66	85.87	3.89	3.71	3.26	3.27	100.0	15
Developing Asia	15.06	90.10	2.43	3.43	2.06	1.98	100.0	134
Latin America	6.05	51.24	40.71	6.13	1.63	0.29	100.0	54
Middle East	2.57	98.59	0.50	0.57	0.18	0.16	100.0	23
OECD Europe	25.96	0.00	48.25	51.73	0.02	0.00	100.0	231
OECD North America	29.04	89.64	3.49	6.77	0.00	0.10	100.0	258
OECD Pacific	17.84	97.23	0.47	2.30	0.00	0.00	100.0	159
Other Europe	0.03	-140.42	0.00	240.42	0.00	0.00	100.0	0
Transition Economies	1.79	87.16	11.25	0.00	1.30	0.28	100.0	16
World Total	**100.00**	**65.53**	**16.73**	**16.83**	**0.50**	**0.41**	**100.0**	**889**
AI Parties	70.94	77.53	0.26	22.20	0.01	0.01	100.0	630
NAI Parties	27.95	86.43	8.85	1.54	1.74	1.44	100.0	248
Least Developed Countries	0.54	68.21	9.10	0.00	11.90	10.80	100.0	5

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

Table 35.8 **Financial intermediation; real estate, renting and business activities**

Region	World GFCF	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	Bilateral ODA	Multilateral ODA	Total	Total GFCF (USD billions)
Africa	0.72	96.62	0.85	2.53	0.00	0.00	100.0	19
Developing Asia	3.56	31.50	67.16	1.34	0.00	0.00	100.0	93
Latin America	2.51	-28.55	19.17	109.37	0.00	0.00	100.0	66
Middle East	1.30	85.15	2.48	12.37	0.00	0.00	100.0	34
OECD Europe	29.98	-11.45	51.51	59.94	0.00	0.00	100.0	783
OECD North America	30.95	50.62	17.55	31.84	0.00	0.00	100.0	808
OECD Pacific	30.12	95.55	0.15	4.30	0.00	0.00	100.0	786
Other Europe	0.02	-4,011.66	0.00	4,111.66	0.00	0.00	100.0	0
Transition Economies	0.85	87.48	11.55	0.97	0.00	0.00	100.0	22
World Total	**100.00**	**43.27**	**23.92**	**32.81**	**0.00**	**0.00**	**100.0**	**2,611**
AI Parties	90.05	44.90	23.01	32.10	0.00	0.00	100.0	2,351
NAI Parties	8.88	83.16	12.03	4.81	0.00	0.00	100.0	232
Least Developed Countries	0.26	98.85	1.15	0.00	0.00	0.00	100.0	7

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

Table 35.9 **Public administration and defence; compulsory social security**

Region	World GFCF	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	Bilateral ODA	Multilateral ODA	Total	Total GFCF (USD billions)
Africa	3.71	94.08	3.89	5.92	3.26	3.27	100.0	23
Developing Asia	9.91	94.51	2.43	5.49	2.06	1.98	100.0	62
Latin America	4.42	4.95	40.71	95.05	1.63	0.29	100.0	28
Middle East	2.30	100.00	0.50	0.00	0.18	0.16	100.0	14
OECD Europe	22.61	70.39	48.25	29.61	0.02	0.00	100.0	141
OECD North America	36.47	96.44	3.49	3.56	0.00	0.10	100.0	227
OECD Pacific	19.23	99.76	0.47	0.24	0.00	0.00	100.0	120
Other Europe	0.03	100.00	0.00	0.00	0.00	0.00	100.0	0
Transition Economies	1.32	-9.85	11.25	109.85	1.30	0.28	100.0	8
World Total	100.00	85.55	16.73	14.45	0.50	0.41	100.0	622
AI Parties	75.45	88.70	0.26	11.30	0.01	0.01	100.0	470
NAI Parties	23.37	73.39	8.85	26.61	1.74	1.44	100.0	145
Least Developing Countries	0.97	100.00	9.10	0.00	11.90	10.80	100.0	6

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

Table 35.10 **Education; health and social work; other community, social and personal services**

Region	World GFCF	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	Bilateral ODA	Multilateral ODA	Total	Total GFCF (USD billions)
Africa	0.72	91.47	4.71	0.00	2.66	1.17	100.0	5
Developing Asia	5.45	76.30	21.50	0.00	2.13	0.07	100.0	38
Latin America	3.52	62.35	36.56	0.46	0.62	0.01	100.0	25
Middle East	2.02	91.71	8.22	0.00	0.07	0.00	100.0	14
OECD Europe	28.28	73.08	26.51	0.38	0.02	0.01	100.0	197
OECD North America	37.64	80.50	18.41	1.09	0.00	0.00	100.0	262
OECD Pacific	21.10	99.27	0.43	0.30	0.00	0.00	100.0	147
Other Europe	0.02	98.93	0.00	0.00	1.07	0.00	100.0	0
Transition Economies	1.24	89.68	9.56	0.00	0.76	0.00	100.0	9
World Total	100.00	81.92	17.30	0.60	0.17	0.01	100.0	696
AI Parties	85.56	82.32	16.99	0.67	0.01	0.01	100.0	595
NAI Parties	13.57	79.80	18.88	0.03	1.20	0.09	100.0	94
Least Developed Countries	0.29	88.26	4.02	0.00	4.93	2.79	100.0	2

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

Table 35.11 **All Sectors**

Region	World GFCF	Domestic investment (private & public)	FDI flows	Debt (international borrowings)	Bilateral ODA	Multilateral ODA	Total	Total GFCF (USD billions)
Africa	1.52	91.92	3.30	2.47	1.41	0.91	100.0	118
Developing Asia	10.37	80.15	16.87	1.64	0.80	0.54	100.0	804
Latin America	4.28	44.70	20.81	33.75	0.59	0.14	100.0	332
Middle East	1.80	91.88	4.18	3.70	0.19	0.05	100.0	140
OECD Europe	26.67	29.73	33.83	36.43	0.00	0.00	100.0	2,067
OECD North America	32.10	66.95	17.95	15.08	0.01	0.01	100.0	2,488
OECD Pacific	21.87	96.51	0.87	2.63	0.00	0.00	100.0	1,695
Other Europe	0.02	-1,109.24	0.00	1,209.16	0.08	0.00	100.0	2
Transition Economies	1.37	79.98	10.70	8.70	0.47	0.15	100.0	106
World Total	100.00	64.65	17.88	17.24	0.14	0.08	100.0	7,750
AI Parties	77.59	68.07	12.51	19.41	0.00	0.00	100.0	6,014
NAI Parties	21.34	85.04	10.17	3.76	0.65	0.38	100.0	1,654
Least Developed Countries	0.51	88.22	4.13	1.30	3.22	3.13	100.0	40

Source: Estimations by UNFCCC secretariat based on data from: UNSTAT, National Accounts Database; BIS, 2007; World Bank, 2006, World Development Indicator; OECD, CRS.
Abbreviations: AI Parties = Parties included in Annex I to the Convention, FDI = Foreign direct investment, NAI Parties = Parties not included in Annex I to the Convention, ODA = Official Development Assistance, OECD = Organisation for Economic Co-operation and Development.

CATEGORIES CONSIDERED TO COMPILE/ANALYZE ODA CAPITAL INVESTMENT DATA FROM OECD CREDITOR REPORTING SYSTEM DATABASE

AGRICULTURE, HUNTING, FORESTRY, FISHING

Agricultural land resources, Agricultural water resources, Forestry development, Fishery development

MINING AND QUARRYING

Mineral prospection and exploration, Coal,Oil and gas, Ferrous metals, Non-ferrous metals, Precious metals/materials, Industrial minerals, Off-shore minerals

MANUFACTURING

Cottage industries & handicraft, Agro-industries, Forest industries, Textiles - leather & substitutes, Chemicals, Fertilizer plants, Cement/lime/plaster, Energy manufacturing, Pharmaceutical production, Basic metal industries, Non-ferrous metal industries, Engineering, Transport equipment industry

ELECTRICITY, GAS AND WATER SUPPLY

Water supply & sanitation - large systems, Basic drinking water supply and basic sanitation, River development, Waste management/disposal, Power generation/non-renewable sources, Power generation/renewable sources, Electrical transmission/distribution, Gas distribution, Oil-fired power plants, Gas-fired power plants, Coal-fired power plants, Nuclear power plants, Hydro-electric power plants, Geothermal energy, Solar energy, Wind power, Ocean power, Biomass

WHOLESALE RETAIL TRADE, REPAIR OF MOTOR VEHICLES, MOTORCYCLES, ETC.; HOTELS AND RESTAURANTS

– NA

CONSTRUCTION

– NA

TRANSPORT, STORAGE AND COMMUNICATIONS

Road transport, Rail transport, Water transport, Air transport, Storage, Telecommunications, Radio/television/print media, Information and communication technology

FINANCIAL INTERMEDIATION; REAL ESTATE, RENTING AND BUSINESS ACTIVITIES

– NA

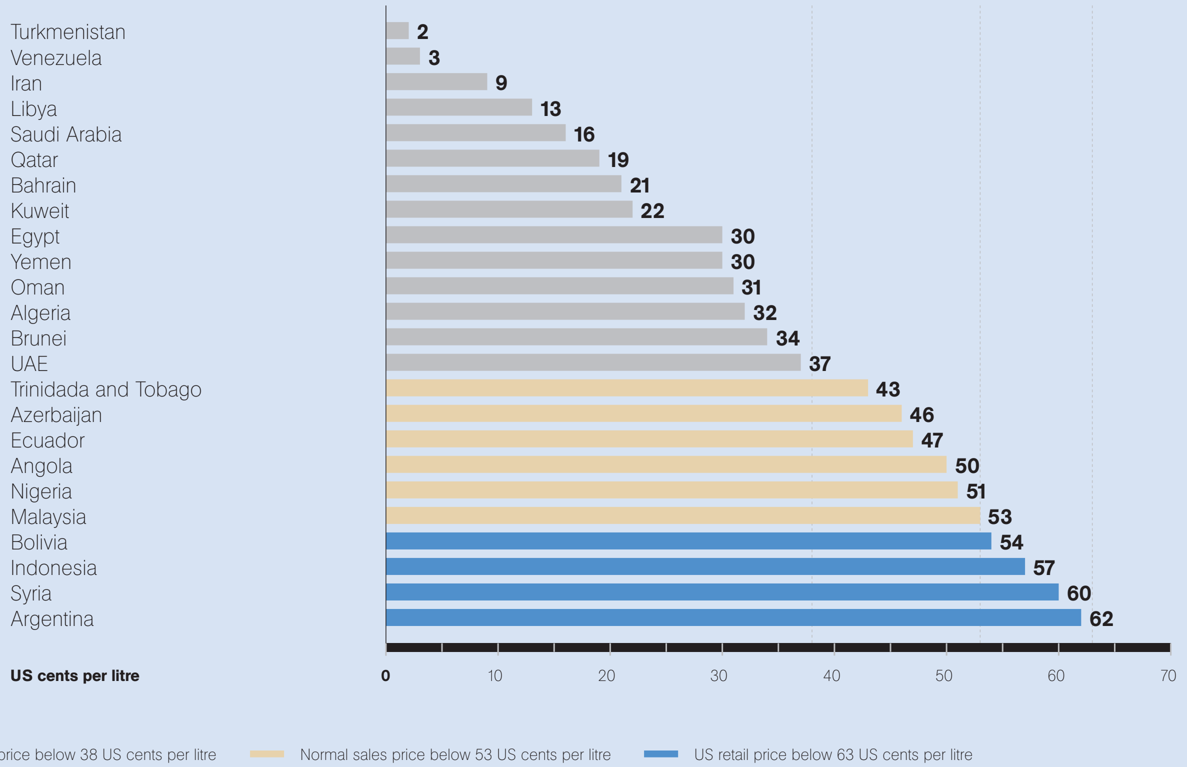
PUBLIC ADMINISTRATION AND DEFENSE; COMPULSORY SOCIAL SECURITY

– NA

EDUCATION, HEALTH AND SOCIAL WORK, OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES

Education facilities and training, Basic health infrastructure, Low-cost housing, Biosphere protection, Bio-diversity, Site preservation, Flood prevention/control

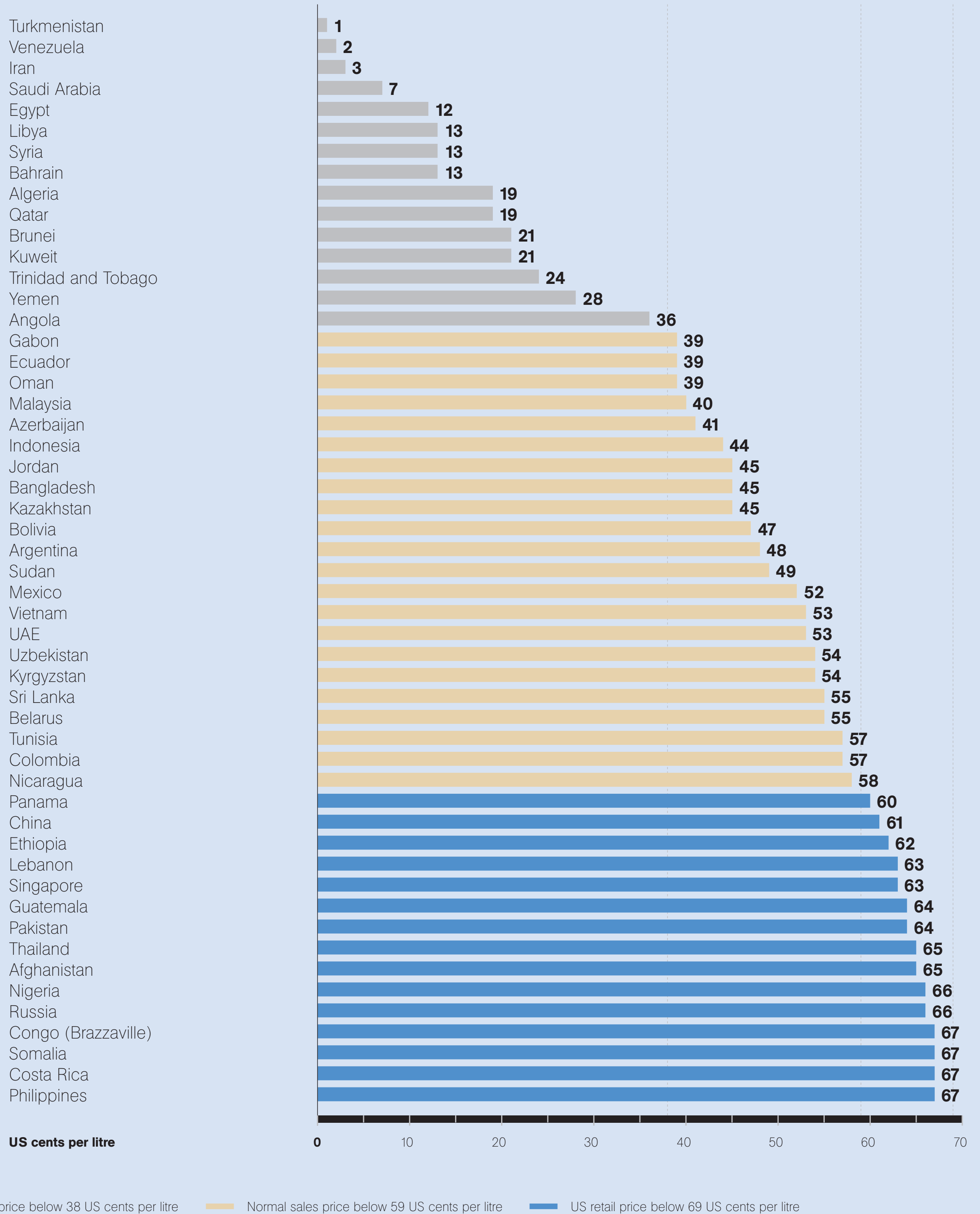
Figure 1. **Subsidies in Gasoline by countries, November 2006 (United States Cents/litre)**



World crude oil price below 38 US cents per litre
Normal sales price below 53 US cents per litre
US retail price below 63 US cents per litre

Source: GTZ, 2007.

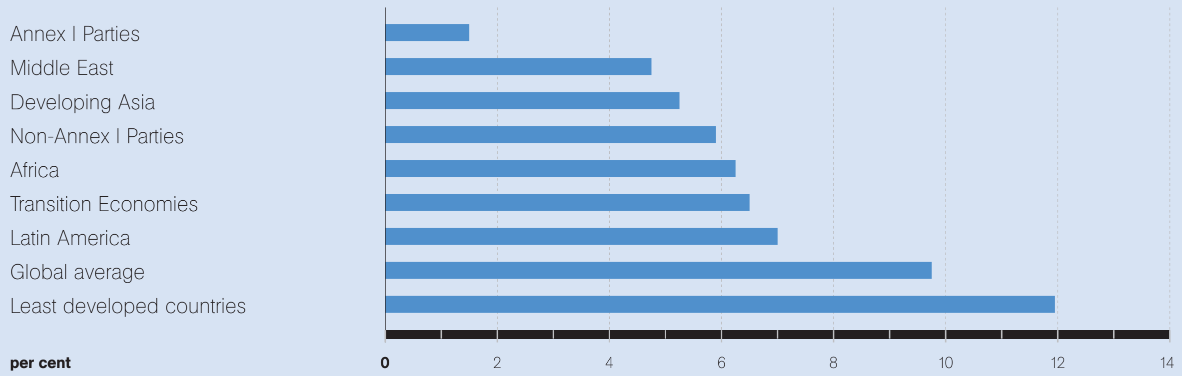
Figure 2. **Subsidies in Diesel by countries, November 2006**



World crude oil price below 38 US cents per litre
Normal sales price below 59 US cents per litre
US retail price below 69 US cents per litre

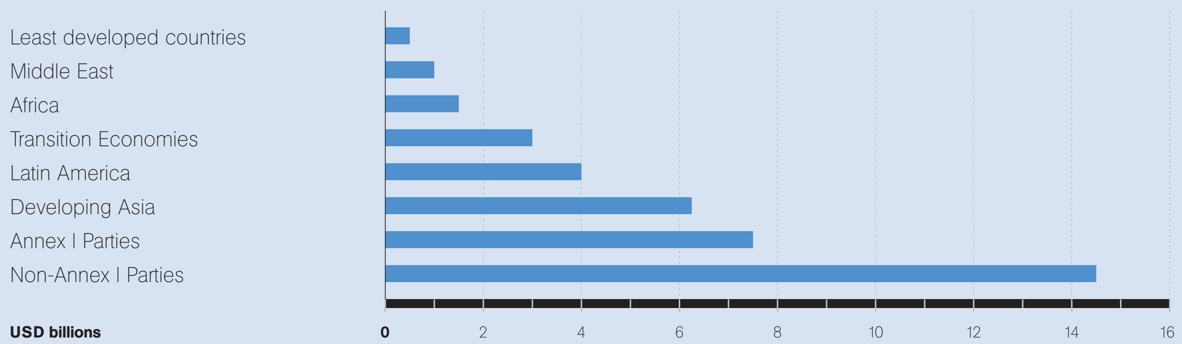
Source: GTZ, 2007.

Figure 3. **Non-technical loss as percentage of total electricity supply**



Source: IEA, 2007; ENERDATA, 2007; Smith, 2004.

Figure 4. **Revenue loss due to non-technical loss of electricity**



Source: IEA, 2007; ENERDATA, 2007; Smith, 2004.

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[1] Data received directly from BIS Monetary and Economic Department.

[2] Electronic data received directly from IEA Economic Analysis Division.

[3] Personal communication with Philip Bagnoli at OECD.

[4] Data and reports are received by personal communication with staff members from the World Bank Carbon Finance Team.

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- International Emissions Trading Association
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World Economic Forum
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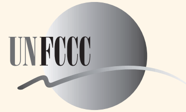

United Nations Framework Convention on Climate Change

2008 Investor Summit on Climate Risk

February 14, 2008 • United Nations Headquarters • New York City

Final Report

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FOREWORD

The next 50 years will require a massive shift to low-carbon energy sources and technologies to avoid unmanageable climate change. Major capital investments are needed to make that shift, creating large economic opportunities.

To consider the scale and urgency of the climate challenge and how investors can advance solutions, Ceres, the United Nations Foundation, and the UN Fund for International Partnerships co-hosted the third Investor Summit on Climate Risk at the United Nations on February 14, 2008. More than 450 investors, representing over $22 trillion in assets, participated in the Summit.

The 2008 Summit featured speakers drawn from the investment community, science, business, labor, and government who discussed the risks investors face from climate change, as well as the very significant economic opportunities of a global transition to a clean energy future—with a particular emphasis on energy efficiency.

At the Summit over 50 leading U.S. and European institutional investors managing $1.75 trillion in assets announced a new Investor Network on Climate Risk (INCR) Action Plan, committing to boosting investments in energy efficiency and clean energy technologies and requiring tougher scrutiny of carbon-intensive investments that may pose long-term financial risks.

We extend our deepest appreciation to the United Nations, the Summit Conveners, and our corporate, foundation, and UN sponsors for their support. This historic gathering would not have been possible without their generosity and commitment.

We look forward to working with you to address the risks and opportunities posed by climate change. Many investors will continue their efforts through INCR, a network of investors coordinated by Ceres and launched at the first Investor Summit on Climate Risk in 2003. We welcome your participation in INCR and other initiatives.

Summit Co-Hosts

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EXECUTIVE SUMMARY

More than 450 investor, financial and corporate leaders from around the world gathered at the United Nations Headquarters in New York City on February 14, 2008 for the third Investor Summit on Climate Risk. Participants engaged in dialogue with leading scientists, investors, business leaders, and others on how investors can minimize climate risk and seize opportunities of the transition to a low-carbon economy.

Summit participants networking in the UN Delegates Lounge

Speakers who addressed the gathering included Harvard University Professor John Holdren, McKinsey Global Institute Director Diana Farrell, AFL-CIO President John Sweeney, International Energy Agency Executive Director Nobuo Tanaka, Khosla Ventures founder Vinod Khosla, Ceres President Mindy Lubber, and Nobel Peace Prize winner and former Vice President Al Gore.

Investor speakers included BT Pension Scheme Trustee Director Donald MacDonald, CalPERS CIO Russell Read, CalSTRS CEO Jack Ehnes, California Controller John Chiang, California Treasurer Bill Lockyer, Connecticut Treasurer Denise Nappier, Florida CFO Alex Sink, New York Comptroller Thomas DiNapoli, and Oregon Treasurer Randall Edwards.

United Nations speakers included UN Secretary-General Ban Ki-moon, UN Fund for International Partnerships Executive Director Amir Dossal, and UN Foundation President Timothy Wirth.

Corporate and Wall Street speakers included Swiss Re Managing Director Richard Murray, PG&E CEO Peter Darbee, Goldman Sachs Chief U.S. Investment Strategist Abby Joseph Cohen, Bank of America Managing Director Richard Cohen, Deutsche Bank Head of Asset Management Kevin Parker, and State Street Global Advisors Executive Vice President Arlene Rockefeller.

Presenters at the Summit noted that:

- The science is clear that global climatic disruption is real, largely human-induced, already producing serious harm, and happening more rapidly than expected. To minimize suffering and avoid catastrophic interference with the climate system, we need significant mitigation and adaptation, which requires putting a price on greenhouse gases (GHGs) immediately.
- Technologies are available and in use today that can make significant differences in reducing GHG emissions. Investments in energy productivity can provide attractive economic returns and are the single most cost-effective, important, short-term steps to address climate change that are already commercially viable.
- New technologies in the next few years have the potential to make a huge impact on emissions reductions. Securing the right policies and incentives can make an enormous difference in spurring technological development, deployment, and investment.
- Investors must show responsibility and leadership, which means engaging with companies in all sectors, collaborating with other investors, investing in clean technology, improving the energy efficiency of real estate portfolios, exploring all asset classes for opportunities to further clean energy, requiring investment managers to evaluate climate risk, and generally undertaking a thorough study of portfolios to assess climate risks and opportunities. Investors cannot wait for governments to act, though they must also continue to engage governments to push for action.

- More and more investors are addressing climate change. In the last two years, investor and asset manager participation in the Investor Network on Climate Risk (INCR) has more than doubled, to over 60 institutional investors. At the 2008 Summit, Deutsche Asset Management, which manages over $800 billion in assets, announced it was joining INCR, increasing INCR's total member assets to over $5 trillion.
- More companies and Wall Street firms are taking action on climate change. Investors have been engaging with a broader range of companies on issues including disclosure of climate risks and actions to address those risks.
- Climate change presents opportunities for economic growth and job creation.

The Summit plenary sessions took place in the Trusteeship Council Chamber of the UN

Over 50 leading U.S. and European institutional investors managing more than $1.75 trillion in assets announced the 2008 Investor Network on Climate Risk Action Plan calling for nine specific steps investors can take to address the growing risks and opportunities from climate change. The investors pledged to collectively invest $10 billion in clean technology opportunities over the next two years; reduce energy use in core real estate holdings by 20 percent over the next three years; incorporate green building standards into their investment decisions; require tougher scrutiny of carbon-intensive investments that may pose long-term financial risks; and a range of other specific steps involving policy support, corporate engagement, and investment practices. *(Please refer to Appendix A for complete text and list of signatories.)*

The Summit would not have been possible without the generous support of our United Nations sponsors, foundation sponsors, underwriters and contributors (see Appendix C for a complete list). Participants included asset managers, state and city treasurers and comptrollers, public and labor pension funds, foundations, and other institutional investors.

The Summit was hosted and organized by the United Nations Foundation, the United Nations Fund for International Partnerships, and Ceres, which directs the Investor Network on Climate Risk (*see Appendix D for more information about INCR*).

SUMMIT AGENDA

9:00 am – Welcoming Remarks *(Trusteeship Council Chamber, 2nd Floor)*
- Amir A. Dossal, *Executive Director, United Nations Fund for International Partnerships*
- Ban Ki-moon, *Secretary-General, United Nations*
- Timothy E. Wirth, *President, United Nations Foundation*

9:15 am – Climate Change: Scientific Findings, Technological Solutions
- John P. Holdren, *Professor, Harvard University & Director, Woods Hole Research Center – presentation and discussion*

10:00 am – The Case for Investing in Energy Productivity
- Diana Farrell, *Director, McKinsey Global Institute – presentation*

10:20 am – Discussion
- Mindy S. Lubber, *President, Ceres & Director, Investor Network on Climate Risk (moderator)*

10:45 am – Panel and Discussion: Unleashing the Business Potential for Clean Energy
- Timothy E. Wirth, *President, United Nations Foundation (moderator)*
- Nobuo Tanaka, *Executive Director, International Energy Agency*
- Peter A. Darbee, *Chairman, CEO, & President, PG&E Corporation*
- Vinod Khosla, *Founding CEO, Sun Microsystems & Founder, Khosla Ventures*

12:00 pm – Panel and Discussion: Factoring Climate Change into Institutional Investment Strategies
- John Chiang, *Controller, State of California (moderator)*
- Donald MacDonald, *Trustee Director, BT Pension Scheme*
- Denise L. Nappier, *Treasurer, State of Connecticut*
- Russell Read, *Chief Investment Officer, California Public Employees' Retirement System (CalPERS)*
- Alex Sink, *Chief Financial Officer, State of Florida*

1:00 pm – Luncheon *(Delegates Dining Room, 4th Floor; closed to press)*
- Luncheon Welcome: Richard H. Murray, *Managing Director & Chief Claims Strategist, Swiss Re*
- UN Welcome: Dr. Srgjan Kerim, *President, 62nd session of the United Nations General Assembly*
- Introduction: Jeff Skoll, *Founder & Chairman, Skoll Foundation & Participant Productions*
- Featured Speaker: Al Gore, *2007 Nobel Peace Prize winner; Former Vice President of the United States; Chairman, Generation Investment Management*

1:30 pm – Investor Press Conference *(Press Room, 2nd Floor)*

2:45 pm – Opportunities for Economic Growth and Job Creation *(Trusteeship Council Chamber, 2nd Floor)*
- John J. Sweeney, *President, AFL-CIO*

3:00 pm – Panel and Discussion: Investing in the Face of Climate Change
- Mindy S. Lubber, *President, Ceres & Director, Investor Network on Climate Risk (moderator)*
- Abby Joseph Cohen, *Chief U.S. Investment Strategist, Goldman Sachs*
- Richard S. Cohen, *Managing Director in the Strategic Investments Group & Head of Environmental Strategic Investments, Bank of America*
- Kevin Parker, *Global Head of Asset Management, Deutsche Bank*
- Arlene Rockefeller, *Executive Vice President & Global Equities CIO, State Street Global Advisors*

4:00 pm – Investor Action Plan to Manage Climate Risk & Capture Opportunities – presentation and discussion
- Bill Lockyer, *Treasurer, State of California*
- Randall Edwards, *Treasurer*, State of Oregon
- Jack Ehnes, *Chief Executive Officer, California State Teachers' Retirement System (CalSTRS)*
- Thomas P. DiNapoli, *Comptroller, State of New York*

4:45 pm – Conclusions and Next Steps
- Mindy S. Lubber, *President, Ceres & Director, Investor Network on Climate Risk*
- Timothy E. Wirth, *President, United Nations Foundation*

INTRODUCTION

Welcome from United Nations

United Nations Secretary General Ban Ki-moon

UN Secretary-General Ban Ki-moon praised the participants at the Investor Summit in his comments at a dinner the evening before the Summit and again in opening remarks delivered on his behalf by Amir Dossal of the United Nations Fund for International Partnerships. He applauded investors for focusing on the delivery of results, such as the investment of $1 billion in clean energy technologies, a target investors pledged to meet at the 2005 Summit and achieved in less than a year.

The Secretary-General reaffirmed the need for participation from the financial community: "The shift towards a greener future is still in its infancy and needs nurturing. The ability of the financial community to determine investment flows gives it great influence over the pace of innovation, technological change and adaptation. While the world looks to the United Nations to steward the negotiating process, the United Nations looks to you, as leaders in the financial sector, to lead in innovative financing and technological development." He urged participants to continue to seek to address climate change in ways that are both affordable and promote prosperity.

The Summit opened with Timothy Wirth, President of the United Nations Foundation, commending Secretary-General Ban Ki-moon for taking such strong leadership in addressing climate change, most recently through his organizing of high-level sessions that led into the Bali negotiations. He explained that throughout the meetings and negotiations surrounding the UN Framework Convention on Climate Change, it has been vital to understand and make the economic case for taking action, as the Investor Summit was designed to do.

Wirth asserted that "one of the things that we hope will ultimately be accomplished coming out of sessions like this is to bring the political leadership along and get them comfortable with the need for transformational change ... and get them to understand that climate should not be viewed as 'woe is me', 'this is a terrible burden on all of society,' - but in fact as the Secretary General said, it becomes a great opportunity for all of the world to develop a job base, a transformed economy, and a very significant new direction." He reminded Summit participants that they have "a very large leadership responsibility" and that "we are all part of this global issue and the global solution."

CLIMATE CHANGE: SCIENTIFIC FINDINGS, TECHNOLOGICAL SOLUTIONS

The first session of the Summit was a presentation by one of the world's preeminent climate scientists, John Holdren, Harvard University Environmental Policy and Earth and Planetary Sciences Professor. He discussed:

- climate science
- climate technology
- climate economics
- climate policy

Dr. John Holdren, Harvard University & Woods Hole Research Center

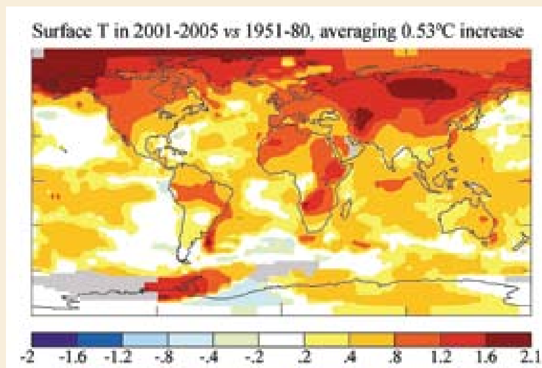
Climate Science: What do we know?

Holdren explained that the term "global warming" is not sufficient in describing the current changes in climate because it implies uniform, gradual, and benign change. "Global climatic disruption" is a more accurate term to use because the changes in climate we are witnessing are non-uniform, rapid, and harmful. This 'disruption,' largely caused by human activity, is already producing significant harm and occurring more rapidly than expected.

"Climate" is the pattern of weather—meaning averages, extremes, timing, and spatial distribution of various weather occurrences. "Climate change", therefore, means altered patterns. While much emphasis is placed on the rising global average temperature (and the earth is getting hotter), this is just an index of the state of the global climate; small changes in the index represent big changes in the patterns. Climate change puts at risk everything that climate governs, including:

- availability of water
- productivity of farms, forests, and fisheries
- prevalence of oppressive heat and humidity
- geography of disease
- damages from storms, floods, droughts, and wildfires
- property losses from sea-level rise
- distribution and abundance of species

The current heating is not uniform geographically



Source: J. Hansen et al., PNAS 103: 14288-293 (2006)

Changes that are already occurring include: warming surface temperatures (though not uniform geographically); changing circulation patterns; increasing evaporation and precipitation (also not uniform geographically); thawing permafrost; shrinking glaciers and sea ice; expanding surface melting on Greenland; and rising sea-level. These changes are causing a range of harms, including floods, wildfires, and altered storm intensity.

Holdren stressed that even bigger disruptions are yet to be seen, asserting that past Intergovernmental Panel on Climate Change (IPCC) scientific assessments have underestimated the pace of emissions growth. Looming

disruptions could include: increased heat waves, increased smog, declining crop yields in the tropics, increased droughts, acidified oceans, and rising seas.

Climate Technology: What can we do?

There are three options for dealing with climate change: mitigation, adaptation, and suffering. Holdren asserted that "we need enough mitigation to avoid unmanageable climate change, and we need enough adaptation to manage the unavoidable climate change."

Mitigation involves measures to reduce the pace and magnitude of the increase in global greenhouse gas (GHG) concentrations. These efforts must include:

- reducing emissions of GHGs and soot
- reducing deforestation
- increasing reforestration and afforestation
- modifying agricultural practices to reduce emissions of GHGs and build up soil carbon

Mitigation may also necessitate "scrubbing" GHGs from the atmosphere or pursuing various "geo-engineering" ideas to create cooling effects.

Adaptation (reducing the adverse impacts of climate change on human well-being) includes:

- altering crop patterns and developing heat-, drought-, and salt-resistant crop varieties
- strengthening public-health and environmental engineering defenses against tropical diseases
- building new water projects for flood control and drought management
- building dikes and storm-surge barriers against sea-level rise
- avoiding further development on flood plains and near sea level

Many adaptation measures are "win-win" and would be wise to pursue even without the risks of climate change.

Noting that we already have "dangerous anthropogenic interference with the climate system, Holdren maintained that the key question we face now is: "can we avoid catastrophic interference?" The chances of catastrophic change are much higher with a rise in average temperature of more than 2ºC above pre-industrial levels, so limiting the change to less than 2ºC is the most prudent target that still might be attainable.

Cutting emissions will be a huge challenge. Carbon dioxide (CO_2) emissions from human activities—75% from burning fossil fuels, 25% from deforestation and burning in the tropics—are the biggest piece of the problem. With $15 trillion already invested in the existing global energy system, the system cannot be changed quickly.

The basic options for reducing emissions are to reduce population growth, the growth of GDP/person, the energy/GDP ratio, or the CO2/energy ratio—all of which have limitations and liabilities. Holdren stressed the need for a portfolio of approaches, in addition to increased research and development. He underscored that to make the necessary emissions reductions, "we can't just think big. We have to think huge."

Climate Economics: Can we afford to address climate change? Can we afford not to?

The cheapest, fastest and cleanest method to reduce emissions is to increase the energy efficiency of buildings, industry, and transport, which saves energy, increases domestic jobs and energy security, and reduces pollution. Putting a price on greenhouse gas emissions, along with carbon capture and sequestration, are necessary to ensure adequate mitigation. Holdren made clear that while the world can afford the costs of avoiding the necessary amount of emissions (and may even benefit economically in the transformation to sustainability), the economic damages of not stabilizing the climate are literally incalculable, and likely higher than the mitigation costs.

Global climatic disruption entails both big dangers (for firms and investors that make bad or no choices about how to respond to climate risks) and big opportunities (for those that act creatively and aggressively to help society reduce climate risks and make money doing so). Business risks include damage to assets, operations, customers, and markets, as well as reputational damage, competitive disadvantages, and potential liability for contributing to climate risks. Opportunities, on the other hand, include new or improved products and services, trading of emissions permits and offsets, and "green" portfolio development and management.

Climate Policy: How do we get it done?

U.S. domestic climate policy must be national, mandatory, stringent, and enacted soon. Internationally, it is important that industrialized nations lead in implementing costlier solutions, offer assistance to developing countries, provide compensation to developing countries for not cutting down their forests, and agree to a formal and binding global instrument for the post-Kyoto Protocol period in 2012.

Key Next Steps

The most important, immediate next steps are to:

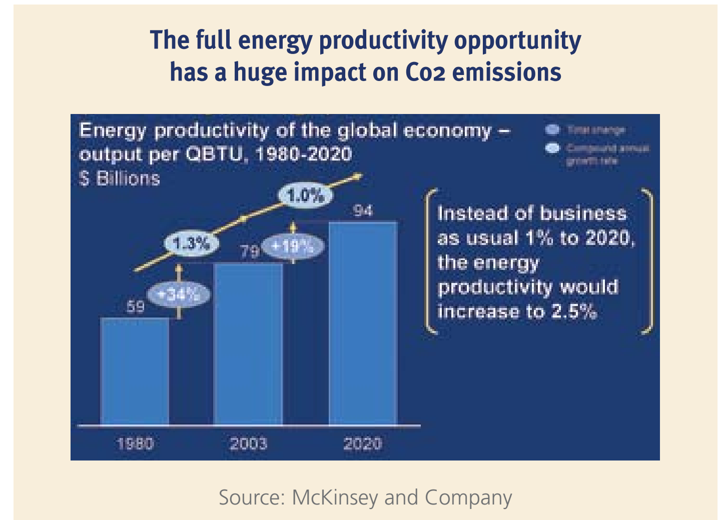
- Accelerate win-win mitigation and adaptation measures
- Put a price on GHG emissions
- Complete a global post-2012 agreement by 2009
- Ramp up investments now in R&D by 4–10 times (public and private combined)
- Expand international cooperation on deploying advanced energy technologies

THE CASE FOR INVESTING IN ENERGY PRODUCTIVITY

Diana Farrell, Director of the McKinsey Global Institute (MGI), presented a strong case for investment in energy productivity (defined as higher economic output per unit of energy) as highlighted in the MGI report released at the Summit entitled, "The Case for Investing in Energy Productivity." She explained that energy efficiency improvements can provide attractive economic returns and are the single most cost-effective, important steps to address climate change that are already commercially viable.

Without mitigation, energy demand will accelerate, but this growth can be cut by more than half by 2020. Farrell argued that energy demand growth could decrease from 2.2% to 0.7%, with positive returns, and that it is possible to realize these cuts in energy demand growth across all regions and end-use sectors.

The full energy productivity opportunity has a huge impact on CO_2 emissions



Source: McKinsey and Company

Although the rate of increase of energy productivity has slowed recently from 1.3% to 1.0%, that rate could be increased to 2.5% by 2020 through investments of $170 billion—or just 1.6% of global fixed investment (0.4% of current global GDP). Realizing the full energy productivity opportunity would have a huge impact on reducing CO_2 emissions, with a negative cost of abatement. The rate of return could be as high as 17%, translating to $900 billion of annual savings by 2020—which means $900 billion available for investment in energy supply infrastructure.

Farrell outlined the largest energy productivity opportunities across the industrial, residential, commercial, and transportation sectors:

- Industrial sector opportunities provide 39% of the opportunity for global energy productivity improvement with an $83 billion investment annually and short payback times. Investments could include combined heat and power generation, optimization of motor-driven systems, and various sector-specific efforts. The capital investments needed are moderate—a cumulative $20 billion per Quadrillion British Thermal Units (QBTU) abated in 2020.
- Residential sector opportunities represent 26% of the potential increase in energy productivity—requiring $40 billion in investment annually in improving lighting, new buildings (heating and cooling), building replacements, water heating, and appliances. These opportunities require the lowest-capital investments—a cumulative $15 billion per QBTU abated in 2020.
- Commercial sector investments, where $22 billion in annual investment could yield 10% of the potential productivity gains, could support improvements in water heating, HVAC, lighting, and appliances. Most of these opportunities are concentrated in developed countries, and they have high capital needs—a cumulative $21 billion per QBTU abated in 2020.
- Transportation sector opportunities also represent about 10% of potential productivity improvement, requiring $25 billion in annual investment in better fuel-saving design. Capital needs in this sector are very high—a cumulative $40 billion per QBTU abated in 2020.

Diana Farrell, McKinsey Global Institute

The biggest energy productivity opportunities are in the U.S., China, and other developing countries, with the Middle East an often overlooked opportunity.

Four key investment opportunities for the public and private sectors were stressed:

- Set efficiency standards for appliances and equipment.
- Finance energy efficiency upgrades in new buildings and remodels.
- Raise corporate standards for energy efficiency. There are extensive opportunities to encourage managers to reduce energy use; to request energy efficiency and greenhouse gas emissions information on a regular basis; and to encourage companies to develop appropriate metrics. Many companies have already demonstrated that these measures can provide huge annual savings. Private equity also has a significant role to play.
- Invest in energy intermediaries. Identify new ways to aggregate and combine skills among energy service companies, green investment funds, regulators, utilities, and others.

Finally, Farrell emphasized that $170 billion of investment in energy productivity provides energy savings that yield attractive returns, a potential source of additional revenue from sales of white certificates or emission permits, reduced exposure to energy related risks, freed-up investment system-wide, and critical CO_2 emissions reductions. These energy productivity opportunities mean that, even while waiting to get essential regulations in place, “there are no-regrets things that can be done.”

UNLEASHING THE BUSINESS POTENTIAL FOR CLEAN ENERGY

Timothy Wirth, President of the UN Foundation, moderated presentations about the potential for clean energy from: Peter A. Darbee, Chairman, CEO, & President of Pacific Gas & Electric (PG&E) Corporation; Nobuo Tanaka, Executive Director, International Energy Agency (IEA); and Vinod Khosla, Founding CEO, Sun Microsystems and Founder, Khosla Ventures.

Experience with Efficiency and Renewables

Mr. Darbee presented remarks based on PG&E's "first-hand practical experience" in California.

He stressed that "technologies are available today and in use today that can make significant differences" in reducing GHG emissions, as demonstrated through California's progress over the last 30 years. Lack of will—not invention—has become the biggest obstacle. Darbee argued that if business leaders are serious about climate change, then they must take accountability for these choices, rather than pretending their hands are tied until future technology hurdles are overcome. The federal government also must set long-term national targets and timetables for reducing greenhouse gases, which would provide clarity and context for businesses.

Peter Darbee, PG&E Corporation

Opportunities in energy efficiency

PG&E views energy efficiency as the "first fuel" to meet energy demand because it is highly cost-effective, relatively fast to implement, and achievable with existing technology. California has kept per capita energy use constant over the last 30 years, while the rest of the country has seen a 50% increase, because California adopted policies that aligned the right incentives for energy efficiency, such as decoupling utility profits from energy sales and providing opportunities to earn returns on energy savings. Darbee advocated that the California experience be replicated in other states, although he recognized that progress is slow because these policies require a substantial change in mindset on the part of both utilities and regulators. He argued that decoupling provides investors with an increased level of predictability in earnings and also focuses management on the customer and innovation, as opposed to putting more capital into constructing new generating capacity.

Opportunities in renewable energy

Darbee affirmed PG&E's support for California's renewable portfolio standard (and for a national standard), but clarified that like energy efficiency, companies need more than just mandates for renewables to reach their full potential. He described the obstacles to achieving California's 20% renewable portfolio standard, including competitive pricing and transmission constraints.

He stressed the need to address these obstacles in an integrated, strategic fashion that blends incentives, standards, public sector investment, and other mechanisms. In particular, Darbee advocated:

- a price and market for carbon so that the real costs of conventional generation can be reflected
- the extension and expansion of renewable energy production and investment incentives by the federal government to reduce investment uncertainty, spur the development of longer-term technology, encourage fuller deployment of these technologies, and send a critical signal to investors to take the long view and commit to these projects
- investment in transmission and distribution infrastructure

Role for the Investment Community

Darbee encouraged the financial community to support calls for transparency on GHG emissions and expressed support for a national reporting standard for GHGs. To separate companies that are internalizing climate change and its impact on business from those that are not, Darbee urged the investment community to consider two questions:

- Is the company engaged in understanding where policy on climate change is headed?
- Is the company running the business with an eye toward the broader changes associated with climate change? (Are they following the science? Are they taking steps to adapt to the impacts on natural resources, energy use patterns, customer needs, infrastructure, etc.?)

As an example, Darbee described how PG&E is examining forecasts of climate impacts on the Sierra Nevada snowpack and is starting to consider how the company would address diminished hydro capacity.

Companies that are asking these questions now are going to have a much richer understanding of the long-term risks and opportunities and will be substantially ahead of the game. If the investment community begins to recognize and reward this kind of thinking, it could go a long way in driving innovation, helping the industry and the country turn the corner on the challenges posed by climate change, and creating significant value and growth opportunities.

Nobuo Tanaka, International Energy Agency

The International Energy Agency (IEA) Perspective

Stating that energy security is IEA's main mission, Mr. Tanaka acknowledged the need for a new energy revolution to reduce energy-related emissions to 23 Gigatons (Gt) by 2030—a large cut from the 42 Gt projected for 2030 and even from the current level of 27 Gt. This reduction, which could allow us to stabilize atmospheric concentrations at 450ppm, should come partially from energy efficiency and partially from decarbonization of power sector technologies.

Simply setting a CO_2 emissions target cannot solve the problem; infrastructure is needed as well. Tanaka emphasized the need to build huge numbers of power plants every year, but recognized the enormous challenge this presents.

Marginal costs for cutting CO_2 emissions are lowest for end-use efficiency, followed by power sector de-carbonization, industry fuel switching (and carbon capture and sequestration), and transport sector fuels. Bringing emissions back to current levels by 2050 can be achieved by end-use energy efficiency, at a marginal cost of $50/ton. Reducing emissions 50% by 2050 would require a marginal cost of $200/ton CO_2. The costs to achieve these reductions could exceed $50 trillion—a huge investment, although only 1% of GDP.

Tanaka emphasized that we must double our energy efficiency efforts, noting that the rate of energy efficiency improvement in IEA countries since 1990 has been less than 1% per year—much lower than in previous decades. IEA has already recommended 16 energy efficiency measures, including phasing out incandescent bulbs and reducing the power consumed by electronic equipment while in a power-off/stand-by mode. Even though energy efficiency is good for the economy, the environment, and security, the challenge has been implementation of these measures—in part due to government hesitation to prescribe stringent standards.

Tanaka also discussed renewable energy, urging that all options be kept open and subject to the market. He pointed out that wind energy is nearly cost competitive with fossil fuels. He also

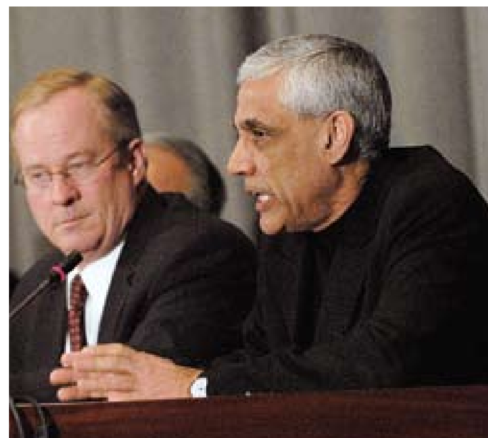
advocated a re-energizing of support for research and development, noting that government spending on R&D has fallen since the 1980s.

Tanaka asserted that open dialogue and cooperation between environmental and energy groups is needed. His goal is to transform the IEA into the International Energy & Environment Agency. He observed that "the scarce resource that we have to talk about is not energy or natural resources or the capital, but probably time."

Role of Technology

Offering "mostly convenient truths from a technology optimist," Mr. Vinod Khosla provided a different point of view. He asserted that forecasting is difficult in a new world. He quoted a Silicon Valley computer scientist who said that "the best way to predict the future is to invent it," noting that today's unimaginable is routinely tomorrow's conventional wisdom.

Khosla forecast that within 10 years, everyone will believe that oil will have to start dropping rapidly in price to compete with second generation biofuels. Even today, it is possible to produce power from solar thermal energy more cheaply than nuclear, carbon capture and sequestration (CCS), and integrated gasification combined cycle (IGCC).



Vinod Khosla, Founding CEO, Sun Microsystems & Founder, Khosla Ventures and Peter Darbee, CEO, PG&E Corporation (left)

Energy efficiency will not be a demand-side phenomenon, Khosla asserted, but rather supply-side. For example, economics will drive the change if we produce an engine that does not cost as much as current engines and uses only half as much gas. Khosla maintained that few of the usual technologies (e.g., wind) will be relevant to addressing climate change and that the "new green" is about technologies that can replace 80% of coal plants without subsidies—new engines, lighting, appliances, batteries, and flow cells. "Capitalist greed will drive the solutions," and new ideas will make all the assumptions in all the forecasts wrong.

Some of Khosla's predictions include:

- Enhanced geothermal and solar thermal will be cheaper than carbon capture & sequestration, and solar thermal will be utility-scale.
- Food-based fuels will be obsolete; corn-based ethanol will be uneconomic within 5 years.
- Cellulosic fuels will be cheap—Khosla Ventures' goal is $1.25/gallon in 3-5 years.
- Wood chips will provide diesel; waste will provide jet fuel.
- Renewable materials (glass, cement, etc.) will be available for use.

All of this will be driven by technology, on the supply side, and technology will change the cost equations. Khosla declared that if it is possible to replicate Khosla Ventures' investments 100 times over, then fossil fuel technology will itself be "fossilized" very quickly. He noted that "a crisis is a terrible thing to waste," that this crisis provides an opportunity, and that "technology is changing the art of the possible."

Discussion

Diana Farrell of McKinsey responded to Khosla by noting that efficiency and technology do not work at counter-purposes and that we should be more efficient as we seek out technological solutions. Khosla agreed that efficiency and technology can be complementary, but he noted that the fundamental difference is that he focuses on making technology cheaper for consumers and allows demand to respond to the lower price. Ms. Farrell also pointed out that there have been

promises of technology breakthroughs for 30 years and asked Khosla what made him think today was different. In response, Khosla explained that it is possible to bring about faster technological breakthroughs today because more people are focused on developing innovation and are applying the Silicon Valley mindset to energy. Years ago, university presidents could not prompt the best 10% of graduate students to enroll in energy studies, whereas today the best 10% all want to work in energy innovation. He predicted that ten years from now, there will be an explosion in energy innovation as a result. Darbee added that a critical driver of technology will be internalizing the cost of carbon emissions, which changes the economics substantially and makes the opportunities pointed out by Khosla much more attractive. He asserted that it is important to get the incentives and polices right, but acknowledged that technology can deliver results far beyond expectation.

E. Angus Friday, Ambassador to the U.N. from Grenada and Chairman of the Alliance of Small Island States (AOSIS), asked the panel whether enough money was going into venture capital for climate change, whether there is a need to encourage more funding to speed up the pace of innovation, and whether carbon trading (or a carbon tax) that changed the competitiveness of fossil fuels would generate new technology fast enough. Tanaka responded that Khosla must convince investors to put money into his ventures and that government has to spend money on R&D. He argued that one of the challenges for governments is to put a price on carbon; otherwise, use of coal—which is currently very cheap—will continue to increase. He expressed hope that Khosla is right regarding the ability to quickly develop the new technologies needed. Khosla commented that despite rapid increases, more venture capital funding is needed, particularly in the area of project finance, since providers of project capital typically finance projects that use existing technologies, not new ones.

FACTORING CLIMATE CHANGE INTO INSTITUTIONAL INVESTMENT STRATEGIES

Mindy Lubber, President of Ceres and Director of the Investor Network on Climate Risk, introduced a panel on factoring climate change into institutional investment strategies. She noted that the panelists "provide enormous hope" as pioneers who have taken on the issue of climate risk as fiduciaries and asset owners, who have encouraged improved disclosure and governance at dozens of companies, and who have begun to engage with policymakers such as Congress and the U.S. Securities and Exchange Commission.

John Chiang, Controller of the State of California, moderated the panel, directing a series of questions to the panelists: Donald MacDonald, Trustee Director, BT Pension Scheme; Denise Nappier, Treasurer, State of Connecticut; Russell Read, Chief Investment Officer, California Public Employees' Retirement System (CalPERS); and Alex Sink, Chief Financial Officer, State of Florida.

Opportunities for Investors

The panel highlighted several themes and key points regarding investor opportunities due to the growing awareness of climate change and corresponding changes in the global market.

Donald MacDonald, BT Pension Scheme; Alex Sink, Florida Chief Financial Officer; Denise Nappier, Connecticut State Treasurer; and John Chiang, California State Controller

- Mr. MacDonald declared that the exercise of investor responsibility and professional leadership, including engaging with companies and collaborating with other investors, is essential in order to assess climate risks and opportunities in portfolios. BT Pension Scheme, a conventional mainstream investor at the forefront of sustainable investments in existing property portfolios, is now looking to invest US $1 billion in clean building technology and clean development. In its conventional portfolio, it is trying to apply existing efficiency and renewable energy technologies in an integrated way.
- Mr. Read emphasized that fundamental to being a successful long-term investor is seeing where capital is needed and then deploying it. For example, CalPERS is doing so in infrastructure, real estate, and clean tech. It is developing its own infrastructure program, in addition to coordinating with other pension funds, and sees the capital requirements and time horizons as well-suited to long-term investors. In terms of real estate, innovations in the housing and construction sector are essential given that roughly 2 billion people will advance from subsistence-level housing. In terms of clean tech, Read noted the importance of getting the incentives right for producers and consumers, including effective pricing of GHG emissions and appropriate disclosure that allows for comparability for investors.
- Treasurer Nappier underscored the point that "all asset classes within our institutional investment portfolio are ripe for innovative ideas to further clean technology and renewable energy initiatives," such as renewable energy project debt financing. Nappier also noted that more individuals in the investment management community are beginning to appreciate climate risks and opportunities.

Progress in Corporate Engagement

Treasurer Nappier then described some of the progress that has been made in terms of corporate engagement on climate risk and opportunity. Nine years ago, companies would not let investors speak to directors about the subject, and many did not even acknowledge that climate change affected a company's bottom line. That attitude is now the exception to the rule; more

executives recognize that they do not have to work through these issues as adversaries, since investors share an interest in companies' growth and success. Fueled in part by the media, consumer demand, government action, and the clout of investor colleagues, shareholder activism on climate change has had a widening scope and reach since 2005. For example:

- Conversations with executives have moved beyond whether climate change is a problem, and with some, the conversation is no longer even about disclosing the risks so much as about taking immediate action to mitigate those risks. Investors are talking with Ford and GM about developing strategic plans to meet the new CAFE standards and are talking to utilities about their strategic plans to be profitable as rate structures change to give utilities incentives to help consumers save energy. Nappier stated her belief that the next Congress will pass a carbon cap that will be signed by the President, and that "our companies need to get ready to operate in that new world."
- Investors' focus has gone beyond the major GHG-emitting sectors to sectors like banking and insurance. Some banks are now adding climate as a risk factor in their assessments and are also looking to reduce the carbon footprint of their loan portfolios. There is also some focus on big-box retailers, some of whom are using their tremendous clout with vendors to reduce energy throughout the supply chain, causing a ripple effect through the business community.
- A lot of major firms in the investment management community are now issuing their own reports on climate risks and opportunities, with sector- and company-specific analyses. Evolving investment strategies, vehicles, and instruments will allow these firms to make a profit on climate risks and opportunities. The more institutional investors demand this kind of approach to the investment of assets, the more the market will respond.

Florida CFO Alex Sink

Monitoring Investments

CFO Sink described the Florida Treasury's initiative, as part of the Treasury's regular semi-annual review of its external managers, to ask its managers how they are incorporating issues of climate risk into their evaluations of their investments on the Treasury's behalf. Manager responses ranged from a dozen pages to "I don't have a clue." She highlighted the frequent response from managers about their lack of sufficient information, which led her to focus on getting public companies to disclose how their boards are thinking about and addressing these issues, which in turn led Florida to sign onto the September 2007 petition calling on the SEC to issue guidance clarifying that material climate-related information must be included in corporate disclosures under existing law.

Controller Chiang shared California's practices, noting that a portion of their public equity portfolios uses environmental screens. In 2008, Chiang asked the investment committees of CalPERS and CalSTRS to seek more disclosure on climate risks from companies. He also asked the committees to improve corporate governance by incorporating the Ceres "Climate Change Governance Checklist" to evaluate best practices. In addition, he asked his staff to work with other investors in INCR and the Ceres staff to develop and implement a survey of public equity investment managers regarding their ability to evaluate climate risks and opportunities, the results of which will be considered in manager reviews and hiring.

Sectors Facing Significant Climate Risk

The panel discussed the sectors they see as facing the most significant climate risks, as well as what can be done to address them.

- MacDonald declared that apart from the more esoteric asset classes, almost every asset class is exposed to risk, including property, infrastructure, private equity, and commodities. Climate change is also a driver for a range of other social, environmental, and political risks. The way that institutional investors set their asset classes in the future will reflect the changes that will occur in the world economy. MacDonald maintained that "the climate change issue should be a real driver for all of us to do a root-and-branch study of our portfolios." He pointed not only to the engagement process with equities, but also to direct investments in property, equities, and infrastructure. He noted that tackling emissions from buildings or making major changes in the electrical grid will require heavy investment and long-term financing—investment that institutional investors can provide. Investments demonstrate a range of risks, from the bond-like investments in infrastructure to seed capital for private equity for scientists and engineers to develop new technology. "We are now reviewing all of our asset classes and all the components that make up each of those classes to see what the impact is of our investments in terms of existing climate problems and where the smart money is going to go." He acknowledged that none of this will be easy, but he noted both a social obligation and an obligation to beneficiaries.
- Read focused on real estate and clean tech. He pointed out that CalPERS has a $20 billion real estate portfolio and is halfway through the "Green Wave" initiative seeking 20% reduction in energy use in 5 years. For clean tech, Read predicted that if we get the incentives right, it will mean that many industries will be re-valued, with lots of winners and losers.
- Nappier emphasized that all sectors are at risk. The biggest issue initially was the huge emitters like the oil & gas sector, but some of the focus has now moved to other sectors like insurance. Insurance companies get hit with a "double whammy" in that climate risks can affect their ability to pay claims but also can affect how they can prudently invest their assets.

Connecticut State Treasurer Denise Nappier

Russell Read, California Public Employees' Retirement System (CalPERS)

Richard Murray, Swiss Re

KEYNOTE LUNCHEON

The featured speaking during the Summit luncheon was 2007 Nobel Peace Prize winner and former U.S. vice president Al Gore. Vice President Gore was preceded by welcoming remarks from Amir Dossal, on behalf of Dr. Srgjan Kerim, President, 62nd session of the United Nations General Assembly, and from Richard H. Murray, Managing Director & Chief Claims Strategist, Swiss Re. Mr. Gore was introduced by Jeff Skoll, Founder & Chairman, Skoll Foundation & Participant Productions.

Luncheon Welcome

Mr. Murray explained that Swiss Re has long been committed to climate responsibility, including producing one of the first corporate reports on climate concerns in 1994, committing to carbon neutrality within five years, focusing on responsible investment, and pledging to develop insurance products and services to facilitate and support clean energy ventures. Swiss Re believes that even greater mobilization of responses to the climate crisis will emerge when reporting and disclosure of corporate systemic and regulatory climate risks are not just best practice but are mandatory.

Referring to Holdren's presentation about the current harms of climate change, Murray commented that "the future is here now," noting that "the insurance industry has the dubious privilege of being able to recognize that commerce mirrors science" since it encounters these conditions in the core of its business earlier than others.

Consequently, Murray emphasized that Swiss Re has three principal reasons for its commitments:

- The obligation to Swiss Re shareholders to understand and properly control the losses already visible.
- The obligation to share the insurance industry's insights into the presence and pace of climate change damage with public sector policymakers and private sector leaders.
- It is the right thing to do, since the problems of climate change fall mostly on those least able to deal with it, threatening life and stability around the world. "Beyond commerce, science, economics—this goes to the heart of humanity."

Jeff Skoll, Skoll Foundation & Participant Productions

Introduction of Al Gore

Mr. Skoll, Founder & Chairman, Skoll Foundation & Participant Productions introduced Vice President Gore. After the 2000 election, Gore updated and expanded his slideshow presentation about global warming. Skoll and his colleagues convinced Gore that he needed to transform the slideshow into a movie in order to reach a mass audience. The result—An Inconvenient Truth, produced by Skoll among others—became the fourth largest grossing documentary of all time. Skoll asserted that this is just the beginning of the story. The next question is: are we prepared to make the difficult decisions to address this challenge?

Featured Speaker—Al Gore

Al Gore, 2007 Nobel Peace Prize winner; Former Vice President of the United States; Chairman, Generation Investment Management

Mr. Gore began his speech by emphasizing that the solutions to the climate crisis are neither mysterious nor complicated. "We have to put a price on carbon. Carbon has to be accounted for in the marketplace." Noting the need for a carbon tax, cap and trade, and renewable energy standards, he declared that "we need all the arrows in the quiver."

The investor community in particular must look far into the future. "This is a group that can't afford to wait until new laws are passed and regulations enacted. You have an obligation to match your long-term assets to the certainty of your long-term threats."

Gore praised the accomplishments of the Investor Network on Climate Risk (INCR) and the UN, and stated that the INCR Action Plan released at the Summit "is an example of great leadership." He noted that many investors have "gone from talking the talk to walking the walk", though others have taken only baby steps. But although the efforts so far have been "fantastic," Gore stressed that "you need to do much more." In particular, he declared: "You need to really scrub your investment portfolios. Because I guarantee you, that if you really take a fine-toothed comb and go through your portfolios, many of you will find them chock-full of sub-prime carbon assets. Now that the world is moving to recognize the true scope and magnitude of this historic challenge we're confronting, the time is drawing nigh when you, like some colleagues in the mortgage business, will be personally held accountable for what you didn't see that you should have seen."

"There are few things as powerful as an assumption whose time has passed," Gore observed, referring to investing in business models that assume carbon is free. He called that "an assumption that is about to go splat."

Summit participants were urged by Gore to "start amping up the actual changes in your portfolio to make them sustainable." He continued: "Don't just talk the talk, don't just walk the walk. Run the run—towards sustainable asset management. When the judgment comes—were you among the sleepwalkers or the ones who saw it and acted?"

Moving to a note of optimism, Gore discussed his vision of what is to come. Thanks to a huge increase in venture capital and private equity investing, Gore sees a range of solutions that are "in the on-deck circle" and "a wave of green-collar jobs ready to open up." He urged the world as a whole to combine the struggle against extreme poverty and the solution to the climate crisis. He maintained that there are substitutes available today for building new "dirty fossil fuel plants", including concentrated solar power, and that putting a price on carbon will bring these new sources into the marketplace.

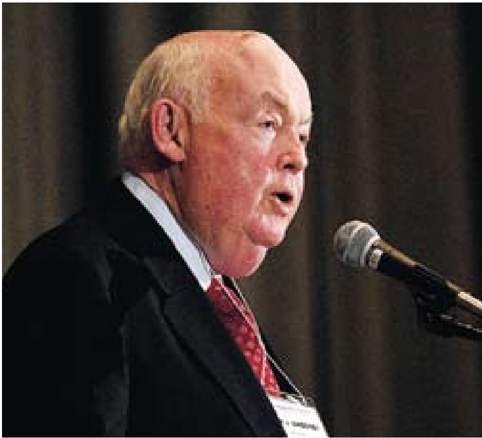
Investment by Summit participants is critical "not only because it is the right thing for you to do as trustees, but because to get this new reality to come to pass, the first movers will have an advantage."

Gore emphasized that this generation ought to see this challenge as "a great privilege" and "confront it with joy in our hearts" because few generations have ever had responsibility for decisions that will affect all future generations. "The fact that that challenge falls to us should cause us to feel like we have the great joy of doing work in our lives that is worth our best efforts. And you are in a position to direct the flows of capital that will make that happen."

OPPORTUNITIES FOR ECONOMIC GROWTH AND JOB CREATION

John J. Sweeney, President of AFL-CIO gave a labor perspective on the climate challenge and the opportunities presented by investments in clean and efficient energy.

Sweeney noted that the AFL-CIO has been part of Ceres' groundbreaking work since Ceres was founded almost 20 years ago. Sweeney expressed pride that the global labor movement was among those who called for decisive action at the December 2007 UN climate talks in Bali. "We hear again and again that we must choose between having a stable climate and having a strong global economy. This is a false choice."



John Sweeney, AFL-CIO

The "colossal challenge" of dealing with energy scarcity and global warming can mean enormous opportunities for developed and developing countries, for investors across asset classes, and for workers. Sweeney suggested that the global nature of the economy and of climate impacts requires global rules. "We need common rules for all of us—worker protections, investor protections and environmental protections." He also emphasized that we need "strategies that work for all of us" at the national and global levels to combat climate change and to create and share wealth.

Executing strategies to combat climate change "requires deploying our current human and financial capital to secure a future we want to live in. Much of that capital is workers' retirement funds." In the U.S. alone, he said, $5 trillion is invested on behalf of union members. "These deferred wages of working people are the capital that can fuel the energy economy of the future." This is not an issue of trading off investment returns for environmental protection; rather, if we want healthy long term investment returns, we must solve the energy and the environmental crisis. Sweeney observed that "for investors, the development and deployment of new energy technology that does not emit carbon is a fantastic old-fashioned opportunity to make money—to be in on the ground floor of the future."

Sweeney urged investors not to wait for governments to act. He encouraged them to look at investments in solar, wind, geothermal, hydro, nuclear, and carbon capture and sequestration—suggesting that a 10-year program to bring 18,500 megawatts of renewable energy on line annually could generate 2 million full-time equivalent jobs. He also supported increasing energy efficiency, including green buildings and a smart grid. He emphasized the need for scale and speed. And he declared that "the AFL-CIO is committed to a continuing effort to inform the stewards of our members' money about the investment opportunities in energy transformation."

Sweeney also urged investors to demand the information necessary to hold corporations accountable for taking responsibility for and seizing the opportunities created by the climate crisis. He applauded the pension funds that led the effort to ask the SEC for mandatory disclosure of climate risks, "but while we wait for an SEC ready to act, investors can use our power, our voice, to get companies to make these disclosures."

Collaboration between investors, labor, and government will be essential; for instance, labor needs business and government partners to ramp up advanced job training and education.

Sweeney urged investors to join with labor and environmentalists to demand that government act to accelerate the pace of change, as “we all win when government finally puts the needed public investment into mass transit, advanced automotive technology, and carbon emissions control technology.”

And Sweeney painted a stark picture of a world that chooses to do nothing about global warming. “It leads to a planet of radical inequalities of wealth and power. It leads to global economic instability. To governments each looking to their armies to pursue the hopeless mission of seizing the world’s dwindling supplies of energy. And all the while all of us will face the unstoppable, unknowable consequences of radical, accelerating global climate change.” But he expressed hope that this would not be the course pursued, maintaining that we can build a world with a stable climate, sustainable energy sources, and an expanding middle class.

“Investors can lead, and make money by leading,” he concluded. “The labor movement expects those who have been entrusted with our members’ money to do just that.”

INVESTING IN THE FACE OF CLIMATE CHANGE

Mindy Lubber, President of Ceres and Director of INCR, introduced four panelists to discuss investing in the face of climate change: Abby Joseph Cohen, Chief U.S. Investment Strategist, Goldman Sachs; Richard S. Cohen, Managing Director in the Strategic Investments Group & Head of Environmental Strategic Investments, Bank of America; Kevin Parker, Global Head of Asset Management, Deutsche Bank; and Arlene Rockefeller, Executive Vice President & Global Equities CIO, State Street Global Advisors.

Mindy Lubber, President, Ceres and INCR Director; Arlene Rockefeller, State Street Global Advisors; Kevin Parker, Deutsche Bank; Abby Joseph Cohen, Goldman Sachs

Goldman Sachs' Actions and Plans

Ms. Cohen observed that since the 2003 Summit progress has been made to encourage more investors to analyze company behavior and enable companies that act proactively on climate change to be rewarded.

Goldman Sachs has undertaken a range of actions, including issuing an environmental statement, setting aside as a protected preserve a huge tract of land in South America, building LEED-certified buildings, and funding scientific research. In terms of Goldman's role as investment banker and broker, the company trades carbon, finds clean tech opportunities in private equity and venture capital, provides information and basic research on what companies are doing, and organizes conferences on science, policy, and investment opportunities. Cohen explained Goldman's belief in integrating the analysis of environmental, social and governance (ESG) factors with the assessment of whether a client should buy or sell: "The analysis on ESG or sustainability is most effective when it is embedded, not separated, from the rest of the investment process." She lamented the lack of access to quality data and noted that Goldman is seeking to build efficacious databases, asking its industry experts to identify and track a small number of critical variables.

Cohen stated that the sectors at risk include "the usual suspects" like industries that are energy intensive, but also include electronics manufacturing, financial firms, and others. The corollary is that there are many sectors that also have opportunities. One area where Goldman can be effective is in gathering capital for environmentally sensitive investment—a category that will likely generate good returns going forward.

Deutsche Bank's Initiatives

Parker asserted that "asset managers should really get out in front on this issue" because they have a fairly self-evident role to play in educating investors and bringing awareness to retail and institutional clients. Many institutional investors are not aware of climate change risks. Deutsche Bank has found that its retail clients are increasingly interested in the subject. Asset managers can mobilize capital to invest in companies involved in mitigation and adaptation. Parker emphasized that for the business of climate investing to be successful, asset managers must deliver returns for investors.

Parker predicted that statements at the Summit from insurance companies and recent landmark decisions from banks concerning coal-fired power plants would impact asset managers greatly going forward. He acknowledged "a seminal change in Wall Street's recognition of this issue" in "really putting its money where its mouth is."

Asset managers have much work to do to address climate change, though Parker pointed out that the mutual fund industry has about $66 billion globally in about 256 specific climate-related investment funds—this figure does not include socially responsible investment (SRI) funds, private equity funds, or hedge funds, which are also very engaged in climate issues. Only 10% of this investment is domiciled and managed in the United States; most of the concern and mobilization is in other countries.

Richard Cohen, Bank of America

Rather than waiting for governments to act or for the U.S. client base to wake up to the issue, Deutsche Bank has identified climate risk as a mega-trend in its business. Deutsche Bank incorporated climate change into the way it looks at equities and fixed income securities, seeing climate change as an issue for all industries. Deutsche Bank's retail fund business has about $11 billion in assets under management in climate change activities and launched its first climate change mutual fund in September 2007 (which contains about $50 million to date). Parker emphasized the disparity in interest in climate change in the United States versus overseas.

Bank of America's Commitments

In March 2007 Bank of America announced a $20 billion 10-year environmental commitment, bringing to bear the bank's strengths of financial acumen, access to capital, a huge infrastructure, and a huge customer base. Just before the 2008 Summit, CEO Ken Lewis announced the creation of a strategic environmental investments team—a cross-functional team bringing together resources from private equity, strategic investments, capital markets, policy, and other divisions.

The goal of the team is to identify, analyze, structure, and execute strategic environmental investments for Bank of America—putting the Bank's capital to work. The two specific goals are to earn appropriate risk adjusted returns on the capital being committed and to look at strategic benefits for the Bank and its customers. Richard Cohen emphasized that the bank sees the environment as strategic for the company and its customers. He noted the ability of the team to work across the entire institution—wealth management, infrastructure, key customers, and capital markets.

As the new effort grows, Bank of America will be actively seeking out partnerships and common ground with other like-minded corporations, government agencies, and other bodies. "We have to act collectively where we can," Cohen said.

State Street Global Advisors' Strategies

Ms. Rockefeller declared that climate change is a major issue that has the potential for both huge risks and opportunities. State Street is working with its clients to position their portfolios to avoid the risks and to use the opportunities to gain value. She agreed that there has been more interest among clients outside the United States, particularly in Australia, which is experiencing a serious drought and takes climate change very seriously. "We are converting all of our funds that are for Australian clients…to ESG portfolios; if we don't do this, we will not have any Australian clients." She also noted interest from European clients and from some endowments and foundations in the United States.

In major market trends, investors can profit most if they are in a trend from the beginning. Rockefeller stated her firm belief that it is not too late to come into this trend. State Street has a fundamental strategy based on analysts who look at the past and anticipate the future. She acknowledged challenges on the quantitative side and the continuing search for more information on the environment and governance. State Street has not yet found a strong relationship between positive returns and environmental concerns, but Rockefeller emphasized that this does not mean it is not a sound way to invest; it simply means it has not taken hold yet, and "that is exactly where you want to be able to place your money going forward."

Deploying Capital

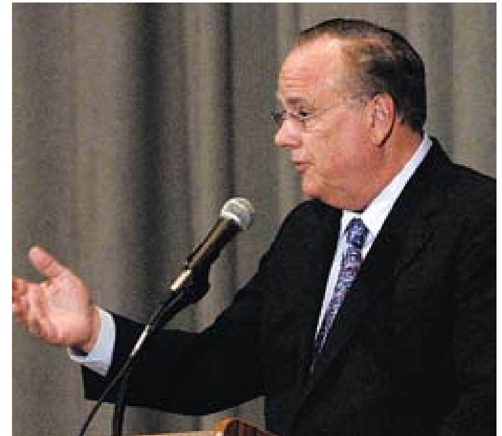
Lubber asked panelists what it will take to reduce emissions to the levels needed to avoid catastrophic climate change.

Ms. Cohen suggested that once you get to the threshold of companies seeing benefits from environmentally sensitive initiatives, "so many other barriers begin to come down." Professional investors have responsibilities to get good returns, and if we are at the point that we are beginning to see better returns from companies paying attention to mitigating long-term liabilities and enhancing revenues, that becomes a positive snowball effect, attracting more capital and liquidity into the area.

He expressed amazement that oil prices, copper, etc. are widely publicized daily, but the price of carbon is not on the minds of most investors every day.

INCR ACTION PLAN TO MANAGE CLIMATE RISK & CAPTURE OPPORTUNITIES

California Treasurer Bill Lockyer, presented the INCR Action Plan, endorsed by over 50 leading U.S. and European institutional investors managing more than $1.75 trillion in assets. The plan builds on the success of INCR Action Plans released at the 2003 and 2005 Investor Summits. Signatories include state treasurers, controllers, pension fund and labor leaders, asset managers, foundations, and other leaders in investing worldwide. *Please refer to Appendix A for complete text and list of signatories.*



Bill Lockyer, State of California Treasurer

Treasurer Lockyer encouraged other investors to sign on to the 2008 INCR Action Plan. “We are determined to create a world economy that is clean, green, and sustainable,” he said.

He reviewed the key elements of the plan, divided into three categories—Managing Our Investments; Engaging Companies, Investors, and Others; and Supporting Policy Action—each containing three goals.

Noting that climate change presents both material risks and significant opportunities, the investors pledged to collectively invest $10 billion in clean technology opportunities over the next two years and to incorporate green building standards into their investment decisions. Calling energy efficiency “one of the fastest, easiest and cheapest ways to significantly reduce emissions and improve the bottom line,” the signatories pledged to reduce energy use in core real estate holdings by 20 percent over the next three years. Other goals include:

- Require and validate that investment managers, investment consultants and advisors report on how they are assessing climate risks in their portfolios, whether from new carbon-reducing regulations, physical impacts or competitive risks.
- Encourage Wall Street analysts, rating agencies and investment banks to analyze and report on the potential impacts of foreseeable long-term carbon costs, in the range of $20 to $40 per metric ton of CO_2, particularly on carbon-intensive investments such as new coal-fired power plants, oil shale, tar sands and coal-to-liquid projects.
- Push the SEC to issue guidance leading to full corporate disclosure of climate risks and opportunities.
- Push Congress for a mandatory national policy to reduce national greenhouse gas emissions in accordance with the 60–90 percent reductions below 1990 levels by 2050 that scientists suggest is urgently needed to avoid the worst and most costly impacts from climate change.

Treasurer Lockyer then introduced three signatories to the INCR Action Plan to give brief remarks: Randall Edwards, Treasurer of the State of Oregon; Jack Ehnes, CEO of the California State Teachers' Retirement System (CalSTRS); and Thomas DiNapoli, Comptroller of the State of New York.

Edwards declared that “states are simply leading the way” because they are tired of waiting for federal action. He emphasized that financial officers have a seat at the table and can make a difference. He described their duty and

Thomas DiNapoli, New York State Comptroller

Randall Edwards, Oregon State Treasurer

responsibility to invest in sustainable businesses and emerging technology and to encourage sustainable business practices. He asserted that financial officers have a national voice, which they will be taking to Congress, to the SEC, and to Wall Street.

CalSTRS CEO Ehnes stated that one of the lessons from the Action Plan is that “there are opportunities for all of us in the room.” He urged the involvement of other investors in shareholder resolutions, declaring that “the power of the proxy is probably as strong as it has ever been.” CalSTRS has taken a comprehensive approach to its portfolio, with its investment staff from all asset classes looking for risks and opportunities from mega-trends and looking to seize opportunities when the competitive landscape changes. CalSTRS has double bottom line goals of returns and environmental performance in global equity, undertakes regular screening of its portfolios, and seeks to incorporate climate change into all models. Ehnes urged investors to look at their real estate holdings for opportunities for risk mitigation and efficiency, announcing that in 2008, the CalSTRS real estate team will make a $100 million commitment to a high-performance green fund (e.g., office buildings certified by the Leadership in Energy and Environmental Design (LEED) system). In clean tech, Ehnes described CalSTRS’ $250 million in alternative energy investments. Ultimately, he maintained that “this Action Plan is an excellent menu of options…a portfolio of approaches for investors to use depending upon your resources and your strategies.”

New York State Comptroller DiNapoli expressed New York’s pride and excitement in signing onto the Action Plan, declaring that as important as legislation is, “this kind of a comprehensive action plan really can do so much more than some of the legislative strategies.” New York is looking at its portfolio with “a green perspective” to create new opportunities, including putting together a new green investment fund and exploring an in-state investment program to grow environmentally sensitive ventures. DiNapoli emphasized the importance of corporate governance, praised Connecticut Treasurer Denise Nappier for her work and guidance on the issue, and encouraged filing shareholder resolutions when the board is not being responsive. He also emphasized the need for coalition-building to push legislation at the federal level, noting the severe lack of leadership out of Washington. DiNapoli further described New York’s efforts to “model the behavior that we’re expecting individuals [and corporations] to buy into”, looking internally at energy efficiency, renewable power, green building retrofitting, and other environmental practices. “For every risk that’s out there,” he said, “there are at least two opportunities.”

Jack Ehnes, California State Teachers’ Retirement System (CalSTRS)

CONCLUSIONS AND NEXT STEPS

Mindy Lubber, President of Ceres and Director of INCR, thanked all the Summit participants for attending. Highlighting the leadership of the signers of the 2008 INCR Action Plan, she declared that "it is our job to make sure we're executing on…every one of those items."

Timothy Wirth summarized the key steps described during the Summit to be taken next:

- Putting a price on carbon
- Working towards a more constructive role for the U.S. Securities and Exchange Commission (SEC), with the Commission being supportive of the requests of investors in INCR
- Changing the existing rules for utilities, recognizing the important role of state public utilities commissions (PUCs)
- Getting the national rules right on fuels and energy efficiency

"This is transformational, and it is an opportunity," he concluded. "Those are the bookends of what we want to do. So we have a great deal of work to do."

APPENDIX A: 2008 INCR ACTION PLAN & SIGNERS

Capitalizing the New Energy Future: Minimizing Climate Risks, Seizing Opportunities

Given the sweeping nature of climate change, climate risks are embedded in every investment portfolio. As fiduciaries entrusted with trillions of dollars of fund assets, we remain firmly convinced that climate change presents both material risks and significant opportunities for investment portfolios.

Since the last Investor Network on Climate Risk (INCR) action plan in 2005, more investors have been taking steps to engage companies and reduce climate risks in their portfolios. More businesses, responding to investor concern, have started to disclose their climate risks and account for the impacts of climate change on their financial performance and competitiveness. More investors and companies have called on political leaders to enact legislation that would provide greater regulatory certainty, provide incentives for climate solutions, and minimize the risks that climate change poses to businesses, investors, and the economy. But greater efforts are needed.

As fiduciaries and long-term investors, we see significant short and long-term risks from climate change to the value and security of our investments and capital markets more broadly. And we recognize that the impacts of climate change will continue to be multi-dimensional – affecting corporations' abilities to secure the full range of necessary resources such as energy and water. At the same time, we also see opportunities presented by the transition to a low-carbon future.

Prudence, common sense, and fiduciary duty compel us to renew our efforts to examine and address the financial ramifications of climate change and to respond to climate challenges and opportunities. Accordingly, we hereby state our intentions to manage our investments; to engage companies, investors, and others; and to support policy action to the best of our abilities, in line with the following agenda:

Managing Our Investments

1. ***Require that our asset managers, consultants, and financial advisors consider climate risks and opportunities.*** To ensure that our investments are managed by firms and individuals that are aware of the financial threats presented by climate change, it is important that we evaluate the ability of investment consultants, advisors, and managers to assess climate risks and opportunities. Accordingly, we will:
   - Require and validate that relevant investment managers currently managing or seeking to manage our fund assets, as well as investment consultants and advisors, report on how they are assessing the risks and opportunities associated with climate change. Such a requirement can be accomplished through Requests for Proposals (RFPs), by making climate risk assessment a required part of regular manager reviews, by requiring managers to use a sustainability or climate risk screen, or by other methods.

2. ***Invest capital in companies developing and deploying clean technologies.*** We believe investments in clean, climate-friendly technologies—such as energy efficiency and renewable energy—represent significant opportunities and will ultimately enhance and sustain the long-term viability of corporate assets and shareholder value by broadening and deepening the range of tools available to help the world avoid the worst impacts of climate change. Accordingly, we will:
   - Seek investment opportunities in all appropriate asset classes to support clean technology efforts. Our goal is to deploy $10 billion collectively in additional investment over the next 2 years.

3. ***Improve the energy performance of real estate portfolios and investments.*** Studies demonstrate that enormous opportunities exist to improve building energy efficiency while enhancing the value of real estate assets. Accordingly, we will:

- Aim for a 20% reduction over a three-year period in energy used in core real estate investment portfolios, using standardized units of measurement, performance baselines, and regular reporting on measures taken and actual energy performance.
- Incorporate green building standards (such as LEED and Energy Star) as a factor in making investment decisions.

Engaging Companies, Investors, and Others

4. ***Urge comprehensive corporate responses to climate risks.*** As investors in publicly-held companies in the auto, electric power, coal, oil & gas, insurance, real estate, construction, financial, forestry, and many other sectors, we desire greater information and action from companies on climate risks and opportunities, recognizing the broader sustainability context. Accordingly, we will:

- Urge companies to elevate climate change as a governance priority, using the Ceres "Climate Change Governance Checklist."
- Urge companies to provide better disclosure about the financial and material risks posed by climate change and to explain how they are factoring carbon costs into operational and capital-planning decisions. Such disclosure should follow the Global Reporting Initiative (GRI) guidelines and the Global Framework on Climate Risk Disclosure.
- Support appropriate shareholder resolutions, company engagements, and other efforts to encourage companies to reduce their carbon footprint, seize new market opportunities, and ask corporate suppliers to disclose and reduce greenhouse gas emissions and energy use.

5. ***Help investors evaluate and address corporate climate risks.*** Investors often need additional information and guidance to better evaluate and engage companies on climate risks and opportunities. Accordingly, we will:

- Urge companies to adhere to best practices in corporate governance on climate risk by producing and distributing through the Investor Network on Climate Risk (INCR) a new "Corporate Governance and Climate Change" report evaluating and scoring 100 leading global companies on their governance practices and responses to the risks and opportunities from climate change.
- Produce and distribute through INCR a report evaluating how climate change is exacerbating water scarcity and evaluating how water-intensive sectors are managing water-related risks.
- Develop and promote proxy voting guidelines that encourage support for reasonable shareholder proposals on climate risk.

6. ***Expand climate risk scrutiny and collaboration by investors, stock market analysts, and others in the finance sector.*** Investors around the world must work together to address the climate risks and opportunities that exist in every market and every asset class, and debt and equity analysts and others in the finance sector must start incorporating climate risk and opportunity into their routine financial analysis and company and portfolio valuation. Accordingly, we will:

- Encourage debt and equity analysts, ratings agencies, and investment banks to incorporate climate risks and opportunities as part of their investment and valuation analysis, including analyzing and reporting on the potential impacts of foreseeable long-term carbon costs (in the range of $20–$40 per metric ton of CO_2eq.), particularly on carbon-intensive investments such as new coal-fired power plants, oil shale, tar sands, and coal-to-liquids projects.
- Encourage debt and equity analysts, ratings agencies, and investment banks to incorporate climate risks, opportunities, and carbon costs into their analysis of a new category of

investment funds—infrastructure—including transportation, water, and other projects needed to support the growth of cities and the transition to a low-carbon economy.

- Engage with mutual funds, hedge funds, private equity firms, and others to promote increased understanding of, and actions in response to, climate risk.
- Support global information-sharing and collaboration by the growing number of institutional investors and organizations around the world concerned about climate risk.

Supporting Policy Action

7. ***Push for guidance from the Securities and Exchange Commission (SEC).*** Climate-related shareholder resolutions and new SEC guidance are each critical to improving corporate disclosure of climate risks and opportunities. Accordingly, we will:
    - Continue to engage the SEC and members of Congress on requiring companies to disclose material climate risks as part of their regular securities filings. Towards this end, we will ask investors and members of Congress to support the September 2007 Investor Petition to the SEC for "Interpretive Guidance on Climate Risk Disclosure."
    - Continue to call on the SEC to recognize shareholders' right to vote on resolutions related to climate change and to enforce existing rules requiring disclosure of material risks.
    - Call on the SEC to develop expertise on climate change risks, as well as other environmental and social issues that pose material financial risks to corporations and investors.
8. ***Encourage companies and investors to support government action on climate policy.*** As fiduciaries and leaders in the investment community, we recognize the need for policies that establish regulatory certainty, minimize climate risks, and provide strong incentives for investment in clean technology and other climate change solutions. Accordingly, we will:
    - Continue to call for a mandatory national policy to contain and reduce national greenhouse gas emissions economy-wide, making sizable, sensible, long-term cuts in accordance with the 60–90% reductions below 1990 levels by 2050 that scientists and climate models suggest are urgently needed to avoid the worst and most costly impacts from climate change.
    - Continue to call for the realignment of incentives and other state and national policies to achieve climate objectives, including a range of energy and transportation policy measures to stimulate research, development, and deployment of new and existing clean technologies at the scale necessary to achieve greenhouse gas reduction goals.
    - Call for strong U.S. leadership in the international negotiations for a successor to the Kyoto Protocol, including a binding target to reduce emissions significantly in the United States.
9. ***Support policies to maximize energy efficiency.*** As fiduciaries and long-term investors, we recognize that getting more use out of the energy we already produce is one of the fastest, easiest, and cheapest ways to significantly reduce emissions and to improve the bottom line of many companies in which we invest, especially with demand for energy increasing. Accordingly, we will:
    - Call for policies at the local, state, and national levels that promote a doubling of the historic rate of energy efficiency improvements in developed countries (to 2.5% per year) and significant energy efficiency improvements in rapidly industrializing and other major energy-using countries.

Investors Signed on to 2008 Action Plan (as of April 15th):

Assets Under Management: $1.75 trillion

State Treasurers, State/City Comptrollers, Pension Funds, Labor

John Chiang, *California State Controller*

Rob Feckner, *Board President, California Public Employees' Retirement System (CalPERS)*

Jack Ehnes, *CEO, California State Teachers' Retirement System (CalSTRS)*

Bill Lockyer, *California State Treasurer*

Denise L. Nappier, *Connecticut State Treasurer*

Alex Sink, *Florida Chief Financial Officer*

General Robert Milligan, *Executive Director, Florida State Board of Administration (SBA)*

Michael Goetz, *Chairman of the Board, Illinois State Board of Investment*

Nancy K. Kopp, *Maryland State Treasurer*

Tim Cahill, *Massachusetts State Treasurer*

Orin S. Kramer, *Chair, New Jersey State Investment Council*

William C. Thompson, Jr., *New York City Comptroller*

Thomas P. DiNapoli, *New York State Comptroller*

Richard Moore, *North Carolina State Treasurer*

Randall Edwards, *Oregon State Treasurer*

Robin L. Wiessmann, *Pennsylvania State Treasurer*

Frank T. Caprio, *Rhode Island General Treasurer*

Andrew Stern, *President, Service Employees International Union*

Bruce Raynor, *President, UNITE HERE*

Jeb Spaulding, *Vermont State Treasurer*

Financial Services Firms, Asset Managers, Other Leaders in Investing

Geeta Aiyer, *President, Boston Common Asset Management*

Barbara J. Krumsiek, *President and CEO, Calvert Group, Ltd.*

Michael Johnston, *Executive Vice President, The Capital Group Companies **

Jeff Skoll, *Chairman, Capricorn Management LLC*

Allan Emanuelsson, *Head of Socially Responsible Investing, DnB NOR Asset Management*

Amy L. Domini, *Founder and CEO, Domini Social Investments LLC*

Don Rolfe, *President and CEO, Ethical Funds*

Karina Litvack, *Director, Head of Governance & Sustainable Investment, F&C Management Ltd.*

Peter Knight, *President, Generation Investment Management, US*

Vinod Khosla, *Founder, Khosla Ventures*

** = firm name listed for identification purposes only*

Jonathon S. Naimon, *CEO, Light Green Advisors*

Mark Schwartz, *Co-Founder and Chairman, MissionPoint Capital Partners*

L. John Doerr, *Partner, Kleiner Perkins Caufield & Byers*

Stephen Dodson, *Chief Operating Officer, Parnassus Investments*

Joe Keefe, *CEO, Pax World Funds*

Rev. William Somplatsky-Jarman, *Presbyterian Church (U.S.A.)*

Michael Crosby, *OFMCap., Province of St. Joseph of the Capuchin Order, Milwaukee*

Joan Bavaria, *President, Trillium Asset Management*

Timothy Brennan, *Treasurer, Unitarian Universalist Association*

Tim Smith, *Senior Vice President, Walden Asset Management*

Jack Robinson, *President, Winslow Management Company*

Foundations

Diane Edgerton Miller, *President and CEO, Blue Moon Fund*

Denis Hayes, *President and CEO, Bullitt Foundation*

Edith T. Eddy, *Executive Director, Compton Foundation*

Eric Heitz, *President, The Energy Foundation*

Jesse Fink, *Co-Founder, Betsy and Jesse Fink Foundation*

Jenny D. Russell, *Executive Director, The Merck Family Fund*

Lance E. Lindblom, *President & CEO, Nathan Cummings Foundation*

Dave Beckwith, *Executive Director, The Needmor Fund*

Stephen A. Foster, *President and CEO, The Overbrook Foundation*

Stephen B. Heintz, *President, Rockefeller Brothers Fund*

Richard Woo, *CEO, The Russell Family Foundation*

Sally Osberg, *President, Skoll Foundation*

Timothy E. Wirth, President, United Nations Foundation

Wren *W. Wirth, President, The Winslow Foundation*

Supporters in Principle:

Assets Under Management: $6.5 trillion

Rob Lake, *Head of Sustainability, ABP investments*

Donald MacDonald, *Trustee, British Telecommunications Pension Scheme (BTPS)*

Kevin Parker, *CEO, Deutsche Asset Management & Member Group Executive Committee, Deutsche Bank*

Peter Dunscombe, *Chairman, Institutional Investors Group on Climate Change (IIGCC)*

Howard Jacobs, *Trustee, Universities Superannuation Scheme (USS)*

APPENDIX B: PARTICIPATING ORGANIZATIONS

ABN AMRO
ABP Investments
Access International
Acuity Investment Management Inc.
AFL-CIO
AIG Global Investment Group
Albright Group
AllianceBernstein
Allianz Global Corporate & Specialty AG
Amalgamated Bank
AP7
Ariel Capital Management
Bank of America
Bank of New York
Barclays Global Investors
Baupost Group
Bear, Stearns & Co., Inc.
BlackRock, Inc.
Bloomberg
Borough President of Manhattan
British Telecom Pension Scheme
Brown-Forman
Cahill Pataki Partners
Caisse de dépôt et placement du Québec
California State Assembly Committee on Jobs, Economic Devlopment, and the Economy
California State Controller
California State Treasurer's Office
CalPERS
CalSTRS
Calvert Group, Ltd.
Camco
Canadian Institute of Chartered Accountants
Capital Group Companies, Inc.
Carbon Disclosure Project
Carbon Trust
Carthage Group
Ceres
CFA Institute Centre for Financial Market Integrity
Change to Win Investment Group
Cherokee Investment Partners, LLC
Chicago Climate Exchange
Chicago Equity Partners, LLC
Christopher Reynolds Foundation
Church of Sweden
Citi
Clean Energy Asset Management, LLC
Clearbridge Advisors
Climate and Energy Funders Group
Climate Change Capital
Climate Cooler
Climate Group
Co-op America
Commonwealth of Massachusetts
Commonwealth of Pennsylvania Department of the Treasury
Con Ed
Connecticut Office of the State Treasurer
Cornell University
Corporate Library
David Gardiner & Associates
Deloitte
Deutsche Asset Management
Deutsche Bank
District of Columbia
Domini Social Investments
Doris Duke Charitable Foundation
DWS Scudder America
Earth School Foundation
Elliot Capital
Embassy of Zambia
Emerald Technology Ventures
Emily Hall Tremaine Foundation
Environment Capital Group
Environmental Grantmakers Association
European Climate Foundation
Evangelical Lutheran Church in America-Board of Pensions
Exelon Corp.
F&C Asset Management
Fair Trade Foundation
Fenwick & West
Florida Democratic Party
Florida Department of Financial Services
Florida State Board of Administration
Flywheel Ventures
Fred Alger Management/Spectra Funds
Generation Investment Management
Georgetown University
Glass, Lewis & Co. LLC
Global Reporting Initiative
Goldman Sachs
Gonzalez Saggio & Harlan LLP
Google
Google.org
Goucher College
Green Atlantic Partners/D1 Oils Plc
HamptonHedges LLC
Harvard University
Heinz Center for Science, Economics and the Environment
Heinz Family Office
Heinz Family Philanthropies
Helius Energy
Henry Crown & Co.
Hermes Investment Management LTD
HSBC Bank USA, N.A.
IFC
Illinois State Board of Investments
Innovest Strategic Value Advisors
Interfaith Center for Corporate Responsibility
International Chamber of Commerce
International Energy Agency
International Fund for China's Environment
JPMorgan Chase
Kansas Insurance Department
Kasina
Kennedy School of Government, Harvard University
Khosla Ventures
Kolibri Group
Landon Butler & Company
LAPF Forum
Lazard Freres & Co. LLC
Legg Mason
Lehigh University Endowment Fund
Lehman Brothers
Loomis Sayles & Coompany, L.P.
Lux Research Inc.
Man Group
Manulife/John Hancock Life Insurance Company
Marsh Inc.
Maryland State Retirement Agency

APPENDIX B: Participating Organizations (continued)

Maryland State Treasurer
McCabe & Associates
McKinsey & Co.
McKinsey Global Institute
Mercer Investment Consulting, Inc.
Merck Family Foundation
Merrill Lynch & Co.
Mertz Gilmore Foundation
MetLife
Michigan Municipal Employees Retirement System
Millstein Center for Corporate Governance and Performance
Mission Point Capital
Mitsubishi UFJ Trust and Banking Co.
Morgan Stanley
Munich Re
Nand & Jeet Khemka Foundation
Nathan Cummings Foundation
National Energy Management Institute
National Grid
Nephila Capital
New Energy Finance
New Jersey Division of Investment
New Jersey State Treasurer's Office
New Mexico State Treasury
New York City Comptroller's Office
New York City Department of Environmental Protection
New York State Comptroller
New York State Teachers Retirement System
Norges Bank Investment Management
North Carolina Department of State Treasurer
Northern Trust
Open Society Institute
Optima Fund Management
Oregon State Treasurer's Office
Overbrook Foundation
Pacific Corporate Group
Parnassus Funds
Pennsylvania Treasurer's Office
Pensions and Investment Research Consultants Limited
Peterson Partners LP
Pew Center on Global Climate Change
Pew Charitable Trusts
PG&E Corporation
PGGM
Piper Jaffray
Presbyterian Church USA
Prime Buchholz Investments
Principles for Responsible Investment
Province of St. Joseph, Capuchin Order
Proxy Governance
Putnam Investments
RBC Asset Management Inc.
Reinhart Institutional Investor Services
Reinsurance Association of America
Responsible Endowments Coalition
Rhode Island State Treasurer
Right Bank Partners
RiskMetrics Group
Robert Trent Jones II, LLC
Rockefeller & Co., Inc.
Rockefeller Brothers Fund
Rockefeller Family Fund
Rockefeller Financial Services
Rockefeller Philanthropy Advisors
RogersCasey
SAC Capital Management
Saunders Hotel Group of Boston
Scherman Foundation
Science First
Service Employees International Union
Sheet Metal Workers' National Pension Fund
Shell US
Sierra Club
Skoll Foundation
Social Risks Inc.
Spectra Funds
Spotlight Capital Management, LLC
Standard & Poors
Stark Investments
State of Maryland Treasurer's Office
State Street Corporation, Public Funds Division
State Street Global Advisors
STEEL Valley Authority
Suntech
Surdna Foundation
Sustainable Endowments Institute
Swiss Re
Thetford Capital Advisors
TIAA-CREF
Travelers Insurance
Tri-State Coalition for Responsible Investment
Trillium Asset Management
Trust Company of the West
Turner Enterprises, Inc.
UBS Global Asset Management
Unitarian Universalist Association
United Food and Commercial Workers International Union
United Methodist Church General Board of Pensions
United Nations Department of Economic and Social Affairs
United Nations Department of Public Information
United Nations Environment Programme
United Nations Foundation
United Nations Fund for International Partnerships
United Nations Joint Staff Pension Fund
United Nations Office for Partnerships
Universities Superannuation Scheme
US State Department
V. Kann Rasmussen Foundation
Vermont Office of the State Treasurer
Walden Asset Management
West Yorkshire Pension Fund
WilderShares, LLC
Williams Capital Group, L.P.
Wisconsin Insurance Commission
Wolf Popper LLP
Woodcock Foundation
World Bank
World Economic Forum
World Pension Forum
World Resources Institute

APPENDIX C: ABOUT THE INVESTOR NETWORK ON CLIMATE RISK (INCR)

Investor Network on CLIMATE RISK a project of **Ceres**

The **Investor Network on Climate Risk (INCR)** is a network of institutional investors and financial institutions that promotes better understanding of the financial risks and investment opportunities posed by climate change.

INCR is coordinated by **Ceres**, a coalition of investors and environmental groups working to advance sustainable prosperity.

For More Information:
Chris Fox
617-247-0700 x15
fox@ceres.org

www.incr.com

INCR in Brief

The **Investor Network on Climate Risk** was launched at the first Institutional Investor Summit on Climate Risk at the United Nations in November 2003. INCR's membership has since grown from 10 investors managing $600 billion in assets to more than 60 investors managing $5 trillion of assets. Members include asset managers, state and city treasurers and comptrollers, public and labor pension funds, foundations, and other institutional investors. INCR leverages the collective power of these investors to promote improved disclosure and corporate governance practices on the business risks and opportunities posed by climate change. INCR has achieved dramatic results, including:

- **Mobilized a Call to Action**, in March 2007 by 65 corporations and institutional investors managing $4 trillion in assets urging Congress to enact strong federal legislation to curb greenhouse gas emissions and requesting the Securities and Exchange Commission (SEC) to clarify what companies should disclose to investors on climate change in their regular financial reporting.
- **Organized more than two-dozen institutional investors**, managing more than $1.5 trillion of assets, to file a petition in September 2007 calling on the U.S. Securities and Exchange Commission (SEC) to require publicly-traded companies to disclose the financial risks of global warming in their securities filings.
- **Spearheaded dozens of breakthrough achievements with companies**, such as: Bank of America launching a $20 billion initiative to support the growth of environmentally sustainable business activity to address global climate change; Dell Inc. committing to reduce its greenhouse gas emissions by 15 percent by 2012 and press its top suppliers for annual reports on their own greenhouse emissions; and ConocoPhilips announcing it will incorporate carbon costs in capital spending plans and earmark $300 million on biofuels and other low-carbon research.
- **Brought together over 450 investor, financial and corporate leaders at the United Nations** in February 2008 to address the growing financial risks and opportunities posed by climate change. Nearly 50 leading U.S. and European institutional investors managing over $1.75 trillion in assets released a 9-point climate change action plan that will boost investments in energy efficiency and clean energy technologies and require tougher scrutiny of carbon-intensive investments that may pose long-term financial risks.
- **Published cutting-edge research reports to help investors better understand the implications of global warming.** Among those: a January 2008 report, *Corporate Governance and Climate Change: The Banking Sector*, analyzing how 40 of the world's largest banks are addressing the business challenges from climate change; an October 2007 report, *From Risk to Opportunity: Insurer Responses to Climate Change*; and a January 2007 report, *Climate Risk Disclosure by the S&P 500*.
- **Established the Global Framework for Climate Risk Disclosure**, a standardized set of guidelines for improving corporate disclosure on the risks and opportunities for climate change. The framework was developed in collaboration with investors worldwide.

OPPORTUNITIES FOR INVESTORS TO FOLLOW-UP ON THE 2008 INVESTOR SUMMIT ON CLIMATE RISK

The Investor Network on Climate Risk (INCR) working groups can be a resource for investors interested in following up on the ideas and implementing the goals discussed at the 2008 Investor Summit on Climate Risk. INCR working groups are facilitated by Ceres staff and aim to help investors address the risks and opportunities posed by climate change.

Through INCR working groups investors can share information and expertise about specific topics such as deploying capital in clean energy, enhancing the energy performance of real estate portfolios, improving corporate governance on climate risk through shareowner resolutions and dialogues, and engaging with the SEC, Congress and other policy makers.

Since 2005 much progress has been made already in these and other areas. A new plan of action was launched at the Summit (see 2008 INCR Action Plan—Appendix A). INCR working groups will help investors implement the goals of the 2008 INCR Action Plan.

Investors are encouraged to contact the coordinator of each working group listed below to learn more about opportunities to get involved. Ideas for new working groups and initiatives are also welcome. If you have questions about INCR or Summit follow-up please contact Chris Fox at fox@ceres.org

Current INCR working groups and coordinators are as follows:

1. **Fiduciary Training Working Group** assists plan sponsors (e.g. pension funds, endowments) with training their trustees and staff on the risks and opportunities related to climate change. Contact Ariane van Buren at vanburen@ceres.org
2. **Clean Energy Investment Working Group** allows institutional investors to develop and share strategies for investing in the clean energy space. This working group is coordinated jointly by Ceres and the Clean Energy Group. Contact Dan Bakal at bakal@ceres.org
3. **SEC / Climate Risk Disclosure Working Group** seeks to improve disclosure of climate risks in SEC filings. Members engage with SEC staff and commissioners and members of Congress to push for SEC action on climate risk disclosure. This group also promotes use of the Global Framework for Climate Risk Disclosure. Contact Jim Coburn coburn@ceres.org
4. **Policy Working Group** updates investors on energy and climate change policy developments and facilitates investor engagement in the policy debate. Contact Chris Fox at fox@ceres.org
5. **Real Estate Working Group** helps investors improve the energy performance of real estate portfolios and investments. Contact Betsy Boyle at boyle@ceres.org
6. **Industry Sector Working Groups:**
    - **Auto / Transportation Sector Working Group** coordinates investor engagement with auto / transport sector companies on climate risk and opportunities, and publishes research. Contact Carol Lee Rawn at rawn@ceres.org
    - **Electric Power & Coal Sector Working Group** coordinates investor engagement with electric and coal companies on climate risk and opportunities, and publishes research. Contact Dan Bakal at bakal@ceres.org
    - **Insurance Sector Working Group** coordinates investor engagement with the insurance industry and insurance regulators, and publishes research on the nexus between climate change and insurance. Contact Andrew Logan at logan@ceres.org
    - **Oil Sector Working Group** coordinates investor engagement with the oil industry and publishes research reports. Contact Andrew Logan logan@ceres.org
    - **Other sector working groups** coordinate investor engagement with companies on climate change in the following industries: **airlines**, **banking/financial services**, **buildings**, **forestry** and **manufacturing**. For more information on these working groups or other industries, contact Rob Berridge at berridge@ceres.org

Investor Network on
CLIMATE RISK a project of Ceres

INCR Membership Information

The Investor Network on Climate Risk was launched at the first Institutional Investor Summit on Climate Risk at the United Nations in November 2003. INCR's membership has since grown from 10 investors managing $600 billion in assets to more than 60 investors managing over $5 trillion of assets. Members include asset managers, state and city treasurers and comptrollers, public and labor pension funds, foundations, and other institutional investors. INCR leverages the collective power of these investors to promote improved disclosure and corporate governance practices on the business risks and opportunities posed by climate change. For more information, please visit www.incr.com

Invitation to Join INCR

INCR welcomes institutional investors and financial institutions that are interested in learning about climate risk to become INCR Members. There are two categories of INCR Members:

- INCR General Members (plan sponsors, pension funds, treasurers, comptrollers, labor unions, foundations, endowments, and religious funds are eligible) and
- INCR Sustaining Members (asset managers and other financial services firms are eligible).

INCR Membership Benefits

- Invitation to send representatives to INCR conferences, briefings, and meetings
- INCR member-only newsletter and other INCR publications
- INCR research services/products and access to experts on climate risk and sustainability issues
- Coordination with other investors and participation in INCR working groups
- Ceres staff support in coordinating media/press events on climate risk and sustainability issues
- Ceres staff support for investor engagement with companies and government agencies (e.g. SEC) including supporting shareowner letters, proposals and company dialogues
- Eligibility for additional fee-for-service benefits if desired (e.g. trustee/staff training programs)

INCR Members are expected to support INCR through the following:

- Participating in INCR meetings and working groups as appropriate
- Annual financial support based on INCR Membership Fee Scale (see attached) – please note that options for how INCR members can participate financially and cover annual fees include dues, sponsoring INCR meetings/conferences/reports, or contributing to INCR research program

Please note that institutions that are interested in becoming INCR General Members or INCR Sustaining Members must submit a written application. Applications for membership will be reviewed and voted on by the INCR executive committee.

INCR Annual Membership Fee Scale

INCR General Members

(Plan sponsors, pension funds, treasurers, comptrollers, labor unions, foundations, endowments, and religious funds are eligible)

Assets under $1 billion =	$500
Assets of $1 billion - $49.99 billion =	$2,500
Assets of $50 billion - $99.99 billion =	$5,000
Assets of $100 billion and over =	$7,500

INCR Sustaining Members

(Asset managers and other financial services firms are eligible)

Assets under $1 billion =	$2,000
Assets of $1 billion - $49.99 billion =	$5,000
Assets of $50 billion - $99.99 billion =	$7,500
Assets of $100 billion and over =	$10,000

To learn more about getting involved in INCR, please contact Chris Fox (fox@ceres.org) or 617-247-0700 ext. 15.

SPONSORS OF THE 2008 INVESTOR SUMMIT ON CLIMATE RISK

We thank the following organizations for their generous support:

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Deutsche Asset Managemet

State Street / State Street Global Advisors

Swiss Re

Supporting Underwriter

Kolibri Group

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AIG Investments

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Spectra

Associate Underwriters

Acuity Investment Management

BlackRock

ClearBridge Advisors

Mercer

Putnam Investments

UBS Global Asset Management

United Nations Conveners

United Nations Fund for International Partnerships (Co-Host)

United Nations Department of Economic and Social Affairs

United Nations Develpment Programme

United Nations Environment Programme

United Nations Industrial Development Organization

United Nations Global Compact

United Nations Joint Staff Pension Fund

Foundation Summit Supporters

United Nations Foundation (Co-Host)

Blue Moon Fund

Doris Duke Charitable Foundation

Energy Foundation

John Merck Fund

Marisla Foundation

Nathan Cummings Foundation

Pew Charitable Trusts

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Corporate Governance and Climate Change:

The Banking Sector

January 2008

A Ceres Report

Lead Author:
Douglas G. Cogan

Ceres commissioned this report from Institutional Shareholder Services,
which was acquired by RiskMetrics Group in January 2007.

Ceres is a national coalition of investors, environmental groups and other public interest organizations working with companies to address sustainability challenges such as global climate change. Ceres directs the Investor Network on Climate Risk, a group of more than 60 institutional investors from the U.S. and Europe managing over $4 trillion in assets.

RiskMetrics Group is a leader in the disciplines of risk management, corporate governance and financial research & analysis. It analyzes a broad spectrum of risk for financial institutions and corporations worldwide.

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Canadian Banks

European Banks

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Acronyms

AAU – Assigned Allocation Unit

ADEME – Agency for Environment and Energy Management (France)

BREEAM – Building Research Establishment Environmental Assessment Method

CaCX – California Climate Exchange

CCFE – Chicago Climate Futures Exchange

CCX – Chicago Climate Exchange

CDM – Clean Development Mechanism

CDO – Collateralized Debt Obligation

CDP – Carbon Disclosure Project

CER – Certified Emission Reduction

CO_2 – Carbon Dioxide

CO_2e – Carbon Dioxide Equivalent

CR – Corporate Responsibility

CSR – Corporate Social Responsibility

Defra – Department for Environment, Food and Rural Affairs (U.K.)

EAI – Enhanced Analytics Initiative

ECX – European Climate Exchange

EHS – Environment, Health & Safety

EMS – Environmental Management System

EPA – Environmental Protection Agency (U.S.)

ERU – Emission Reduction Unit

ESCO – Energy Service Company

ESG – Environmental, Social and Governance

EUA – EU Emission Allowance

EU ETS – European Union Emissions Trading Scheme

FTE – Full Time Equivalent

GHG – Greenhouse Gas

GRI – Global Reporting Initiative

HVAC – Heating, Ventilation & Air Conditioning

ICE – Intercontinental Exchange

IETA – International Emissions Trading Association

IPCC – Intergovernmental Panel on Climate Change

IPO – Initial Public Offering

ISO – International Standards Organization

JI – Joint Implementation

KW – Kilowatt

KWh – Kilowatt hour

LEED – Leadership in Energy and Environmental Design

MDG – Millennium Development Goals

MW – Megawatt

MWh – Megawatt hour

NRE – Nouvelles Régulations Économiques (New Economic Regulations)

NGO – Non-Governmental Organization

OTC – Over The Counter

PPM – Parts Per Million

REC – Renewable Energy Certificate

RMB – Renminbi

SME – Small & Medium Enterprise

SRI – Socially Responsible Investment

UNEP – United Nations Environment Programme

UNFCCC – United Nations Framework Convention on Climate Change

VER – Verified Emission Reduction

Foreword

Banks are the backbone of the global economy, providing capital for innovation, infrastructure, job creation and overall prosperity. Banks also play an integral role in society, affecting not only spending by individual consumers, but also the growth of entire industries.

As the impacts of global warming from the heat-trapping gases released by power plants, vehicles and other sources take root in everyday life, banks have never been more important to chart the future. The companies that banks decide to finance will be a linchpin in slowing Earth's warming and moving the world economy away from fossil fuels and into cleaner technologies.

There is now overwhelming scientific evidence that worldwide temperatures are rising, glaciers are melting, and drought and wildfires are becoming more severe. Scientists believe most of the warming in the last 50 years is human-induced. This confluence of evidence has galvanized public attention and governments worldwide to take action to avert a possible climate catastrophe.

This report is a comprehensive assessment of how 40 of the world's largest banks are preparing themselves to face the colossal climate change challenge

With nearly $6 trillion in market capitalization, the global financial sector will play a vital role in supporting timely, cost-effective solutions to reduce U.S. and global greenhouse gas emissions. As risk management experts, it is essential that banks begin now to consider the financial risk implications of continued investment in carbon-intensive energy technologies.

This report is the first comprehensive assessment of how 40 of the world's largest banks are preparing themselves to face this colossal challenge. It pays particular attention to how corporate executives and board directors are addressing the governance systems that will be needed to minimize climate risks while maximizing investments in solutions that mitigate and help society adapt to climate change.

The report employs a "Climate Change Governance Checklist" to evaluate how 16 U.S. banks and 24 non-U.S. banks are addressing climate change through board oversight, management execution, public disclosure, greenhouse gas emissions accounting and strategic planning. In addition to the U.S. banks, the study includes 15 European, five Asian, one Brazilian and three Canadian banks in several different classes of financial services to provide a global cross-sectional analysis of the banking sector.

The results provide some basis for encouragement. The report finds evidence that many banks are responding to climate change, with European banks being in the forefront and many U.S. banks following closely behind. Many of the positive actions have come in the past 12 to 18 months, especially in regard to overall disclosure, research and financial support for clean energy. Among the highlights:

- The banks have issued nearly 100 research reports on climate change and related investment and regulatory strategies, more than half of them in 2007 alone.
- Thirty-four banks responded to the latest climate-disclosure annual survey conducted by the Carbon Disclosure Project, a non-profit organization that seeks information on climate risks and opportunities from companies on behalf of an investor coalition of 315 firms with a combined $41 trillion in assets under management.
- Twenty-four of the banks have set some type of greenhouse gas reduction target for internal operations.
- Twenty-nine of the banks have reported on their financial support for alternative energy projects; eight of these banks have provided more than $12 billion of direct financing and investments in renewable energy and other clean energy projects.

Yet for all of the positive momentum, many of the 40 banks have done little or nothing to elevate climate change as a governance priority—a trend that cuts across European, North American and Asian banks alike. For example, only a dozen of the 40 banks have board-level involvement in climate change, and all but one of those firms are non-U.S. based. Only 14 banks have adopted risk management policies or lending procedures that address climate change in a systematic way. Only a half-dozen banks say they are formally calculating carbon risk in their loan portfolios, and only one of the 40 banks—**Bank of America**—has announced a specific target to reduce the rate of greenhouse gas emissions associated with the utility portion of its lending portfolio. And no bank has set a policy to avoid investments in carbon-intensive projects such as coal-fired power plants.

While many banks have made improvements, the actions to date are the tip of the iceberg of what is needed

While many banks have made improvements, the actions to date are the tip of the iceberg of what is needed to reduce greenhouse gas emissions consistent with targets scientists say are needed to avoid the dangerous impacts of climate change. In this regard, more banks should:

- elevate climate change as a governance priority for board members and CEOs, especially at U.S. banks where direct board involvement has been virtually non-existent;
- provide better disclosure about the financial and material risks posed by climate change, their own emissions reduction strategies, and emissions resulting from financing and investment;
- explain how they are factoring carbon costs into their financing and investment decisions, especially for energy-intensive projects that pose financial risks as carbon-reducing regulations take hold worldwide;
- set progressively higher targets to shrink the carbon footprint of their lending and investment portfolios, and be more transparent about how they intend to meet these objectives.

As one of the world's largest economic sectors, and as one that reaches virtually every consumer and business, the financial services industry must be involved in mitigating climate change and its impacts. At the same time, banks face an immense but as yet largely untapped opportunity to enter new markets and develop more efficient and environmentally sound industries that will benefit generations to come, while preserving their longstanding leadership role in wealth and capital formation.

Banks have the reach, influence and access to capital required to lead the changes needed to expeditiously address global warming.

Mindy S. Lubber
President, Ceres
Director, Investor Network on Climate Risk

I. Executive Summary

This report analyzes the corporate governance and strategic approaches of 40 of the world's largest banks[1] to the challenges and opportunities posed by climate change. With delegates of 190 nations meeting in Bali, Indonesia, in December 2007 to decide whether to extend or replace the 10-year old Kyoto Protocol after 2012, climate change has become not just a future political consideration, but also a key driver of how global business is being conducted today.

Banks will play a vital role in finding timely, practical and cost-effective solutions to mitigate climate change

The financial community is at the center of this economic transformation. With nearly $6 trillion in market capitalization, banks are the world's major capital providers and risk management experts. As such, banks have a vital role in finding timely, practical and cost-effective solutions to mitigate climate change and adapt the economy to its already apparent effects. Bringing greenhouse gas (GHG) emissions under control presents a formidable technological and financial challenge that will require an effective "de-carbonization" of the global economy over the next 50 years. Banks can begin by factoring a market price for carbon dioxide (the main greenhouse gas) in lending and investment decisions, while helping to build new markets through GHG emissions management, trading and brokerage.

Yet the responsibility of banks does not end there. New global energy supply is expected to require more than $20 trillion of capital investment over the next-quarter century. If GHG emissions are to be brought on a downward path—and soon—banks must begin to systematically address a re-balancing of corporate and project financing away from carbon-intensive energy sources and technologies toward more efficient and low-carbon alternatives. At the same time, banks must account for the effects of a warming climate and emerging GHG-reducing regulations that will alter the costs of production, the pricing of securities, the size of liabilities and the assignment of credit and asset valuations. Growing demand for "climate friendly" financial products and services will also lead banks into whole new markets.

Banks and Climate Governance

Clearly, banks that have strong governance structures in place to address climate change and take early action on the attendant risks and opportunities will be at an advantage. The broad reach of climate change requires a holistic and forward-looking management approach. To stay ahead of the curve, banks will need to combine practical considerations of managing their own GHG emissions with the broader implications of how climate change affects the competitive marketplace, lending and investment strategies, and ultimately, their financial bottom lines.

This report is designed as a benchmarking tool that highlights climate change best practices within the financial sector. It employs a "Climate Change Governance Checklist" to evaluate the 40 selected banks in their approaches to climate change in five governance areas: board oversight; management execution; public disclosure; GHG emissions accounting; and strategic planning. Because the 40 banks are varied and are not all engaged in the same financial service offerings, scores for asset managers and investment banks were adjusted to account for their particular lines of business. Therefore, analysis of sector peers offers the most useful basis for comparison of leaders and laggards *(see p. 7 for rankings)*.

1. The banking sector includes a diverse group of financial services firms, including investment banks and brokerages, diversified commercial banks, and custodial banks and asset managers. For purposes of this report, these firms are described generically as "banks."

Leading the Way

This report provides fresh evidence that banks are responding to the climate challenge. However, the report also finds a divergence in strategies and priorities being employed by the 16 U.S., 15 European, five Asian, three Canadian and one Brazilian bank included in this study. Most leading banks are addressing climate change as a risk management issue as they would other credit, operational and reputation issues. European banks are at the forefront of integrating climate change into environmental policies, risk management and product development. The majority of other banks in this study, including many of the leading U.S. banks, are working towards better disclosure of climate risks as an essential first step toward embracing a changing regulatory and economic environment. Asset managers that do not offer traditional banking services and banks based in emerging markets like China and Brazil have the most catching up to do in terms of climate risk disclosure and management practices.

Leading banks are addressing climate change as they would other risk management issues

This study finds that climate change is a rapidly growing topic of interest and concern in the banking community:

- Of the 40 banks profiled in this study, 23 include a reference or discussion of climate change in their latest annual shareholder reports.
- Collectively, these banks have written nearly 100 research reports on climate change and related investment and regulatory topics; *more than half of these reports were issued in 2007 alone*.
- In addition, 26 of these banks are signatories to the Carbon Disclosure Project (CDP), which seeks information on climate risks and opportunities from companies on behalf of an investor coalition of 315 firms with $41 trillion in assets under management; 34 of these banks responded to the latest annual survey conducted by CDP.
- However, only nine of the 40 banks mentioned climate change or related issues in their latest Form 10-K or comparable regulatory filings. This suggests that most banks have yet to evaluate and disclose their own material risks and opportunities posed by climate change.

Board Oversight

Leading banks are beginning to view climate change as an issue that corporate board directors have a fiduciary duty to address:

- Of the 40 banks examined in this study, nine banks have assigned a board member to oversee the company's climate-related policies and initiatives.
- Twenty-two of the banks conduct periodic board reviews of the company's environmental affairs, and 12 integrate climate change as part of this review process.
- Notably, 11 of the 12 banks with board-level involvement on climate change are non-U.S. firms—seven in Europe, three in Canada, and one in Japan. This indicates a need for U.S. banks in particular to re-examine the emerging role of boards in climate change oversight, policy formation and risk management.

Board Oversight Leaders

ABN AMRO
Deutsche Bank
HBOS
HSBC
Royal Bank of Scotland
UBS

Management Execution

Management Execution Leaders

ABN AMRO
Citi
Crédit Agricole
Goldman Sachs
HBOS
HSBC
Royal Bank of Canada

At the management level, climate change is commanding more attention of senior executives and is translating into more formal policies and governance programs.

- Thirteen of the 40 banks in this study have developed specific climate-related policies and/or strategies.
- In addition, 13 banks have created executive-level committees, working groups or task forces focused on climate change. In some instances, new executive positions and departments are being defined around climate change specifically.
- Sixteen banks have also made formal public policy statements on climate change—ranging from basic expressions of support for GHG cap-and-trade mechanisms to active membership in organizations lobbying for near-term government controls.

Internal Greenhouse Gas Management

Many banks are altering their energy procurement policies in favor of renewable energy sources and integrating energy efficient, green building principles into real estate management.

- Twenty-eight of the 40 banks have calculated and disclosed their GHG emissions from operations.
- At the same time, 24 of these banks have set some type of GHG emissions reduction target.
- A growing number of banks are declaring targets to achieve "carbon neutrality." Ten banks say they have either achieved or are committed to carbon neutrality for their operations.

Risk Management and External Financing

Twenty-three of the banks in this study have adopted the Equator Principles to incorporate environmental, social and governance (ESG) factors for development projects in emerging markets. Some leading banks are going further to institute climate-specific lending policies and alternative energy investments throughout their institutions:

Risk Management Leaders

ABN AMRO
Bank of America
Citi
Fortis
HBOS
HSBC
Goldman Sachs
Merrill Lynch
Mizuho Financial Group
Royal Bank of Canada
Royal Bank of Scotland

- Thirteen of the 40 banks have adopted risk management policies or lending procedures that address climate change in some form. Most of these policies are process oriented and focused on due diligence research; many apply to the power sector specifically.
- A small but growing number of banks also are formally calculating carbon risk in their loan portfolios, including **Citi**, **Mitsubishi UFJ Financial Group**, **Mizuho Financial Group**, **Royal Bank of Canada** and **Wells Fargo**.
- **Bank of America** is the only one of the 40 banks to announce a specific target to reduce GHG emissions associated with its lending portfolio. Its policy applies to its utility corporate finance portfolio, for which it is seeking a 7 percent reduction in the rate of GHG emissions by 2009, as represented by the carbon-intensity mix of utilities in the portfolio.
- Additionally, 29 banks document their involvement in the burgeoning renewable energy and "clean tech" market. Several U.S. and European banks have made multi-billion dollar investments or financing commitments in this growing sector.

Investment and Retail Products

Climate change also offers an opportunity for banks to diversify their investment and retail product lines. Growing client interest in climate risk management, carbon offsets and socially responsible investing is fueling interest in these businesses.

- Twenty-one of the banks evaluated offer climate-related products, including 10 with climate-specific funds and index offerings. Many of these products have been launched in 2007, and most are coming out of European banks.
- Twenty-two of the banks examined offer climate-related retail products—from preferred-rate "green" mortgages to climate-focused credit card programs and "green" car loans.

Investment Product Leaders

ABN AMRO
Credit Suisse
Deutsche Bank
HSBC
ING
JPMorgan Chase
Merrill Lynch
UBS

Retail Product Leaders

Bank of America
Barclays
BNP Paribas
Fortis
HBOS
ING
Société Générale
Wells Fargo

Carbon Trading Leaders

Bank of America
Barclays
BNP Paribas
Credit Suisse
Deutsche Bank
Fortis
Merrill Lynch
Mitsubishi UFJ
Morgan Stanley

Carbon Trading

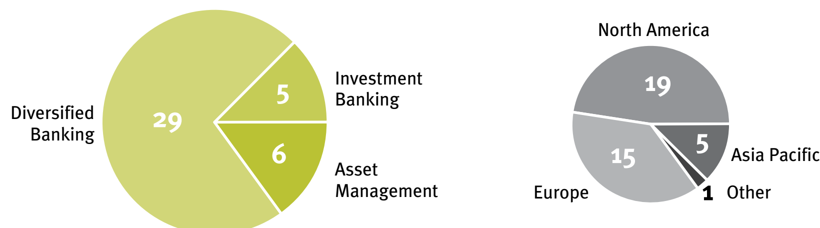
Banks that engage in commodities trading and brokerage services are recognizing a huge growth opportunity presented by GHG emissions trading.

- Seventeen banks are actively trading under the European Union Emissions Trading Scheme, while seven banks in this study are involved with voluntary emissions trading exchanges, such as the Chicago Climate Exchange (CCX) and the new "Green Exchange" announced by the New York Mercantile Exchange in December 2007.
- Many banks are also involved in the financing of Clean Development Mechanism (CDM) and Joint Implementation (JI) projects under the Kyoto Protocol to generate tradable emissions reduction credits. Nineteen banks have participated and a smaller number are developing risk management, derivative and guarantee products to support this market.

How Companies Were Selected

This report analyzes 40 of the largest publicly traded banks and financial services firms in the world. The firms were selected mainly on the basis of market capitalization and assets under management. As of June 30, 2007, these 40 banks had a market capitalization of $3.6 trillion, representing more than 60 percent of the total market capitalization of the global publicly traded banking sector.

A further objective of this report was to analyze a cross-section of banks across geographic regions and financial sectors. Banks were selected on the basis of General Industrial Classification (GIC) codes for the largest publicly traded companies classified as Diversified Banks, Diversified Capital Markets, Other Diversified Financial Service Firms, Asset Management and Custody Banks, and Investment Banking and Brokerage. For purposes of this report, the diversified firms have been grouped together under the label of "Diversified Banking."



Sector and Regional Distribution of Banks

The 40 banks in this study represent about 60 percent of the market capitalization of the global banking sector

The regional distribution is oriented toward the largest banks based in North America and Europe. The five largest Asian banks and largest South American bank are also included to provide a more global survey sample.

To analyze these banks, information was gathered and reviewed from securities filings, company reports, company websites, media accounts and third-party questionnaires. Each of the 40 banks in this report was given an opportunity to comment on the draft profiles, and 33 companies offered comments.

During the evaluation period in the fall of 2007, one of the banks—**ABN AMRO**—was subject to a takeover by other banks included in this study. Its company profile remains in this report for purpose of comparison with other banks.

How Companies Were Scored

RiskMetrics Group, in consultation with Ceres and the Investor Network on Climate Risk (INCR), has developed the Climate Change Governance Checklist (below) to analyze corporate responses to climate change. This checklist has 14 indicators to evaluate corporate climate change activities in five main governance areas of board oversight, management execution, public disclosure, emissions accounting and strategic planning. Within each of these areas, many sub-factors are considered to produce a score of pro-active company measures to address climate change. (See the Profile Key on p. 40 for examples of these sub-factors.)

The Climate Change Governance Checklist is designed to be flexible and apply to a broad range of industries. For the banking sector, the checklist has been adapted in terms of weightings and specific areas of analysis to reflect the particular circumstances of this industry. For example, this application of the checklist to banks places less weight on accounting for and controlling energy use and direct GHG emissions than in other sectors that are larger direct GHG emitters. Conversely, this application places more emphasis on board and management strategies to address climate change and to integrate the associated risks and opportunities in lending, investment and brokerage operations. (For examples of banking sector best practices for each of the 14 indicators in the Climate Change Governance Checklist, see the illustrated checklist on pp. 8–10.)

Banks' individual scores have been determined according to a 100-point scale. Because not all banks are engaged in the full spectrum of financial service offerings assessed by the Climate Change Governance Checklist, however, scores are weighted differently for each of the three classes of financial services firms included in the study. Companies classified as asset managers were scored according to an 80-point scale, with points removed for scoring metrics related to activities that fall outside the purview of the companies' traditional business operations. The scores listed for these banks reflect the company's raw score calculated as a percentage of the maximum 80 points. Similarly, investment banks were assessed according to 97-point scale. Diversified banks, whose range of traditional business operations cover all "best practice" indicators addressed in the Climate Change Governance Checklist, were scored according to the full 100-point scale.

A 14-point 'Climate Change Governance Checklist' has been used to evaluate banks in this report

Due to these variations within the financial sector, analysis of sector peers forms a more useful basis for comparison of leaders and laggards than analysis of banks across financial sectors.

Climate Change Governance Checklist — Banking Sector		
	Board Oversight	**Points**
1	Board is actively engaged in climate change policy and has assigned oversight responsibility to board member, board committee or full board.	Up to 16
	Management Execution	
2	Chairman/CEO assumes leadership role in articulating and executing climate change policy.	Up to 22
3	Top executives and/or executive committees assigned to manage climate change response strategies.	
4	Climate change initiatives are integrated into risk management and mainstream business activities.	
5	Executive officers' compensation is linked to attainment of environmental goals and GHG targets.	
	Public Disclosure	
6	Securities filings disclose material risks and opportunities posed by climate change.	Up to 18
7	Public communications offer comprehensive, transparent presentation of response measures.	
	Emissions Accounting	
8	Company calculates and registers GHG emissions savings and offsets from operations.	Up to 14
9	Company conducts annual inventory of GHG emissions and publicly reports results.	
10	Company has an emissions baseline by which to gauge future GHG emissions trends.	
11	Company has third-party verification process for GHG emissions data.	
	Strategic Planning	
12	Company sets absolute GHG emission reduction targets for facilities, energy use, business travel and other operations (including indirect emissions).	Up to 30
13	Company participates in GHG emissions trading programs.	
14	Company pursues business strategies to reduce GHG emissions, minimize exposure to regulatory and physical risks, and maximize opportunities from changing market forces and emerging controls.	

Scores by Banking Sector

Sector	Bank	Score
ASSET MANAGERS*	State Street Corp.	36
	Northern Trust Corp.	14
	BlackRock, Inc.	4
	T. Rowe Price Group, Inc.	4
	Legg Mason, Inc.	3
	Franklin Resources, Inc.	1
DIVERSIFIED BANKS	HSBC Holdings PLC	70
	ABN AMRO Holding N.V.	66
	Barclays PLC	61
	HBOS PLC	61
	Deutsche Bank AG	60
	Citigroup Inc.	59
	Bank of America Corp.	56
	Royal Bank of Scotland Group PLC	55
	Fortis N.V.	54
	ING Groep N.V.	52
	UBS AG	52
	Credit Suisse Group	50
	Royal Bank of Canada	49
	BNP Paribas	48
	Crédit Agricole SA	47
	Société Générale	46
	JPMorgan Chase & Co.	43
	Wells Fargo & Co.	41
	Mitsubishi UFJ Financial Group, Inc.	39
	Sumitomo Mitsui Financial Group, Inc.	33
	Wachovia Corp.	27
	The Bank of Nova Scotia	26
	Intesa Sanpaolo S.p.A.	26
	TD Bank Financial Group	25
	Mizuho Financial Group, Inc.	24
	Banco Santander, S.A.	22
	Banco do Brasil	14
	Industrial & Commercial Bank of China	8
	Bank of China Ltd.	4
INVESTMENT BANKS*	Goldman Sachs Group, Inc.	53
	Merrill Lynch & Co., Inc.	52
	Morgan Stanley	49
	Lehman Brothers Holdings Inc.	26
	The Bear Stearns Companies Inc.	0

Scores for All Banks

Bank	Score
HSBC Holdings PLC	70
ABN AMRO Holding N.V.	66
Barclays PLC	61
HBOS PLC	61
Deutsche Bank AG	60
Citigroup Inc.	59
Bank of America Corp.	56
Royal Bank of Scotland Group PLC	55
Fortis N.V.	54
Goldman Sachs Group, Inc.	53
ING Groep N.V.	52
Merrill Lynch & Co., Inc.	52
UBS AG	52
Credit Suisse Group	50
Morgan Stanley	49
Royal Bank of Canada	49
BNP Paribas	48
Crédit Agricole SA	47
Société Générale	46
JPMorgan Chase & Co.	43
Wells Fargo & Co.	41
Mitsubishi UFJ Financial Group, Inc.	39
State Street Corp.	36
Sumitomo Mitsui Financial Group, Inc.	33
Wachovia Corp.	27
The Bank of Nova Scotia	26
Intesa Sanpaolo S.p.A.	26
Lehman Brothers Holdings Inc.	26
TD Bank Financial Group	25
Mizuho Financial Group, Inc.	24
Banco Santander, S.A.	22
Banco do Brasil	14
Northern Trust Corp.	14
Industrial & Commercial Bank of China	8
Bank of China Ltd.	4
BlackRock, Inc.	4
T. Rowe Price Group, Inc.	4
Legg Mason, Inc.	3
Franklin Resources, Inc.	1
The Bear Stearns Companies Inc.	0

* Scores weighted (see pg. 6 for explanation)

Source: Ceres and RiskMetrics Group

Climate Change Governance Checklist — Banking Sector Best Practices

	Board Oversight	16 Total Points
1	*Board is actively engaged in climate change policy and has assigned oversight responsibility to board member, board committee or full board.* **HSBC** has assigned environmental and climate change oversight to its board's Corporate Responsibility Committee. In addition, Group Chairman Stephen Green has been designated as having ultimate responsibility for climate change matters. The Group Management Board is also involved in climate change policymaking, including the firm's decision to become carbon neutral and new business expansion relating to carbon market opportunities. Finally, the board assesses social, ethical and environmental risks and receives training on corporate responsibility issues. • *For full credit, would need climate change-specific training and explicit board oversight of climate change as a risk management issue.*	**Awarded 13 out of 16 points**

	Management Execution	22 Total Points
2	*Chairman/CEO assumes leadership role in articulating and executing climate change policy.* **ABN AMRO**'s former Managing Board Chairman Rijkman Groenink has publicly advocated for a complete regulatory framework to address climate change, stating: "We as a private sector cannot do that alone. We need long-term policy guarantees and incentives to achieve carbon reduction." At the end of 2006, Groenink co-signed a letter to the Dutch government urging for more government action towards combating climate change. ABN AMRO has also co-signed letters on climate change policy to the President of the European Commission and the Prime Minister of the United Kingdom.	**Awarded 4 out of 4 points**
3	*Top executives and/or executive committees assigned to manage climate change response strategies.* At **Goldman Sachs**, Mark Tercek, Managing Director and Head of the Environmental Strategy Group and Center for Environmental Markets, reports directly to the CEO. In addition to the Environmental Strategy Group, business area heads oversee investment, capital markets advisory and other business activities in environmental markets. In addition, Goldman Sachs has carried out global due diligence training with respect to its Environmental Policy Framework and training for the Corporate Services and Real Estate team on green building standards.	**Awarded 6 out of 6 points**
4	*Climate change initiatives are integrated into risk management and mainstream business activities.* **Royal Bank of Canada** established an Environmental Risk Management Group in 1992 (the group is now incorporated into Corporate Environmental Affairs). RBC utilizes a suite of environment credit risk policies to address ESG issues in its lending and investment activities. In addition, in May 2002, RBC launched its Carbon Risk Management Project, which has involved a carbon risk profile of the firm's lending portfolio and a review of the potential physical impacts of climate change to North American business sectors and regions. RBC has also integrated ESG analysis into its wealth management division. • *For full credit, would need a detailed explanation of integration of climate change issues into investment and business opportunity planning.*	**Awarded 9 out of 10 points**
5	*Executive officers' compensation is linked to attainment of environmental goals and GHG targets.* **Credit Suisse** Information Technology (IT) is promoting energy conservation internally by evaluating managers according to how well they have reduced energy use. The IT department recently introduced green scorecards - an evaluation tool that provides metrics around green computing. • *For full credit, would need a climate change specific link to wider executive compensation policies.*	**Awarded 1 out of 2 points**

	Public Disclosure	18 Total Points
6	*Securities filings disclose material risks and opportunities posed by climate change.* **Bank of Nova Scotia**'s 2006 40-F includes an overview of environmental risk management policies, including monitoring of climate change policy developments. • *For full credit, would need identification of material risks and strategic business opportunities posed by climate change and further discussion of climate change and/or GHG regulations in the context of risk management.*	Awarded 4 out of 8 points
7	*Public communications offer comprehensive, transparent presentation of response measures.* **Bank of America** announced in March 2007 a $20 billion ten-year climate change initiative, detailing the company's emissions reduction targets and energy efficiency efforts. In May 2004, the company released a Climate Change Position Paper and the firm's Sustainability Report is in accordance with GRI reporting standards. In addition, the firm's 2006 Annual Report Letter to Shareholders discusses climate change and Bank of America has publicly responded to the Carbon Disclosure Project. Finally, Bank of America has advocated for a U.S. cap and trade system and federal emissions regulations; the firm's Investment Strategies Group also distributes materials to clients on the economic transitions posed by climate change and potential legislation.	Awarded 10 out of 10 points

	Emissions Accounting	14 Total Points
8–11	*Company calculates and registers GHG emissions savings and offsets from operations.* *Company conducts annual inventory of GHG emissions and publicly reports results.* *Company has an emissions baseline by which to gauge future GHG emissions trends.* *Company has third party verification process for GHG emissions data.* **Citi** has conducted a GHG emissions inventory that measures direct (Scope 1) emissions as well as indirect (Score 2 and 3) emissions resulting from electricity purchase and business travel. In addition, the company has calculated the CO_2 emissions associated with power plant financing. Citi has calculated emissions savings associated with its renewable energy purchases, and has set 2005 as a baseline by which to compare current/future emissions in setting its targets. The company's GHG inventory was conducted according to the GHG Protocol and was verified by consultants designated by the EPA Climate Leaders program. • *For full credit, would need to set emissions baseline prior to 2004 and estimate forward projection of emissions trends. Would also need to estimate savings from energy efficiency measures and banking/lending variations.*	Awarded 10 out of 14 points

	Strategic Planning	30 Total Points
12	*Company sets absolute GHG emission reduction targets for facilities, energy use, business travel and other operations (including indirect emissions).* **Barclays** has achieved carbon neutrality in the United Kingdom. In addition to this carbon neutrality target, the company has also set an absolute emissions target (20% total emissions reduction by 2010 in the U.K.), two energy use targets (for both the U.K. and global operations), and an emissions intensity target (12.6 tonnes CO_2 per €1 million U.K. income). Barclays has also made a commitment to increase its renewable energy purchase from 3% to 50% of its U.K. operations. • *For full credit, would need to set an emissions reduction target for financing/lending operations.*	Awarded 7 out of 10 points
13	*Company participates in GHG emissions trading programs.* **Fortis** has been active in the European Union Allowance (EUA) trading market since 2003. Today, Fortis trades in all existing carbon contracts and provides services to over 100 carbon clients globally. Apart from carbon trading services, Fortis provides various carbon finance, clearing, trust and fund services. Fortis is also a co-sponsor of the European Carbon Fund and is the financial services provider for the UNDP's Millennium Development Goals Carbon Facility.	Awarded 5 out of 5 points

Strategic Planning (continued)		
14	*Company pursues business strategies to reduce GHG emissions, minimize exposure to regulatory and physical risks, and maximize opportunities from changing market forces and emerging controls.* **HSBC** participates in a variety of climate-related third party initiatives and coalitions, including the Climate Group, the Institutional Investors Group on Climate Change, and the G8 Gleneagles CEO Roundtable on Climate Change. The company also ranked first in the Low Carbon Finance and Investment Leaders category in a survey by BusinessWeek and the Climate Group (December 2006) for its debt financing for low carbon projects and technologies, as well as equity capital for early stage project development. In June 2007, HSBC launched a Global Environmental Efficiency Program, a commitment to reduce the firm's direct environmental impacts. The $90 million commitment over five years will support renewable energy technology, water and waste reduction programs and employee engagement. In addition, HSBC offers a variety of climate-related investment products, including the HSBC Global Climate Change Benchmark Index (and four sub-indices) and a climate change fund that aims to outperform the index. HSBC is also developing risk consultancy services to help customers assess and manage their physical exposures to climate change and insurance products to facilitate the development of renewable energy projects and carbon markets. • *For full credit, would need to currently offer climate-related retail products.*	**Awarded 14 out of 15 points**

To view a sample bank profile, go to p. 36. To view all 40 bank profiles, go to www.ceres.org.

II. Overview

The Climate 'Mega-Trend'

Climate change is changing the world of banking in many ways. One investment bank described climate change recently as "the next global mega-trend," after the fall of the Iron Curtain and the Internet revolution.[2] From a macro-economic standpoint, a carbon-filled atmosphere is joining capital and labor as a new resource constraint in production. Moreover, cost impacts from extreme weather events and greenhouse gas (GHG) regulation are emerging as risk factors in pricing securities and assigning credit and asset valuations.

For a global economy already faced with $100-barrel oil and a projected 50 percent increase in energy demand over the next 25 years, the climate change "mega-trend" may bring the global economy to a historic tipping point. While globalization and the spread of market-based economies have created wealth for a fast-growing human population, they have also hastened a day of reckoning when fossil fuel shortages and excess climate-changing emissions could combine to spawn a global climate and energy crisis. As Theodore Roosevelt IV, a managing director for Lehman Brothers, stated recently, "The economic transformation driven by climate change, we believe, will be more profound and deeper than globalization, as energy is so fundamental to economic growth."[3]

From a macro-economic standpoint, a carbon-filled atmosphere is joining capital and labor as a new resource constraint in production

A new report from the United Nations Intergovernmental Panel on Climate Change (IPCC) makes the strongest case yet for near-term, concerted action to combat global warming.[4] The report concludes that as a result of rapid consumption of fossil fuels since the start of the Industrial Revolution, "There is very high confidence that the net effect of human activities since 1750 has been one of warming." This extensively peer-reviewed report—whose authors share in the 2007 Nobel Peace Prize—finds:

- Earth's surface temperature has increased 1.33 degrees Fahrenheit since 1900 (0.74 degrees Celsius), mostly in the last 50 years, likely making this the warmest period of the last 1,300 years.
- Eleven of the last 12 years have been the warmest in the instrumental record, dating back to 1850.
- Recent temperature and carbon dioxide (CO_2) emission trends are at the high end of the range forecast by the IPCC, with the global average temperature now rising about one-half degree F per decade.
- The frequency of heat waves, forest fires and heavy precipitation events has increased globally since 1950.
- Areas affected by drought have spread globally since the 1970s.
- The incidence of coastal flooding has increased since 1975.
- Arctic sea ice cover has shrunk 20 percent since 1978, when satellite measurements began.
- The rate of sea level rise has jumped 70 percent since 1993, compared to the prior 30-year measurement period. Rapid melting of the Greenland ice sheet is now raising new concerns that the amount of sea level rise that might occur this century will be measured in meters, not inches.

Climate change is already taking a discernible human and financial toll, with an increase in heat-

2. Elga Bartsch, "The Economics of Climate Change—a Primer," Morgan Stanley Research Europe, Morgan Stanley, Oct. 3, 2007.
3. Clive Horwood, "The new colour of money," *Euromoney*, September 2007.
4. "Summary for Policymakers of the Synthesis Report of the IPCC Fourth Assessment Report," Intergovernmental Panel on Climate Change, Geneva, Switzerland, Nov. 16, 2007.

related mortality in Europe, drought-induced famine in Africa, and spread of infectious disease vectors and allergenic pollen across the Northern Hemisphere. Receding mountain glaciers and snow cover are shrinking the water supply of some major population centers, including California; transforming Arctic communities that depend on hunting and travel over snow and ice; and threatening the livelihood of winter resort communities in some lower-elevation alpine areas, such as the European Alps and northeastern United States.

Ominously, the IPCC warns of "abrupt or irreversible" damage that might occur as a result of delays in curbing GHG emissions. Left unchecked, global temperatures could rise fully 10 degrees F by the end of this century, with thermal expansion of the oceans causing at least two feet of sea level rise. Such global temperatures, if sustained, could set in motion irreversible melting of the Greenland ice sheet, resulting in 23 feet of sea level rise over a matter of centuries, inundating the world's coastal cities and wasting trillions of dollars of urban infrastructure.

As the main providers of capital and with their expertise in risk management, banks can do much to combat climate change

Even more modest temperature increases—on the order of 3 to 5 degrees F—are expected to accelerate the trend toward more frequent heat waves, flooding rainstorms, rising sea level, severe hurricanes and a poleward shift of extra-tropical storms. The consequences for the global economy could be devastating. One study commissioned by the U.K. Treasury Department estimated that if CO_2 emissions are left unabated, climate change could cause a 5 to 20 percent reduction in the projected global gross domestic product by 2050.[5] Damage from catastrophic storms and sea level rise, rising agricultural and forestry losses, growing food and water shortages, and massive refugee problems could bring about economic losses equivalent to those suffered during the Great Depression, this report found. In presenting the study's findings, Sir Nicholas Stern, the report's lead author and a former chief economist at the World Bank, cast climate change as "the greatest market failure the world has ever seen."

Banks' Leadership Role

Can banks correct this market failure? Not by themselves. But as the main providers of capital to the global economy, and with their expertise in risk management, banks can do much to combat climate change.

First and foremost, banks can start factoring in a market price for CO_2 as carbon-reducing regulations and carbon emissions trading expand globally. With the start of emissions trading in Europe in 2005, CO_2 has become a fungible commodity that could eclipse the value of oil over time.[6] This puts banks in a pivotal position to help build new markets through carbon emissions management, trading and brokerage. At the same time, through lending and investing, banks can help lead a "clean energy" revolution in energy efficiency technologies and renewable resources that could spur hundreds of billions of dollars in new annual revenue streams in the decades ahead.

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Whether banks will seize these opportunities—and this report finds preliminary evidence that they are pursuing at least some—banks will come to realize that climate change affects all facets of their business and all classes of investing. On the way toward a warmer, carbon-constrained world, equity valuations will be shaped by everything from new regulatory schemes and incentives, to physical damage to facilities, and shifts in consumer preferences toward "climate friendly" products and services. The ability of companies to adjust to this fast-changing physical and regulatory environment—by mitigating climate risks and capitalizing on new investment opportunities—will become

5. *Stern Review Report on the Economics of Climate Change*, U.K. Treasury Department, October 2006.

6. "Emissions Trading Expert Peter Fusaro: Carbon Trading is going to be Bigger than Oil Trading." July 31, 2007. *See http://energytechstocks.com.previewmysite.com/wp/?p=120*

increasingly central to banks' financing of corporations, equity research and portfolio management.

At the same time, banks will need to re-examine their treatment of fixed-income assets, many of which are designed to last for decades but which may come under rising inflationary pressure from weather-related losses and carbon regulations that will make carbon emissions more costly. Demand for "climate protection" products and services could lead banks into whole new markets to support efficient risk sharing of increasingly vulnerable infrastructure. In addition, government securities may be called upon to backstop climate-related risks that the private sector is no longer willing or able to finance and insure. Even global trade and currency valuations will be affected, with countries lacking the necessary financial resources and adaptive capacity seeing their currencies weakened, as others benefit from new international trade and capital flows spurred by carbon-related emissions trading and project development.

$500 billion	Value of low-carbon energy markets by 2050 *(Stern)*
$100 billion	Demand for projects generating GHG emissions credits by 2030 *(UN)*
$100 billion	Worldwide investment in clean energy by 2009 *(New Energy Finance)*
$18.6–$23.1 billion	Estimated solar industry revenues by 2010 *(Solar Buzz)*
$15 billion	Global fuel cell and distributed hydrogen market by 2015 *(The Climate Group)*
$84 billion	Cumulative net savings from energy efficient products in US by 2012 *(The Climate Group)*

Size of the Opportunity

Source: Deutsche Bank. "Investing in Climate Change." October 2007

Need for Action

While the transition to a lower-carbon economy will take decades, "What we do in the next two or three years will determine our future," says Rajendra Pachauri, an economist and scientist who heads the the Intergovernmental Panel on Climate Change. If no further action is taken to control GHG emissions before 2012, "it's too late," Pachauri believes. "This is the defining moment."[7]

Bringing GHG emissions under control presents a formidable challenge for the global economy. In the last 35 years, anthropogenic emissions of CO_2, the most important greenhouse gas, have increased 80 percent, mainly as a result of rapid increases in the rate of combustion of fossil fuels. The atmospheric concentration of CO_2 now stands at 380 parts per million—far above the natural range over the last 650,000 years.

Since 2000, even the amount of carbon *per unit of energy produced* has increased, reversing a trend toward use of lower-carbon energy sources since the start of the Industrial Revolution. This reversal is mainly the result of emerging economies like China and India that are relying heavily on coal and oil—the most carbon-intensive energy sources—to fuel their economic booms. But it is also because fossil energy developers elsewhere have begun to tap unconventional sources that require far more energy to refine and produce, such as tar sands and oil shale in Canada and the western United States. From a carbon emissions standpoint, expanded use of these carbon-rich fuels has canceled out the sizeable gains made in production from non-carbon resources like wind and solar since 2000.

If current trends continue, a climate and energy crisis is virtually unavoidable. Between now and

7. Elizabeth Rosenthal and James Kanter, "Grim Report on Climate Change Described as Too Rosy," The New York Times, Nov. 17, 2007.

2030, CO_2-equivalent (CO_2e) emissions are expected to nearly double under business as usual forecasts. Even with more optimistic assumptions about gains in energy efficiency and expansion of renewables, emissions are expected to rise by at least 25 percent. Such forecasts make it virtually impossible to achieve what scientists say is needed by 2050 to avoid "dangerous human interference" with the climate system—a 60 to 80 percent reduction in CO_2e emissions below current levels.

Tipping Point?

To keep major GHG reductions by 2050 in the realm of possibility, the IPCC is recommending an emissions path where global energy-related CO_2 emissions peak by no later than 2020 and return to current levels by 2030. In that time frame, more than $20 trillion of energy-related capital investment is projected to occur. With an additional net investment of 5 to 10 percent a year to speed the penetration of non-carbon based fuels, the IPCC believes it would be possible to return emissions to current levels by 2030, even as the global economy grows virtually unabated. This places an enormous responsibility on energy companies and the banks that finance them to make sound investment decisions, since most of the energy stock added now will still be in use in 2030. Yet there must be a substantial shift away from carbon-based fuels over the period if these emissions goals are to be achieved.[8]

Only one of the banks in this report has made a formal, but modest, commitment to shift the balance of its financing in the power sector in favor of lower-carbon companies

One piece of good news in this report is that banks are stepping up their investments in "clean technology" to make this possible. Of the 40 banks profiled, 29 document their involvement in the renewable energy and clean tech market through everything from private equity and fund investments, to underwriting of initial public offerings, debt financing and even direct ownership stakes in some companies. Altogether, annual investment in renewable energy globally passed the $100-billion mark in 2006, according to the United Nations Environment Programme.[9]

Even so, the amount of investment in traditional fossil fuels far exceeds that of renewables, and few banks have yet given any indication that they are willing to scale back their funding of carbon-intensive energy sources like tar sands and new conventional coal-fired power plants. Only one of the banks evaluated in this report—**Bank of America**—has made a formal, but modest, commitment to shift the balance of its financing in the power sector in favor of lower-carbon utilities, so that its lending portfolio will have reduced carbon exposure over time. (See p. 26 for details.) Yet even this bank along with others has come under fire for its continued role in financing large coal-based utilities.[10] In any event, more banks will need to follow this precedent of tracking the relative flow of capital into carbon vs. non-carbon energy sources—and place increasingly aggressive limits on the proportion going into carbon sources—if there is to be any prospect of halting the atmospheric buildup of GHGs by 2050.

What this report can say with certainty is that climate change has galvanized the attention of the banking community. A growing number of banks recognize the challenges and opportunities posed by global warming, and some of the leading banks are treating this as a risk management issue—as they would other credit, operational and reputation issues:

- Of the 40 banks profiled in this study, 23 include a reference or discussion of climate change in their latest annual shareholder reports.
- Twenty-six of these banks were signatories to the latest annual survey conducted by the Carbon Disclosure Project, a non-profit organization that seeks information on climate risks and

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8. Successful commercialization of carbon capture and storage technology could offset the need for some fossil fuel replacement, but not eliminate the need for this shift toward new energy sources.

9. "Global Trends in Sustainable Energy Investment 2007," United Nations Environment Programme, June 2007.

10. "Banks, Climate Change and the New Coal Rush," Rainforest Action Network, October 2007.

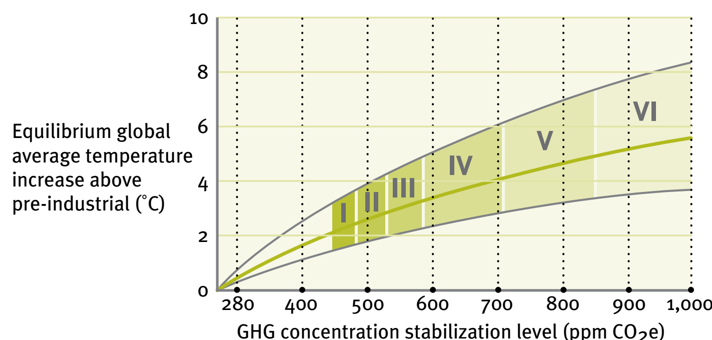
opportunities from companies on behalf of an investor coalition of 315 firms with $41 trillion in assets under management, and 34 of the banks filled out the latest survey.

- Collectively, these banks have produced at least 97 research reports on climate change—58 in 2007 alone. The reports run the gamut from broad assessments of climate change, to specific analyses of public policy and carbon emissions trading, to investments in renewables and other "clean" technologies.

The question now is how this growing understanding of climate change will spur the banking industry to take a leadership role in driving a low-carbon economy. Without substantial investment flows and effective technology transfer, it will be difficult to achieve timely carbon emission reductions at significant scale. By factoring carbon prices into equity valuations and lending decisions now, banks can promote more rapid diffusion and commercialization of advanced low-emissions technologies and reduce the total costs of GHG mitigation.

Early analytical results presented by the IPCC suggest that the net macro-economic effect of achieving a stable atmospheric level of CO_2 by 2050 would be a 0.12 percentage-point reduction in average annual GDP growth—practically a rounding error in the field of economic forecasting. This is a small price to pay to avert a possible climate catastrophe, and to put the planet on a sustainable course where the development needs of the present do not compromise the ability of future generations to meet their needs. And in doing so, banks can spur new business for themselves, lessen the liabilities associated with financing climate-damaging technologies and preserve their leadership role in wealth management and capital formation.

CATEGORY	I	II	III	IV	V	VI
CO_2 concentration at stabilization (ppm) *(2005 = 379 ppm)*	350–400	400–440	440–485	485–570	570–660	660–790
Peaking year for CO_2 emissions	2000–2015	2000–2020	2010–2030	2020–2060	2050–2080	2060–2090
Change in global CO_2 emissions in 2050 (% of 2000 emissions)	-85 to -50	-60 to -30	-30 to +5	+10 to +60	+25 to +85	+90 to +140
Global average temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity (˚F)	3.6–4.3	4.3–5.0	5.0–5.8	5.8–7.2	7.2–8.8	8.8–11.0
Global average sea level rise above pre-industrial at equilibrium from thermal expansion only (Feet)	1.3–4.5	1.6–5.5	1.9–6.2	1.9–7.8	2.6–9.4	3.2–12.0



CO_2 emissions and equilibrium temperature increases for a range of stabilization levels

Source: Intergovernmental Panel on Climate Change Fourth Assessment Report

III. Findings: Climate Governance

Today's bankers and business leaders must recognize that Earth's climate is no longer a static boundary condition for conducting their affairs. The strategic investment decisions they make have a direct bearing on the climate and the natural environment that underpins economic growth. New governance principles must emerge that take this into account.

Increasingly, boards of directors and company CEOs see climate change as an issue they have a duty to address. In a recent survey of 390 CEOs whose firms have endorsed the United Nations Global Compact, 69 percent said they believe that companies should "have the board, as part of its risk-management and fiduciary responsibilities, discuss and act on" environmental, social and governance (ESG) issues. Moreover, 61 percent of these CEOs identified "increasing environmental concerns" as the greatest influence on society's expectations of business. And fully one-third identified responding to climate change as "critical" to addressing the future success of their businesses.[11]

Corporate directors and CEOs who disagree with these statements may find themselves increasingly on shaky ground. As one attorney who advises corporate boards observed recently, "Shareholder litigation against officers and directors who fail to respond to climate change... may be on the horizon. Expectations flowing from the board's duty of care—including its obligations to inquire, to be informed and to employ adequate internal monitoring mechanisms—may create new consequences for boards and modify the standards by which their conduct is judged."[12]

Eleven of the 12 banks with board-level involvement in climate change initiatives are non-U.S. firms—seven in Europe, three in Canada and one in Japan

Board Oversight

Corporate directors in the banking sector are waking up to this changing set of expectations. Of the 40 banks examined in this study, 22 now have board reviews of the company's environmental affairs, and 12 integrate climate change as part of their review processes. Nine banks have also assigned a board member to oversee the company's climate-related initiatives. Four banks have implemented training programs for directors on sustainability issues.

In terms of regional distribution, board involvement in environmental issues is relatively uniform. (This study includes 19 banks based in North America, 15 in Europe, five in Asia and one in South America.) Three U.S. banks, four European banks and two Canadian banks report having a board-level committee charged with oversight of the company's environmental affairs. However, none of the Asian banks reviewed for this study have followed this trend.

The regional differences widen, however, as the oversight focus narrows to climate change. Eleven of the 12 banks with board-level involvement in climate change initiatives are non-U.S. firms—seven in Europe, three in Canada, and one in Japan. **HSBC**, for one, has an extensive climate governance structure involving the company's board of directors. The General Management Board, chaired by the Group Chief Excecutive, is responsible for HSBC's 2004 decision to become the world's first "carbon neutral" bank. The board also oversees the company's investments in emission-reducing projects and other carbon market opportunities. A board-level Corporate Responsiblity Committee also oversees the company's social responsibility and sustainability policies.

At **ABN AMRO**, the Managing Board acts as the governing and strategic decision-making body for the bank's sustainable development activities. Like HSBC, this board approved the bank's decision

11. Debby Bielak, Sheila M. J. Bonini, and Jeremy M. Oppenheim, "CEOs on Strategy and Social Issues," *The McKinsey Quarterly*, October 2007.

12. Jeffrey A. Smith and Mathew Morreale, Cravath, Swaine & Moore LLC, Boardroom Climate Change, *New York Law Journal*, Vol. 238, no. 10, July 16, 2007.

to become carbon neutral, and it receives regular updates from the company's Sustainability Department.

Management Execution

At the executive level, management of climate change issues has started to move beyond the purview of government relations and public affairs departments and into the realm of traditional risk management. The broad reach of climate change compels a holistic and forward-looking management approach. It combines practical considerations of how banks manage their own energy use and associated greenhouse gas emissions with the broader implications of how climate change affects their lending and investment operations, competitive positioning, reputations and, ultimately, financial bottom lines.

Twenty-six of the banks in this study have established general environmental policies, and 13 have specific climate-related policies and/or strategies

Senior-level support and engagement are the most critical components of any successful climate strategy, according to a recent report from the Pew Center on Global Climate Change.[13] Among survey respondents for this report, CEO leadership was identified as a key driver at all stages of climate program development and implementation. CEO leadership is also key indicator in the Climate Change Governance Checklist featured in this report.

Environmental Management

Increasingly, senior-level management attention to climate change is translating into formal company-wide environmental policies. Twenty-six of the banks reviewed in this study have established general environmental policies, and 13 have specific climate-related policies and/or strategies. Of the banks with climate-specific policies, eight are based in Europe, four are in the United States and one is in Canada—and all are diversified banks. None of the banks in the asset management and investment banking sectors, or the five Asian banks examined in this study, have thus far developed climate-specific policies or strategies. These figures are likely to rise, however, as much of the corporate policy focus on climate change has come only recently. Of the 13 banks with formal policies, nine created or updated them in just the past two years.

Morgan Stanley, for example, updated its Environmental Policy Statement in 2007. The policy commits the bank to helping clients in GHG intensive industries to develop financial strategies for responding to emerging regulatory mandates, devoting resources towards sustainable and renewable sources of energy, continuing to provide investment research that enhances understanding of the impacts of climate change and carbon constraints on businesses, and encouraging clients to evaluate the issue of GHG emissions and to consider investing in and making use of emerging environmental technologies.

Royal Bank of Canada (RBC) unveiled an Environmental Blueprint in October 2007 that is focused on climate change, biodiversity and water issues. Among other things, this policy commits the bank to reducing its environmental footprint, providing a suite of environmental credit risk policies for its clients and offering new climate-focused products and services. This is the latest outgrowth of a Carbon Risk Management Project that RBC began in 2002. As part of this project, RBC undertook a carbon risk profile of its lending portfolio in order to assess potential credit risk impacts, and undertook a review of the potential physical impacts of climate change to North American business sectors and regions.

Barclays PLC adopted its Environmental Policy in January 2005, which includes a five-point Climate Action Program. The goals are to increase energy efficiency, purchase renewable energy, achieve carbon neutrality for its U.K. operations, offer climate products and services to customers, and actively

13. Andrew Hoffman, "Getting Ahead of the Curve: Corporate Strategies to Address Climate Change," Pew Center on Global Climate Change, October 2006.

engage in the climate change policy debate. Several other banks have adopted similar climate-related goals as part of their environmental policies in recent years.

Risk Management

For some banks, however, climate change is not merely an extension of environmental policy; it is an important component of the company's risk management. "Take the issue of CO_2 emissions and climate change," **Barclays** wrote in its 2005 Corporate Responsibility Report. "We have already seen how business is responding commercially to the challenge. But we also have to deal with it as a risk management issue."[14] In Barclays' case, the firm has established an Environmental and Social Impact Assessment Policy to ensure that "lending proposals are thoroughly assessed to identify any environmental and social risks." The policy is implemented through its lending managers and credit teams as well as a specially designated Environmental and Social Risk Policy team. The Brand and Reputation Committee, a subcommittee of Barclays' Executive Committee, oversees the process.

> ***"We have already seen how business is responding commercially to the [climate] challenge. But we also have to deal with it as a risk management issue."***
>
> **–Barclays PLC**

Several other European banks have variations on this risk management scheme. **ABN AMRO**'s Group Risk Committee (GRC) is mandated to include environmental, social and ethical (ESE) considerations in decision-making on client and transaction engagements. To help fulfill this mandate, a Sustainable Risk Advisory (SRA) team works within the Group Risk Management division to assess ESE risks and advise the GRC on business engagement decisions. With respect to climate change and project finance, the company identifies regulatory risk from emerging GHG emissions policies, cash-flow risks from volatile costs and physical risks from weather events.

HSBC also has an Environmental Risk Standard, established in 2003, and has since adapted it into a Sustainability Risk Framework. HSBC is upgrading its risk approval systems to include sustainability risk ratings, which will be gradually assigned to clients globally. The risk ratings will enable the firm to differentiate deal approval levels, the type of facility it would offer a client and provide portfolio information. HSBC has a network of 27 environmental risk managers that support its Sustainability Risk team in London. It also recently hired a dedicated climate change executive who heads a Climate Change Center for Excellence. "Over the next five years," Group Chairman Stephen Green stated in 2007, "HSBC will make responding to climate change central to our business operations and at the heart of the way we work with our clients across the world."[15]

Executive Task Forces

As climate change evolves as a risk management issue, banks must consider how it will affect their diverse lines of business and operations that often span several continents. One way banks are coordinating their governance responses at the executive level is by establishing climate-focused committees or task forces led by the CEO or other top-ranking executives. Twenty-five of the banks analyzed in this study have established general environmental/sustainability executive committees, task forces or working groups; 13 have created working groups focused specifically on climate change.

Crédit Agricole has organized a top-down climate governance response that reaches from the CEO all the way to lending officers within its regional development banks. The three-tiered structure includes a top-level Sustainable Development Committee, a Sustainable Development Mission and a network of Sustainable Development officers. The Sustainable Development Committee is chaired by the CEO and includes several top executives who are responsible for drafting the main guidelines for the

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14. Barclays PLC, 2005 Corporate Responsibility Report.

15. News conference to announce the HSBC Climate Partnership, London, U.K., May 30, 2007.

Sustainable Development Mission. Crédit Agricole has also established a 12-member specialized Environmental Unit responsible for developing the company's carbon assessment tools and new climate-related products. This unit reports directly to the Sustainable Development Committee.

Other companies have implemented climate governance strategies with a more decentralized structure, where working groups operate within different business units. At **UBS**, the primary responsibility for implementing environmental policies lies within its business groups, each of which has appointed an environmental representative to act as sponsor of environment-related initiatives within that group. UBS also has an executive-level Environmental Committee, chaired by the Group Chief Credit Officer, which consists of each group's environmental representatives and other senior executives. A Group Environmental Policy unit supports the Environmental Committee's work.

Adhering to the philosophy that environmental issues should be incorporated as a standard business consideration by all business lines and operating areas within the company, **Bank of America** has also taken a more decentralized approach. An Environmental Council with executive representation meets periodically throughout the year to help business lines drive their performance objectives. In addition, cross-functional teams have been developed to address environmental issues and opportunities. These teams focus on areas such as credit risk, reporting and tracking, operations and supply chain management, procurement and corporate services, energy management and associate engagement.

Fortis utilizes a hybrid climate governance structure combining these centralized and decentralized approaches. At the corporate level, it has a Corporate Social Responsibility (CSR) department, with CSR managers deployed in each of the company's businesses. The CSR department coordinates and synthesizes broad sustainability policies in line with the company's overall global strategy, while the CSR managers integrate specific climate-related issues into their business units. In addition, Fortis has established a Corporate Sustainability Steering group, comprised of 10 senior managers from various parts of the organization to "embed sustainability deeper within the organization." In 2007, Fortis also set up a CSR Advisory Board, comprised of external experts, to offer additional perspective on the company's CSR initiatives.

Public Disclosure

The lack of climate risk disclosure in securities filings continues to be of particular concern to many shareholders

Corporate disclosure of climate change risk is growing steadily in response to investor and other stakeholder initiatives—and the banking industry is no exception. Twenty-six of the 40 banks in this study were signatories to the latest annual survey of climate-related risks conducted by the Carbon Disclosure Project.[16] In addition, 34 of the banks completed this survey and shared the results with other CDP signatories.

However, banks have a spottier record when it comes to direct communication with their shareholders on climate change. Only 23 of the 40 banks analyzed in this report included a reference to climate change in their latest annual reports. And only nine of the banks mentioned climate change or related issues in their latest Form 10-K or comparable regulatory filings. The lack of disclosure in securities filings continues to be of particular concern to many shareholders:

- In September 2007, 22 institutional investors and other organizations filed a petition requesting that the U.S. Securities and Exchange Commission issue interpretive guidance on what material climate-related information should be included in corporate disclosures.[17]

16. Carbon Disclosure Project Report 2007: Global FT500 and USA S&P500 reports, September 2007.
17. Rebecca Smith, "SEC Pressed on Climate Change Disclosure," *Wall Street Journal*. Sept. 18, 2007. See http://sec.gov/rules/petitions.shtml.

- Also in September, New York Attorney General Andrew Cuomo, acting to protect investors including New York state's public employees, filed subpoenas against five large U.S. power companies for failing to "evaluate or quantify" the possible effects of future GHG regulations in their most recent Form 10-K filings. "Selective disclosure of favorable information or omission of unfavorable information concerning climate change is misleading," Cuomo wrote in his letters to the companies.[18]
- In October 2007, the U.S. Senate Banking Committee's Subcommittee on Securities, Insurance and Investment held a hearing in which leading institutional investors reiterated their calls for more detailed climate risk disclosure in securities filings. In his opening remarks, Subcommittee Chairman Sen. Jack Reed (D-R.I.) argued that more Form 10-K disclosure would help financial markets "to price climate risks and opportunities efficiently."[19] If the SEC fails to clarify disclosure requirements, Sen. Robert Menendez (D-N.J.) said an alternative course of action might be to insert additional language in a climate bill that the Senate is now considering.

Bank of America, Citi, Goldman Sachs, JPMorgan Chase, Lehman Brothers and Merrill Lynch have all spoken out about the need for federal climate change legislation in the United States

The outcome of the SEC petition, New York subpoenas and possible legislative action all bear close watching in 2008. At the same time, investors plan to file up to 50 shareholder proposals with U.S. corporations on climate change during the 2008 annual meeting season, including several resolutions filed with U.S. banks. This shareholder campaign is entering its nineteenth year. In 2007, a record 47 shareholder resolutions were filed with U.S. companies seeking, among other climate-related actions, greater disclosure on the financial risks and opportunities associated with climate change. The proposals that came to votes received average support of nearly 20 percent, also a record.

Public Policy Statements

Like many private enterprises, banks were for many years leery about government intervention to regulate GHG emissions. However, as new opportunities emerge in carbon emissions trading and clean technology investments, banks are starting to advocate a more pro-active government role. Increasingly, they see that uncertainty over the form of regulatory controls is getting in the way of substantive financial decisions that will be a boon to their industry.

Seventeen of the 40 banks in this study now have made formal public policy statements on climate change. These range from basic expressions of support for cap-and-trade mechanisms in their annual or CSR reports to active membership in organizations lobbying for government controls. Notably, U.S. banks have been very active in this area, reflecting the lack of U.S. government action to address climate change.[20]

Bank of America, **Citi**, **Goldman Sachs**, **JPMorgan Chase**, **Lehman Brothers** and **Merrill Lynch** and have all spoken out in recent years about the need for federal climate change legislation in the United States. Citi's Position Statement on Climate Change, issued in February 2007, is typical: "U.S. national action and leadership are critical elements of a global solution because of the size of the U.S. economy and our emissions and because a global solution is highly unlikely without U.S. action. We believe that the United States must act now to create a national climate change policy to avoid the economic, social, and environmental damage that will result if GHG emissions are not reduced."

18. Felicity Barringer and Danny Hakim, "New York Subpoenas 5 Energy Companies," The New York Times, Sept. 16, 2007.
19. "Investors Push Congress for Full Corporate Dislcosure on Climate Risk." www.incr.com. Oct. 31, 2007.
20. With Australia's approval of the Kyoto Protocol on Dec. 3, 2007, the United States is now the only major industrialized country that has not endorsed this international agreement.

Merrill Lynch has taken the further step of joining a group of 65 companies and institutional investors organized by Ceres. In March 2007, the group, whose members manage more than $4 trillion in assets, called on the U.S Congress to adopt a mandatory, market-based policy, such as a cap-and-trade system. The group's Call to Action statement recommends achieving GHG emissions reductions of 60-90 percent below 1990 levels by 2050, as well as establishing an economy-wide carbon price. The group also called on the SEC to require better corporate disclosure of climate risks.

European banks, meanwhile, have been advocating for GHG emissions trading as the key climate change policy solution over imposing carbon taxes or other command-and-control government policies. Many of these are joint initiatives. **ABN AMRO** has participated in several policy forums and has co-signed letters on climate change to the President of the European Commission and the Prime Minister of the United Kingdom. **Barclays** Chairman Marcus Agius is a member of the Confederation of British Industry's Climate Change Taskforce, a group of chairmen and CEOs from some of the U.K.'s biggest companies who are trying to frame a business policy agenda to tackle climate change. **HBOS** is a member of the Institutional Investors Group on Climate Change, which has explicitly supported the U.K. government's policy target of a 60 percent reduction in U.K. GHG emissions below 1990 levels by 2050.

Additionally, in November 2007, **ABN AMRO**, **Barclays**, **Fortis**, **HBOS** and **HSBC** signed the Bali Communiqué, organized by the Prince of Wales's UK and EU Corporate Leaders Groups on Climate Change. The Communiqué calls for a comprehensive, legally binding United Nations framework to tackle climate change and was announced at the start of the Bali, Indonesia negotiations for a post-2012 Kyoto Protocol agreement.

Findings: Internal Greenhouse Gas Management

While banks are not large GHG emitters on the scale of utilities or industrial firms, they still have a vital role to play in managing their emissions. Since the building sector accounts for up to 40 percent of GHG emissions in some countries, banks can set an important example for their clients by adopting formal emissions accounting and management systems. Many banks are altering their energy procurement policies in favor of renewable energy sources and integrating green building principles into real estate management. In addition, banks are expanding their GHG management programs to include limits on business travel, which in some cases rivals emissions from company-owned buildings.

Twenty-four banks in this study have some type of GHG emissions reduction target

Moreover, large multinational banks with thousands of branch offices around the world can influence local uptake of energy efficiency and clean energy technologies. Some banks are looking beyond their own properties to include financing of other energy efficiency initiatives in urban areas. For example, five banks—**ABN AMRO**, **Citi**, **Deutsche Bank**, **JPMorgan Chase** and **UBS**—each have pledged $1 billion to support an Energy Efficiency Building Retrofit Program under the Clinton Foundation's Climate Initiative. This program is being conducted in partnership with 16 large city governments around the world to arrange financing for cities and private building owners to undertake retrofits that pay for themselves through energy savings over the life of the investments. The $5 billion being committed by these banks will double the global market to finance energy retrofits in buildings.[21]

21. President Clinton Announces Landmark Program to Reduce Energy Use in Buildings Worldwide," May 16, 2007. See http://www.clintonfoundation.org/051607-nr-cf-pr-cci-president-clinton-announces-landmark-program-to-reduce-energy-use-in-buildings-worldwide.htm

Emissions Inventory

The first step for most banks in managing their GHG emissions internally is to conduct a formal inventory of energy-related emissions from their office buildings and retail branches. In this study, 28 of the 40 banks reported that they have calculated and disclosed their GHG emissions. Most of these banks use an inventory accounting method called the Greenhouse Gas Protocol (GHG Protocol) developed by the World Resources Institute and the World Business Council for Sustainable Development, and most report their emissions annually to the Carbon Disclosure Project.

Since banks have few direct emissions from on-site power generation (referred to as Scope 1 emissions in the GHG Protocol), most of their emissions come indirectly through power purchases for their facilities. These Scope 2 emissions account for the lion's share of banks' emissions disclosure. However, 23 of the banks also report Scope 3 emissions (indirect emissions) from business travel and sometimes employee commuting. Air travel, in particular, is a large source of Scope 3 emissions for banks. Six banks also report Scope 3 indirect emissions in areas beyond business travel, as follows:

- **Crédit Agricole:** materials and services purchased
- **Credit Suisse:** products (waste management) and supply chain (paper/water input)
- **Morgan Stanley:** products (waste production/disposal)
- **Royal Bank of Canada:** supply chain
- **Société Générale:** supply chain
- **UBS:** products (waste disposal) and supply chain (paper)

Emissions Management and Carbon Neutrality

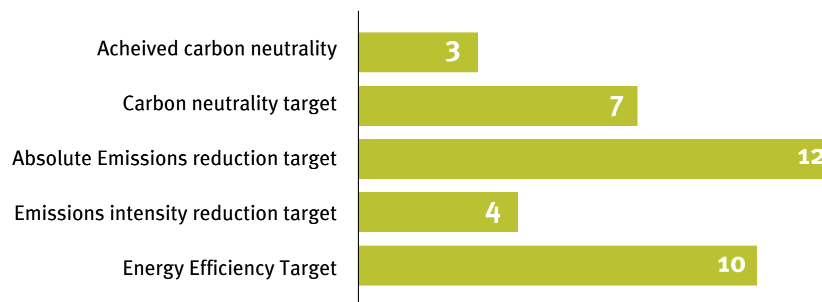
Many banks have gone beyond conducting GHG emission inventories to setting emission reduction targets and regularly reporting on their progress to interested stakeholders. Twenty-four banks in this study have set some type of GHG emissions reduction target. This includes 12 banks that have set targets for absolute reductions in their total emission inventories (not including banks with commitments to carbon neutrality). Ten banks have also set targets for reductions in energy use. Finally, four banks have set targets to reduce the intensity of their GHG emissions (i.e., without setting absolute reduction targets), and two have set energy use-intensity reduction targets.

Bank	Target Reduction	Baseline Year	Target Year
Bank of America	9%	2004	2009
Barclays	20%	2000	2010
Citigroup	10%	2005	2011
Goldman Sachs	7%	2005	2012
HSBC	5%	2004	2007
Industrial & Commercial Bank of China	5%	2004–2006	2009–2011
JPMorgan Chase	7%	2005	2012
Morgan Stanley	7–10%	2006	2012
State Street	5%	2006	2011
Sumitomo Mitsui	6%	2001	2012
UBS	40%	2004	2012
Wachovia	10%	2005	2010

Absolute Emissions Reduction Targets from Facilities and Energy Use

In addition, 22 banks in this study are purchasing renewable energy to reduce their emission footprints, and 19 are purchasing certified emissions reduction offsets. Some of these bank programs are not company-wide, but are limited to certain countries of operation or facilities.

A growing number of banks are declaring targets to achieve "carbon neutrality" for their operations. Ten banks in this study say they have either achieved or are committed to carbon neutrality. In each instance, this includes commitments to purchase renewable energy to help power their facilities and other means of offsetting their emissions.



Emissions Reduction Targets

While carbon neutrality can be an appealing concept to bank customers, how banks define and go about achieving neutrality is drawing further scrutiny. In particular, questions have been raised about the efficacy of certain offset programs in stimulating additional renewable energy production and bringing about actual emissions reductions. In November 2007, a Voluntary Carbon Standard (VCS) was announced to provide more investor confidence and transparency around the offset process, which has lacked standardized verification methods.[22] The VCS could help maintain the momentum of the voluntary carbon offset market, which by some estimates could reach $4 billion over the next five years.

Several banks with carbon neutrality commitments have identified measures beyond offsets to achieve this goal. Key to these efforts is improvement in energy efficiency at bank facilities. Twenty-one banks in this study cite the use of programs such as EPA's ENERGY STAR and the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) green building rating system to document their commitment to achieving cutting-edge energy efficiency improvements at one or more of their facilities.

Goldman Sachs has developed uniform green building standards for use in the construction and major renovation of its facilities. The standards are designed to ensure that the firm meets the intent of Leadership in Energy and Environmental Design (LEED) Gold certification or other whole building standards on all future projects. The firm has a LEED-certified building in Jersey City, N.J., and is working towards LEED Gold certification for its new world headquarters in New York City, scheduled to be completed in 2009. Following the completion of this building, Goldman Sachs will be the largest owner of LEED-certified commercial office buildings in the world.

22. "New Carbon Standard Guarantees Environmental Integrity and Transparency for Global Offset Market," May 16, 2007. See http://www.ieta.org/ieta/www/pages/getfile.php?docID=2713.

Findings: External Financing

If climate change is the next “mega-trend” that a growing number of bankers believe it will be, it will have a profound effect on the asset values and credit ratings of corporations and, ultimately, how banks engage companies through financing. According to Michael Klein, chairman and co-CEO of Citi Markets and Banking, “The sectors that will be most affected [by climate change] are infrastructure, transport, energy and technology. These can account for up to half the global financing needed in any given year. The impact on financing could be hundreds of billions of dollars.”[23]

As discussed in Section IV of this report, banks increasingly see climate change as a risk management issue. Their lending to extractive industries like oil, gas and mining has always carried considerable operational, credit and political risks. Now climate change is exacerbating these risks—while adding reputational risk to the mix as banks face greater scrutiny of the environmental impacts of their lending operations.

> ***“The impact on financing could be hundreds of billions of dollars.”***
>
> **–Michael Klein, Citi Markets and Banking**

Thirty of the banks in this study have a general environmental risk assessment policy in place, including several that have created specialized environmental risk management teams or integrated environmental issues into mainstream risk assessment processes. However, such assessments often are confined to traditional environmental risks, such as site contamination, or assessing high-polluting sectors. Such processes do not necessarily address emerging environmental risks like climate change or involve any public disclosure requirements.

Equator Principles

Mindful of the lack of transparency guiding financing decisions for development projects in emerging markets, four banks—**ABN AMRO**, **Barclays**, **Citigroup** and **WestLB**—worked with the World Bank’s International Finance Corporation to launch the Equator Principles in 2003. These principles are intended to help banks assess, mitigate, document and monitor the credit risk and reputation risk associated with financing such development projects, and through collaboration establish industry best practices. Although the Equator Principles do not directly address climate change mitigation, they are a first step at integrating environmental considerations into project finance, and signatory banks may be more likely to develop robust climate change governance policies going forward. To date, 54 banks have signed on to the Equator Principles, including 23 of the 40 banks included in this study. Some banks that are not involved in project finance also say they refer to the principles to help guide their financing decisions on sensitive projects.

As part of an annual review process, banks are supposed to report on development projects they have considered for financing, ranking the degree of social and environmental impact the projects might have. Signatories are asked to disclose the number of projects they declined to finance due to their negative effects, as well as the projects they did support. As part of the most recent update of the principles in July 2006, the threshold for project-finance reporting was dropped from $50 million to $10 million.

Whether the Equator Principles will set a precedent for evaluating broader financing programs by commercial and investment banks remains to be seen. **Royal Bank of Canada**, for one, now analyzes carbon intensity as part of a broader social and environmental review that is included in its assessment of a firm’s exposure to credit risk. But some critics of the Equator Principles and other like-minded initiatives say these evaluation processes do not translate into any actual requirements for mitigation of climate change impacts. However, as discussed at the end of this section, some new ideas are emerging that could point a new way forward.

23. Clive Horwood, “The new colour of money,” *Euromoney*, September 2007.

Climate Considerations in Lending

Thirteen of the 40 banks in this study have adopted risk management policies or lending procedures that address climate change in some way. Most of these policies are process oriented and focused on due diligence research; many apply to the power sector specifically:

- **Citi** says it incorporates the potential costs of carbon in the firm's financing of power generation.
- **Merrill Lynch** has a specific policy on financing coal-fired electricity generation (see box).

> **Merrill Lynch**'s coal financing policy recognizes that GHG emissions associated with coal have become a significant environmental concern and that incentives are needed to commercialize a cost-effective technological solution. The firm says it prefers to "finance electrical generation when the producer is a recipient of effective initiatives to reduce GHG and other pollutants, subject to the current state-of-the-art, including energy conservation." Where the producer has not received such incentives, Merrill Lynch will advocate best practices.

In addition, some banks are assisting clients in analyzing carbon exposure and developing emissions reduction strategies:

- **Crédit Agricole**'s Chevreux, the bank's European brokerage and research arm, has hired a full-time carbon analyst to measure the financial impact of carbon constraints on European companies subject to the E.U. Emissions Trading Scheme.
- **HSBC** has called on clients to disclose their carbon emissions and mitigation strategies in a consistent way.
- **Fortis**, as part of its due diligence process, says it discusses with borrowers whether they have taken carbon pricing into account.
- **Citi**, **Royal Bank of Scotland** and **TD Bank Financial Group** have also said that they will encourage clients that are large GHG emitters to develop carbon mitigation plans.

A small but growing number of banks also say they are formally calculating carbon risk in their loan portfolios:

- **Mitsubishi UFJ Financial Group** and **Mizuho Financial Group** have developed "carbon accounting" methodologies that take into account GHG emissions in project financing.
- **Royal Bank of Canada** has undertaken a carbon risk analysis of its lending portfolio, and has developed a proposal to incorporate carbon risk into the credit and risk rating methodologies of the entire firm.
- **Wells Fargo** has conducted a GHG assessment of three key lending portfolios—agriculture, primary energy production and power generation.

> **HBOS** considers climate change risk under five main categories: credit, market, liquidity, insurance and operational risks (the latter including reputation and regulatory risks). The firm's asset management business, Insight Investment, also helped develop the Investor Statement on Climate Change, sponsored by the U.K. Institutional Investor Group on Climate Change. The Statement, issued in October 2006, follows the United Nations Principles for Responsible Investment and directs pension funds and asset managers to incorporate climate change risks and opportunities in their investment analysis and selection.

Constraints on Lending?

Whether the emergence of these climate policies will have a tangible effect on lending decisions remains to be seen. To date, only one bank—**Bank of America**—has announced a specific target to reduce GHG emissions associated with its lending portfolio. Its policy applies to its utility corporate finance portfolio, for which it is seeking a 7 percent reduction in the rate of GHG emissions by 2009, relative to electricity produced. To accomplish this goal, Bank of America is changing its portfolio mix to add customers with lower-carbon emission profiles.

While Bank of America's policy is precedent setting, it still leaves ample room to finance traditional carbon-intensive power suppliers. Some environmental organizations are calling on banks to adopt tougher lending restrictions—or even outright bans—on companies with high-carbon intensity profiles and projects. In 2007, Rainforest Action Network, an environmental group that focused early attention on the impact of banks' lending policies on the environment, launched a new campaign against **Bank of America** and **Citi** for their involvement in corporate and/or project financing of coal-fired power generation. BankTrack, a European group of non-governmental organizations focused on ethics in finance, has also taken aim at banks like **ABN AMRO** for its funding of the huge Shell-led Sakhalin II oil and gas project in Siberia and **Royal Bank of Scotland**, which until recently promoted itself as "the oil and gas bank."

> ***"To be effective, risk management needs to minimize the overall carbon footprint of the project-financing portfolio and to work in the context of the newly emerging carbon markets."***
>
> **–ABN AMRO, 2006 Sustainability Report**

Thus, a big question for banks going forward is the extent to which they should be held to account for their financing of new carbon-based energy projects. After withdrawing its "oil and gas bank" advertising campaign in July 2007, **RBS** Chairman Sir Tom McKillop questioned, "Are we really saying that banks should take on the entire carbon footprint of the world? It's preposterous."[24]

To be sure, banks are hardly in a position to halt all financial support of the fossil fuels industry and carbon-intensive energy projects. This would not only be bad for business, but also would leave the global economy in a lurch as the transition from fossil fuels may take decades to complete. Yet banks no longer are in a position to carry on with "business as usual," either, if real progress is to be made in curbing GHG emissions.

So what can banks do? **ABN AMRO** offers one preliminary answer in its 2006 Sustainability Report, stating, "To be effective, risk management needs to minimize the overall carbon footprint of the project-financing portfolio and to work in the context of the newly emerging carbon markets."[25] This would entail tracking GHG emissions from lending operations and factoring in a meaningful price for carbon emissions.

BankTrack, for one, believes banks could do much more. It is recommending that banks adopt the "Kiribati Principles," named after a Pacific atoll threatened by sea level rise. The Kiribati Principles would address all forms of bank lending, not just project finance. As part of this "collective commitment to deal with the climate crisis," banks would pledge to move away from fossil fuel financing and instead increase renewable energy investments, agree on portfolio level GHG reduction targets, prioritize preservation of forests and encourage energy efficiency.[26]

Renewable Energy Finance

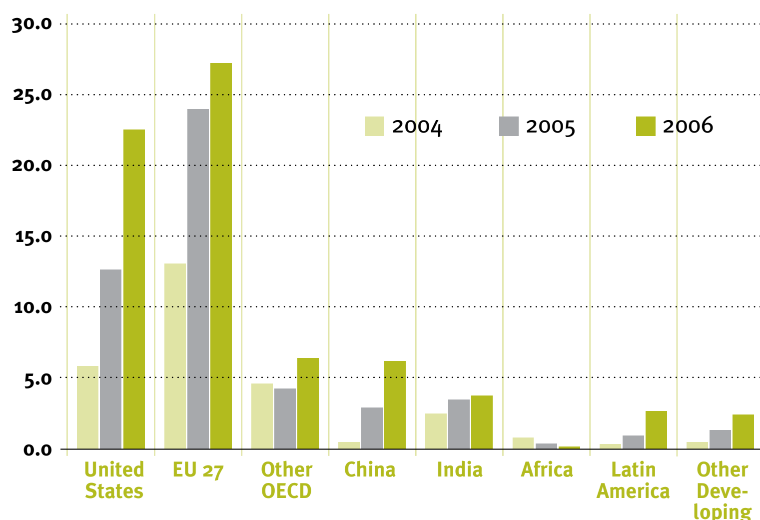
While most banks remain relatively quiet about their continued support of the fossil fuels industry, many have been eager to advertise their growing involvement in the burgeoning renewable energy industry. The United Nations Environment Programme reported in June 2007 that investment capital flowing into renewable energy reached a record $100 billion in 2006. In total, 29 banks of

24. Ed Crooks and Paul J Davies, "Bank seeks climate change credentials," Financial Times, July 10, 2007.

25. ABN AMRO, 2006 Sustainability Report.

26. "The Equator Principles: A toddler finds its feet, but still takes an occasional tumble," Ethical Corporation, Nov. 17, 2007.

the 40 banks in this study have highlighted their involvement in the renewable energy market. Banks are participating through direct ownership stakes in renewable energy companies, debt financing, private equity and fund investments, underwriting of initial public offerings and offering financial advisory services.



Worldwide Investment in Clean Energy (US$ billions)

Source: New Energy Finance

The following banks have made multi-billion dollar commitments to the renewable energy sector, with the scale of financing rising substantially in the last year:

While most banks remain quiet about about their financing of the fossil fuels industry, 29 of the 40 banks in this study have highlighted their involvement in the burgeoning renewable energy market

- **Fortis** has provided almost $2 billion in financing for renewable energy projects over the last 10 years.
- **Royal Bank of Canada**'s transactions in the renewable energy sector have totaled approximately $4.5 billion since 2003.
- **Royal Bank of Scotland** gained the leading global market share of renewable energy finance in 2006, providing $2.6 billion of capital, according to Infrastructure Journal magazine.
- **BNP Paribas** ranked fourth globally in renewable energy finance in 2006, with more than $1 billion financed through eight projects, according to New Energy Finance.
- **JPMorgan Chase** raised $1.5 billion of equity for the wind power market in 2006, and its own portfolio of investments in renewable energy totals $1 billion.
- **Goldman Sachs** has made significant investments in renewable energy technologies through its Principal Investments division, totaling more than $2 billion as of year-end 2007.
- **Wells Fargo** has made a five-year commitment to lend or invest more than $1 billion for environmental businesses. Since mid-2006, Wells Fargo has invested more than $125 million in renewable energy projects.
- **Bank of America** in March 2007 announced a $20 billion, 10-year initiative to support the growth of environmentally sustainable business activity to address global climate change. The broad-based initiative, encompassing its real estate banking, corporate and investment banking and consumer finance divisions, encourages development of environmentally sustainable business practices and low-carbon technologies.
- **Citi** in May 2007 announced plans to invest in and finance more than $31 billion in clean energy and alternative technology over the next 10 years, as part of a $50 billion commitment to address global climate change.

Some banks have developed financing specializations in renewable energy technologies such as wind power. **BNP Paribas** is considered the world's top wind financier. **Santander** is another leading wind banker, having financed nearly one-third of Spain's installed wind power. Santander is also active in ethanol project financing in the United States and Europe. **Goldman Sachs** has invested in other emerging technologies, such as cellulosic ethanol. **RBS** is the only bank in this study that mentioned financing carbon capture and storage (CCS) technology for fossil fuels; the firm is supporting one of the largest pilot projects to demonstrate CCS in coal beds.

> **Fortis Venturing** has initiated the Start Green Sustainable Innovation Fund I to help entrepreneurs who have sustainable new technology ideas in the Netherlands. The fund is a joint venture between Fortis, DOEN Participaties and Triodos Innovation Fund. Fortis also has its own 'Green Bank'—Fortis Groenbank—to serve the sustainable energy financing field in the Netherlands.

Findings: Investment/Retail Products

As the climate mega-trend unfolds in the banking industry, it is also revealing itself through a growing number of investment and retail products aimed at environmentally conscious customers. An August 2007 United Nations Environmental Program - Finance Initiative (UNEP-FI) study found that rising environmental awareness and media coverage of climate change, combined with growing support for regulatory and legislative action, is spurring rapid growth in green financial products. The study finds:[27]

> *In interviews, most banks currently consider climate change as the most important environmental issue they face. In response, carbon commodity products and services are developing at an extraordinary pace, particularly among European and Japanese banks. The innovation displayed by the front-runners in carbon finance is based on their capacity to identify opportunities for carbon asset generation across all types of financing activities... We are in the midst of a promising drive towards 'green' financial product development into mainstream banking.*

The findings of this report parallel those of the UNEP-FI study. Twenty-seven of the 40 banks examined now offer climate-related investment and/or retail products to clients.

> **Intesa Sanpaolo** announced in October 2007, with the Association of Producers of Energy from Renewable Sources (APER), preferential financing terms for producers of solar photovoltaics and other renewable energy sources. The firm has designed incentive schemes for small and medium enterprises to reduce initial capital costs and take advantage of government subsidies. Intesa has signed an agreement with a local electrical services operator, whereby government incentives can be used both as a loan guarantee and as direct payment for the loan installment.

27. Green Financial Products and Services: Current Trends and Future Opportunities in North America, United Nations Environment Programme—Financial Initiative, August 2007.

Investment Products

21 of the banks evaluated offer climate-related investment products, including 10 with climate-specific funds and indices

Most notable are the trends in the asset management business. Twenty-one of the banks evaluated offer climate-related investment products, including ten with climate-specific funds and indices (see Appendix II for a complete list). Notably, nearly all the banks with climate-focused funds and indices launched the products within the past two years—and of the 15 climate-specific funds/indices, ten were launched in 2007. Only four of these products come from the United States.

In September 2007, **HSBC** Corporate, Investment Banking and Markets (CIBM) launched the HSBC Global Climate Change Benchmark Index, together with a family of four investable global climate change sub-indices. The Benchmark Index is designed to provide exposure to companies that are best positioned to profit in the face of climate challenges. HSBC now offers a climate change fund based on this index.

Also in 2007, **UBS** launched five different climate-specific products, including several indices, structured products and investment funds (see box).

UBS has launched several indexes, structured products and investment funds that take into account the increasing demand for climate change related products. These include:

- UBS Investment Bank's UBS Global Warming Index (UBS-GWI). The index is a tradable benchmark for global investments in the weather derivatives market.
- UBS World Emissions Index (UBS-WEMI). These index-linked products offered by the Investment Bank allow clients to participate in the index's performance, which is linked to tradable derivative instruments referencing emissions allowances.
- UBS Investment Bank's UBS Diapason Global Biofuel Index, the world's first biofuel index.
- UBS Climate Change Strategy Certificate. This actively managed basket of around 25 stocks, launched in February 2007, includes companies developing solutions in renewable energy and energy efficiency.
- UBS Global Asset Management's UBS (Lux) Equity Fund—Global Innovators. The fund's investment themes include renewable energy, mobility, water, nutrition and healthcare.

Retail Products

The retail banking sector has also become involved in climate product development. Green products in this sector span a diverse and innovative suite of offerings—from "green" mortgages to climate-focused credit card programs and "green" car loans. As Richie Prager, **Bank of America**'s Head of Global Rates, Currencies and Commodities, observed recently, "We have 57 million clients in the U.S. domestic market, and they have gone beyond the tipping point in terms of environmental awareness. We're going to see more credit cards, auto financing and home loans aimed at making a contribution to combating climate change."[28]

This study confirms such trends. Twenty-two of the banks examined currently offer a diverse array of climate-related retail investment products. **Bank of America** introduced a credit card in November 2007 that allows customers to earn carbon offset credits through their purchases. Several other banks have similar cards available. **Wells Fargo** was the first U.S. financial services firm to offer Renewable Energy Certificates through credit and debit card reward programs. **Barclays** has launched several

28. Clive Horwood, "The new colour of money," *Euromoney*, September 2007.

innovative products linked to its credit and debit card programs, including a carbon neutral debit card that the company is rolling out to all of its clients (see box).

> **Barclays** launched Barclaycard Breathe in July 2007, a credit card that donates 50 percent of net profits after tax to projects that address climate change. Barclays also developed the first carbon neutral debit card in the United Kingdom, and is in the process of rolling out the card out to the company's 11 million debit card users. All carbon credits used to offset the manufacturing of the cards are generated from emission reduction projects located in the U.K. Barclaycard Business Commercial Cards has launched a Carbon Offset corporate charge card that provides customers with offsetting services.

Fortis offers an Energy Saving Credit program, a credit facility with lower interest rates for consumers that are financing the purchase of energy saving products. The company also offers a Clean Car Credit program, a car-financing arrangement to encourage motorists to cut CO_2 emissions, and a Clean Car Insurance product, which offers a 10 percent discount on coverage for hybrids and bio-fuel models. In France, **Société Générale** has partnered with ADEME, the French Agency for Environment and Energy Management, to offer "ecological mortgages," loans that offer preferential rates to customers in financing and renovations of energy-efficient/low-impact homes.

The three Japanese banks examined in this study—**Mitsubishi UJF Financial Group**, **Mizuho Financial Group** and **Sumitomo Mitsui Financial Group**—in the last two years have also started to offer preferred rate loans (typically 0.5 percent below posted rates) for small and medium enterprises that meet specific environmental standards. Mizuho has extended this loan program to residential customers installing photovoltaic generation equipment, and it is providing Life Cycle Assessments of environmental products for its corporate clients. Through their asset management businesses, all three banks have also established "eco-funds" that invest in Japanese companies with pro-active environmental management policies.

> **Santander**, through its Company Banking division, has launched "Crédito IDi," a financing line that allows clients to finance the cost of both the energy audit and the investment needed to achieve emissions savings in private residences/facilities.

American banks have fewer retail offerings focused on climate change than their European and Japanese counterparts. Just four of the 22 banks offering climate-related retail products are U.S.-based. As climate change continues to rise on the social and political agenda, however, it is expected that U.S. banks will seize the opportunity to provide more climate-related offerings. As the UNEP-FI observed in its recent study, the true challenge of banks is no longer "the introduction of new green niche products, but the integration of environmental incentives into mainstream offerings."[29]

Findings: Carbon Trading

Banks that engage in commodities trading and brokerage services have another huge growth opportunity presented by climate change—GHG emissions trading. With the advent of cap-and-trade regulatory schemes in Europe that soon may be adopted in the United States and elsewhere, the carbon emissions trading market is "going to be bigger than the credit derivatives market," predicts Louis Redsahw, head of environmental markets at **Barclays Capital**.[30] Already, trading volume on the European Union Emissions Trading Scheme (EU-ETS)—the one regulated exchange for GHG

29. Green Financial Products and Services: Current Trends and Future Opportunities in North America, United Nations Environment Programme—Financial Initiative, August 2007.

30. Clive Horwood, "The new colour of money," *Euromoney*, September 2007.

emissions trading—has increased from approximately €5 billion in 2005 to €14.6 billion in 2006, a threefold increase. As the EU-ETS enters an expanded, second phase in 2008, trading volume by some estimates could see another sevenfold increase, rising to 140 million tonnes of CO_2e by 2010 from an estimated 2 million tonnes in 2007. The UNFCCC estimates that with a truly global carbon market demand for GHG reduction credits could increase to six billion tons of CO_2e, worth as much $300 billion, in 2030.[31]

The three main areas of opportunity for banks presented by emissions trading are: the brokerage of GHG emissions allowances and credits; the financing and development of carbon offseting projects; and speculative investing and derivative offerings in emissions credits.

Seventeen banks included in this study are actively trading under the EU-ETS. Barclays was the first U.K. bank to establish a carbon trading desk for the EU-ETS, and today Barclays Capital's Emissions Trading Desk is the largest intermediary in the carbon market. As GHG emissions trading goes global, further expansion of this commodities market will be enormous, with the value of carbon trades likely to eclipse that of oil in coming decades.

	2005		2006	
	Volume ($MtCO_2e$)	Value (MUS$)	Volume ($MtCO_2e$)	Value (MUS$)
Allowances				
EU ETS	321	7,908	1,101	24,357
New South Wales	6	59	20	225
Chicago Climate Exchange	1	3	10	38
UK-ETS	0	11	N/A	N/A
Sub total	**328**	**7,971**	**1,131**	**24,620**
Project-based transactions				
Primary CDM	341	2,417	450	4,813
Secondary CDM	10	221	25	444
JI	11	68	16	141
Other compliance	20	187	17	79
Sub total	**328**	**2,894**	**508**	**5,477**
TOTAL	**710**	**10,864**	**1,639**	**30,098**

Carbon Market at a Glance, Volumes & Values in 2005–6

Source: The World Bank. "State and Trends of the Carbon Market 2007", Washington, D.C., May 2007.

Emissions Trading Exchanges

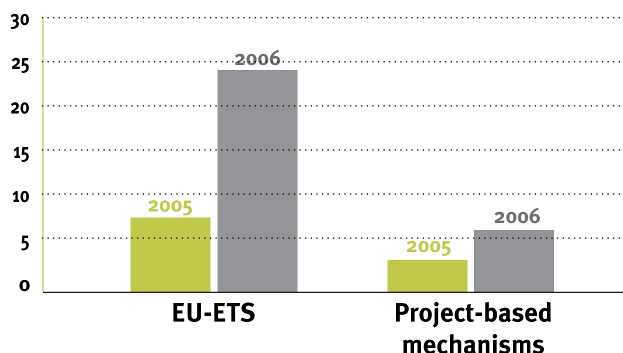
Many companies are beginning to develop GHG emission-trading strategies in anticipation of regulation in the United States and elsewhere. Banks can assist these companies in sourcing offset projects and hedging against future regulation. Seven banks in this study are active in voluntary exchanges like the Chicago Climate Exchange (CCX). The CCX has seen significant growth in trading volume in recent years, though not on the scale of the EU-ETS.

Recognizing the growth potential of such exchanges, **Goldman Sachs** in September 2006 took a minority equity stake in the Climate Exchange PLC (CLE). The CLE owns the Chicago Climate Exchange and the European Climate Exchange (ECX) as well as the newly created California Climate Exchange (CaCX). **Bank of America** has also taken a 0.5 percent investment stake in CLE. In addition, Bank of America has joined the CCX as a full, emissions-reducing member and as a liquidity provider. Soon Bank of America will launch CLE-linked offset products and services for retail and institutional customers.

In December 2007, NYMEX announced the formation of the Green Exchange, a new exchange to offer

31. "Carbon Crunch: Meeting the Cost," United Nations Environment Programme—Financial Initiative, December 2007. Assumes a price of $50 per ton of CO_2 in 2030.

a range of environmental futures, options and swap contracts for climate change-focused markets. Products are expected to begin trading during the first quarter of 2008 and a U.S. Commodity Futures Trading Commission (CFTC)-regulated exchange is expected to launch in 2009. **Morgan Stanley**, **Credit Suisse**, **JPMorgan Chase** and **Merrill Lynch** are founding partners of the venture, along with four other firms.



EU Emissions Trading (US $ billions)

Source: Deutsche Bank, "Coping with Climate Change", November 15, 2007, citing The World Bank, 2007.

Kyoto Protocol Mechanisms

Nineteen of the banks in this study are also involved in Clean Development Mechanism (CDM) and Joint Implementation (JI) project development or financing under the Kyoto Protocol. These mechanisms allow for emissions abatement projects, such as landfill methane gas capture and replacement of diesel generators with solar power, to generate credits that can be used toward meeting overall Kyoto Protocol emission reduction targets. Although project registration can be a lengthy and complicated process, the number of CDM projects has quadrupled in the last two years. Certified emission reductions (CERs), resulting from CDM projects, equal to more than 2.3 million tonnes of reductions have now been certified for 2012.

> ***Carbon trading is "going to be bigger than the credit derivatives market."***
>
> **–Louis Redshaw, Barclays Capital**

Thus far, CDM project development for the most part has been left to specialized consulting firms and large corporations with technical expertise. Some banks are investing directly in offset project developers, however. **Credit Suisse**, **UBS**, **Goldman Sachs** and **Morgan Stanley** have all bought shares in EcoSecurities, a CDM project developer and consultancy. As a sign of growing pains in this still-nascent market, EcoSecurities' shares fell by nearly 50 percent in November 2007 after the firm announced a delay in its CDM project pipeline and lower-than-expected earnings. **Morgan Stanley** holds a 38 percent stake in MGM International, another leader in CDM project development.

Some banks are pursuing the option of partnering directly with local project developers. In September 2007, **ING Bank** and the Chinese government co-launched the Sino-Dutch CDM Capacity Building Program in Jiangxi Province, China. The program will establish technical service centers for CDM projects in five provinces in China. **ABN AMRO** has cultivated similar relationships in the Brazilian market. Through subsidiary Banco Real, ABN AMRO conducted €9.7 million in carbon credit trades in Brazil in 2006, and assisted the Brazilian Central Bank in building capacity for carbon trading.

Because project completion and credit delivery are key risks in emissions trading, some banks are starting to address these issues with various risk management, derivative and guarantee products. **BNP Paribas**, **Deutsche Bank** and **ING** all offer derivative emissions products, such as "guaranteed delivery" CER and Emission Reduction Unit (ERU) contracts. Leading Japanese banks, meanwhile, have specialized in CDM/JI project consulting for clients and emissions credit-backed trust accounts. **Mitsubishi UFJ Trust and Banking** and **Sumitomo Mitsui** both offer trust accounts that provide corporate clients with CER credit purchase services and additional market liquidity.

Additional Opportunities

Some banks are also becoming involved in specialized carbon funds that buy forward CER streams of abatement projects at a discount and sell them as prices rise. While hedge funds continue to lead in this space, **Fortis** and Caisses d'Epargne have set up the European Carbon Fund (ECF). The original €142 million investment holds 5 million tonnes of issued CERs and 20 million tonnes in forward contracts. The ECF plans to launch a second fund with a target size of €300–500 million. Société Générale purchased a €10 million stake in the ECF in 2004, and now sits on the fund's board.

Morgan Stanley is also positioning itself as a major player to source an ongoing stream of carbon credits. The firm has committed $3 billion over the next five years to emission reduction initiatives globally; 90% of this will go towards the purchase of CERs and other carbon credits.

Carbon trading has also developed as a complement to traditional project finance. For smaller projects, CER credits rarely contribute more than a 1–3 percent improvement in a project's internal rate of return. However, this can increase to 30 percent for a landfill gas project, where methane is extracted and burned as fuel, offsetting the emission of a highly potent greenhouse gas.[32] **BNP Paribas**' view is that carbon should be considered a new asset class that is integrated into existing lines of project finance. The firm's Carbon Finance Solutions team is expanding its CER portfolio, which surpassed the $25 million mark in December 2006. However, the main obstacle to integrating carbon finance further with project finance is the low value of carbon credits because of uncertainty surrounding a post-Kyoto regulatory agreement.

Standardization for voluntary offset markets remains another key challenge. As noted earlier, the Climate Group, the International Emissions Trading Association and the World Business Council for Sustainable Development launched a new global carbon offset standard at the London Stock Exchange in November 2007 to increase participation and confidence in voluntary offsets. While a minimum project quality benchmark has been set and the public will be able to access information on all approved projects, the World Wildlife Fund has criticized the initiative for insufficient verification mechanisms. As verification standards are sorted out, banks can assist in building market liquidity and offering credibility to transactions. In August 2007, **Morgan Stanley** announced that it would partner with Det Norske Veritas (DNV) to establish an integrated carbon verification and offsetting service. In this service, clients get to choose the carbon credit sources that will be purchased by Morgan Stanley's Commodities Group.

32. Peter Koh, "Carbon markets: Hot times for emissions trading," *Euromoney*, September 2007.

IV. Conclusions

Climate change is a "mega-trend" that will affect all facets of the financial services industry and all classes of investing. This report provides fresh evidence that the banking sector is beginning to respond to the climate challenge, but hard work and difficult choices still lie ahead. "De-carbonization" of the global economy will require banks not only to manage their own GHG emissions, but also to consider how climate change affects the competitive marketplace, lending and investment strategies, and ultimately, their financial bottom lines. To date, banks have said relatively little in securities filings to suggest that they fully appreciate the material risks and opportunties posed by climate change.

A warming climate and emerging carbon-control regulations will alter the costs of production, the pricing of securities, the size of liabilities and the assignment of credit and asset valuations. Leading banks are starting to factor a market price for carbon dioxide in lending and investment decisions, while helping to build new markets through GHG emissions management, trading and brokerage. Yet none of the banks in this report have committed to a fundamental re-balancing of corporate and project financing away from carbon-intensive technologies toward more efficient and low-carbon alternatives. A key test going forward is whether banks will begin to turn down financing opportunities representative of business-as-usual, carbon-intensive development strategies.

A key test going forward is whether banks will continue financing business-as-usual, carbon intensive development strategies

The 40 banks evaluated in this study have a divergence of interests, programs and priorities when it comes to addressing climate change. European banks are at the forefront of integrating climate change into environmental policies, risk management and product development. The majority of other banks in this study, including many of the leading U.S. banks, are working towards better disclosure of climate risks as an essential first step toward embracing a changing regulatory and economic environment. Asset managers that do not offer traditional banking services and banks based in emerging markets have done the least to embrace climate change in their business practices.

Four key findings of this report are as follows:

- **Disclosure:** Banks are increasingly discussing climate change business opportunities in their annual reports, and they have more than doubled the volume of climate change-related research reports issued in the last year. Yet banks' securities filings still have a dearth of disclosure—only nine of the 40 banks in this study mentioned climate change-related issues in their latest filings, and none have cited climate change as a material risk.
- **Emissions Management:** Twenty-eight of the 40 banks in this study have calculated and disclosed their GHG emissions from operations, and 24 have set some type of GHG emissions reduction target. However, only six banks are formally calculating carbon risk in their loan portfolios, and only one bank has set a specific target to reduce GHG emissions associated with a portion of its lending portfolio.

- **Investment Opportunities:** Growing demand for "climate friendly" financial products and services is leading banks into whole new markets. Twenty-nine of the 40 banks document their involvement in the burgeoning renewable energy and "clean tech" market. Twenty-one of the banks offer climate-related investment products, while 22 offer climate-related retail banking products. However, more than three-quarters of the banks offering these new products are based outside of the United States.
- **Emissions Trading:** In this rapidly growing market, investment banks have taken a leading role in supporting emissions trading mechanisms and introducing new risk management products. Twenty-three of the banks in this study are actively involved in GHG emissions trading, and six have taken equity stakes in GHG commodity exchanges.

In addressing climate change, banks can spur new business, lessen liabilities for climate damage, and preserve their leadership role in wealth and capital formation

The broad reach and high stakes of climate change requires banks to take a holistic and forward-looking management approach. Banks that have strong governance structures and that take early action on climate risks and opportunities will be at an advantage over time. Ultimately, all banks will gauge their success or failure to some degree on their ability to adjust to this fast-changing physical, regulatory and competitive environment.

While the transition to a lower-carbon economy will take decades, this is a defining moment. If current trends in fossil energy use continue, a climate and energy crisis is virtually unavoidable. Banks must start now to track the relative flow of capital into carbon vs. non-carbon energy sources—and place increasingly aggressive limits on the proportion going into carbon sources—if there is to be any prospect of halting irreversible climate-related damage.

By factoring carbon prices into equity valuations and financing decisions, banks can promote more rapid diffusion and commercialization of advanced low-emissions technologies and reduce the total costs of GHG mitigation. While this would result in huge capital swings relative to business-as-usual forecasts, the net effect on global economic growth would be vanishingly small and would help achieve a stable atmospheric level of CO_2 by 2050. This seems a small price to pay to avert a possible climate catastrophe. In the process, banks can spur the growth of new industries and new business for themselves, while lessening the liabilities associated with financing climate-damaging industries, and preserve their leadership role in wealth and capital formation.

HSBC Holdings

NYSE: ***HBC***

In December 2004, HSBC made a commitment to become the world's first major bank to achieve carbon neutrality. The firm met this target in October 2005, and now believes it is well-positioned to offer clients new climate change-related products and services based on its own experience. In September 2007, the firm announced the launch of several investable climate change indices and plans for its own climate change fund. HSBC has also recently announced the appointment of Sir Nicholas Stern, former chief economist at the World Bank and lead author of a U.K. Treasury Department report on climate change, as its Special Advisor on Economic Development and Climate Change.

Summary Score: 70

Company Information

The second-largest bank in the world by assets, HSBC Holdings is active in more than 80 countries, providing consumer and commercial banking services, credit cards, asset management, private banking, securities underwriting and trading, insurance, and leasing. Its North American operations include HSBC USA, consumer lender HSBC Finance, and HSBC Bank Canada.

Contact Information

Chairman	Stephen K. Green (Group Chairman)
CEO	Michael F. Geoghegan (Group CEO)
Contact	Tel: 44-20-7991-8888 • Web: www.hsbc.com
Address	8 Canada Square London, E14 5HQ United Kingdom

Board Oversight

Score: 13

Board Committee: Environmental Oversight	Corporate Responsibility Committee
Committee Chair	The Right Honorable Lord Butler of Brockwell
Board Committee: Climate Change	Corporate Responsibility Committee
Board Member: Climate Change	Stephen Green, Group Chairman
Board Role	Stephen Green, Group Chairman, has ultimate responsibility for climate change matters. At the board level, there are two committees that have responsibility for climate change matters. The Group Management Board (GMB), which is chaired by the Group Chief Executive, operates as a general management committee under the direct authority of the board. GMB responsibilities include the firm's 2004 decision to become carbon neutral, emissions reduction project investments and new business expansion relating to carbon market opportunities. The second committee with board representation is the Corporate Responsibility Committee, which is responsible for overseeing corporate responsibility and sustainability policies. Additionally, reputation risks, including social, ethical and environmental (SEE) risks, are considered and assessed by the board, the Group Management Board, subsidiary company boards, board committees and/or senior management during policy formulation.
Board Training	The Corporate Responsibility (CR) Committee gives guidance on the CR component of directors' induction and training programs and provides the board with assurance that relevant executive training programs, including credit officer training courses, contain appropriate CR training.

Management Execution

Score: 17

CEO Leadership/ Statements	Speaking at a May 2007 news conference to announce HSBC's Climate Partnership, discussed below, Group Chairman Green said, "We believe we can tackle the causes and impacts of climate change. Over the next five years HSBC will make responding to climate change central to our business operations and at the heart of the way we work with our clients across the world."
Company Policy	In June 2006, HSBC announced its Carbon Finance Strategy. While the firm said it would continue to support fossil fuel electricity generation, it pledged to seek out new opportunities in key low carbon technologies (wind, solar, biofuels, energy/ transport efficiency, landfill gas/methane capture, geothermal energy) in priority countries where government policy and fiscal regimes support early adoption. Jon Williams, Head of Group Sustainable Development, stated at Ethical Corporation's September 2007 Sustainable Finance Summit, "We can finance a wholesale shift to a low carbon economy... Climate change can be tackled at minimal economic cost if we do it today."
Chief Environmental Officer	Jon Williams, Head of Group Sustainable Development In addition, Simon Martin is Head of Group Corporate Sustainability. Francis Sullivan is Deputy Head of Group Sustainable Development and Advisor on the Environment, Group Corporate Sustainability.
Levels to CEO	0

HSBC Holdings

Climate Change Executive	Nick Robins, Head, Climate Change Center of Excellence In July 2007, HSBC announced the appointment of Nick Robins as head of its newly created Climate Change Center of Excellence. Robins is based in HSBC's London office and reports jointly to David Burnett, Head of Global Research, and Jon Williams, Head of Group Sustainable Development. Also in July 2007, HSBC appointed Sir Nicholas Stern as Special Adviser to the Chairman on Economic Development and Climate Change. Stern is the former World Bank Chief Economist and author of the *Stern Review on the Economics of Climate Change*. For HSBC, Stern serves as an advisor on strategic issues, contributes to management development programs and provides client advice related to climate change and sustainable business strategies.
Executive Committee	The Group Corporate Sustainability function is responsible, among other things, for addressing risks and opportunities derived from climate change and for embedding sustainability within the firm's mainstream operations from both a risk and business development perspective. Group Corporate Sustainability has five focus areas: business development, risk management, footprint management, communications/reporting and internal sustainable development advisory. In 2006, HSBC also created a Climate Change Center of Excellence, based in Bangalore, India, to evaluate the implications of climate change for the HSBC Group, its Global Research division and other business units. The Center is intended to be HSBC's central source of climate knowledge and will support the implementation of the firm's Carbon Finance Strategy.
ESG Factors in Risk Management/ Financing	HSBC established an Environmental Risk Standard in 2003, which has been adapted into a Sustainability Risk Framework. HSBC is upgrading its risk approval systems to include sustainability risk ratings, which will be gradually assigned to clients globally. It is working with a third party to develop the underlying sustainability risk decision support tool. The risk ratings will enable it to differentiate deal approval levels, the type of facility it would offer a client and provide portfolio information. HSBC has a network of 27 environmental risk managers that support the Sustainability Risk team in London. In financing, HSBC has issued five sector lending guideline reports on forest lands and forest products, freshwater infrastructure, the chemicals industry, the metals & mining industry, and the energy industry. The Energy Sector Risk Policy report, issued in May 2006, states that "HSBC supports a transition to a lower carbon economy." It says it expects its clients to abide by regional or national laws to implement greenhouse gas (GHG) reductions under the Kyoto Protocol and the EU ETS. HSBC has also called on clients to disclose their carbon emissions and mitigation strategies in a consistent manner.
Staff Training/Education	In 2006, HSBC added a climate change module in the Group Graduate Development Program to inform participants about climate change and the role of HSBC in the issue. Climate change issues are also considered in other HSBC training courses, including the Chairman's Strategic Forum and Group Credit and Risk training. All project and export finance teams have been trained in the Equator Principles. In 2006, HSBC also staged a road show in mainland China, Hong Kong SAR, India, Malaysia and Singapore to educate more than 100 employees on carbon finance and other issues. The firm is also conducting a benchmarking survey of employee engagement on sustainability issues and planning e-learning forums. In 2007, HSBC launched the HSBC Climate Partnership, a five-year, $100 million partnership between HSBC, The Climate Group, Earthwatch Institute, Smithsonian Tropical Research Institute and WWF. HSBC will work in some of the world's major cities to influence climate change policy and create employee "climate champions" who will undertake field research on climate change issues. The program will involve carbon measurement in the world's forests and protection of major rivers from the impacts of climate change.
External Initiatives	• The Bali Communiqué • The Climate Group • EPA Climate Leaders • EPA Green Power Partners • Equator Principles • Extractive Industries Transparency Initiative • G8 Gleneagles Initiative CEO Roundtable on Climate Change • Institutional Investors Group on Climate Change • Principles for Responsible Investment • Roundtable on Sustainable Palm Oil (Board member) • UNEP-Finance Initiative In 2004, HSBC formed the HSBC Partnership for Environmental Innovation with Newcastle University and the University of East Anglia. This three-year global program conducts research on climate change and other environmental challenges.
Investment Research	HSBC Investments launched a new SRI team in 2006 covering environmental, social and governance issues. The team consists of six SRI analysts based in Europe, India and Brazil, plus two product specialists. HSBC Global Research, a division of HSBC's Corporate, Investment Banking and Markets group, also offers coverage of alternative energy stocks.
Climate-related Research Reports	None identified.
Compensation Link	HSBC's Group Corporate Real Estate is responsible for proposing environmental targets and with the support of Purchasing and IT Functions ensuring delivery of such targets. Incentives around sustainability performance are built into objectives and reward structures for these units. More broadly, senior managers at HSBC have Corporate Responsibility objectives — including objectives related to climate change — as part of their remit with reward schemes recognizing achievements. In addition, starting in 2007, the cost of procuring carbon offsets to maintain HSBC's carbon neutrality is being borne by the regional offices responsible for the emissions, providing an increasing incentive to manage the company's total emissions.

HSBC Holdings

Public Disclosure

Score: 9

Annual Report
HSBC's 2006 annual report does not include a discussion of climate change. However, it provides a broad overview of corporate social responsibility issues and consideration of reputational risk issues arising from social, environmental and ethical issues as part of its corporate governance policy.

Securities Filings Statement
None identified.

Sustainability Report
2006 Corporate Responsibility Report, published May 2007
http://www.hsbc.com/1/2/corporate-social-responsibility/csr-reports-and-updates

GRI Accordance: 2002: CI

Carbon Disclosure Project
Member: Yes ***2007 Signatory:*** Yes ***CDP5 (2007):*** Answered Questionnaire (Public)

CDP5 Risk Disclosure: The response states, "climate change risk will need to be increasingly factored in when performing equity valuations and making investment decisions." Customer-related risk ranges from business disruptions to slowed economic growth due to extreme climate events. To address potential physical risks, HSBC is undertaking an internal assessment of insurance coverage for facilities that may be impacted by extreme weather events or sea level changes. The firm has also established contingency plans for environmental risks. In terms of regulatory risk, HSBC notes that the firm is well-positioned to respond to future regulation regarding emissions limits and energy efficiency standards due to its voluntary implementation of its carbon neutrality policy. HSBC also recognizes the credit and reputational risk the firm may face due to client exposure to regulatory changes.

Public Policy Statements
HSBC states in its CDP5 response: "Climate change is a challenge that will require global solutions; collective action will be required from governments, business and individuals to stimulate adoption of energy efficiency and clean generation technologies to stabilize carbon dioxide (CO_2) emissions." HSBC also states that it supports an international cap and trade system to achieve global emissions reduction targets.

Jon Williams, head of Group Sustainable Development, said at Ethical Corporation's September 2007 Sustainable Finance Summit that "emissions trading needs to go global." He also suggested that a post-Kyoto global agreement could be negotiated with 20 major carbon-emitting countries.

In November 2007, HSBC signed the Bali Communiqué, organized by the Prince of Wales's UK and EU Corporate Leaders Groups on Climate Change. The Communiqué calls for a comprehensive, legally binding United Nations framework to tackle climate change.

Emissions Accounting

Score: 7

GHG Emissions Inventory
Year: 2006 ***Facility/Region:*** All internal operations ***Protocol:*** GHG Protocol

Emissions	CO_2e (Metric Tonnes)
Total Emissions	**813,000***
Scope 1 (Direct)	
Scope 2 (Indirect—Electricity)	634,000**
Scope 3	
Travel	179,000
Products	
Supply Chain	

* Total emissions offset in 2006.
** Includes Scopes 1 & 2—While the vast majority of energy use is purchased energy (Scope 2), HSBC does own some on-site electrical generation facilities, but these are currently not tracked separately.

Accounting Methods
HSBC converts data on building energy use (covering 96% of full-time employees) and employee business travel using emission factors set out by the local environmental authority or the utility supplier. If such information is not available, factors from the International Energy Agency and the DEFRA, the U.K. Government's Department of Environment, Food and Rural Affairs, are used.

Third Party Certification
Det Norske Veritas Certification BV (DNV) verifies HSBC's direct environmental performance. DNV conducted an audit of HSBC's CO_2 emissions and carbon neutrality.

Certification Year
2006

Emissions Savings & Offsets
2006 % Renewable Energy: 40%
Energy Efficiency Savings: None calculated

Certified CO_2 Offsets: 2006 was the first full year that HSBC was carbon neutral. The firm estimated the quantity of emissions that would cover all properties and buildings (i.e., 100% of full-time equivalent employees), and then applied an additional 2.5% to estimated emissions from electricity, 10% to estimated emissions from other energy sources and 5% to estimated emissions from transport to account for any uncertainty in estimates. To achieve carbon neutrality HSBC purchased verified emissions reductions (VERs) from several renewable energy projects in China and Thailand.

HSBC Holdings

Strategic Planning — ***Score: 24***

GHG Emissions Targets

	Reduction Targets	Baseline Year	Target Year	Region
Total Emissions	5%	2004	2007	All internal operations
Energy Use	7%	2004	2007	All internal operations

Target Details

HSBC's carbon neutrality is achieved through a Carbon Management Plan, which involves reducing direct emissions, buying green electricity and offsetting remaining emissions (these costs are now included as part of the firm's normal operating budget). HSBC has set three-year reduction targets for energy, water and waste, as well as CO_2 emissions, covering 90% of its product portfolio. HSBC is setting new targets in 2007 for the 2008–2010 period, including emissions intensity targets. The firm also issued environmental target progress reports in 2005 and 2006. Its 2006 Corporate Responsibility Report states, "During 2006, our CO_2 emissions per person, our key CO_2 measure, increased due to a change in the type of energy we were able to purchase and an increase in air travel. We have programmes in place to reverse this trend. For a growing business, it is a challenge to reduce emissions consistently."

Emissions Trading

All emission reductions, including the bank's carbon neutrality goal, have been made on a voluntary basis. HSBC is also exploring options for participation in the CDM and JI markets under the Kyoto Protocol. In addition to traditional project financing structures, HSBC will increasingly look at new structures incorporating carbon as a stream of repayment. HSBC also plans to apply its own experience in the voluntary carbon markets to address client needs in this area.

Renewable Energy

HSBC ranked first in the Low Carbon Finance and Investment Leaders category in a survey by BusinessWeek and the Climate Group in December 2006. The firm provides debt financing for low carbon projects and technologies, as well as equity capital for early stage project development.

For its own operations, HSBC currently purchases green electricity in the U.K., the U.S., Australia, Brazil, Ireland, Luxemburg, Sweden and Switzerland. The firm has installed solar power panels at offices in the U.K. and France, introduced a bio-diesel plant at its Global Technology Centre in Pune, India, and installed micro wind turbines in the U.K. In 2006, HSBC was awarded the U.S. EPA "Green Power Partner of the Year" recognition for renewable energy purchases.

Energy Efficiency

In June 2007, HSBC launched a Global Environmental Efficiency Program, a commitment to reduce the firm's direct environmental impacts. The $90 million commitment over five years will support renewable energy technology, water and waste reduction programs and employee engagement. Initiatives will include:

- Developing flagship buildings to benchmark environmental standards;
- Footprint management and innovation;
- Environmental Management Systems to optimize process efficiency.

Achievements to date include building HSBC's first "zero carbon" branch in Greece, New York; the building achieved Leadership in Energy and Environmental Design (LEED) Gold certification and optimizes energy efficiency using a ground-source heat pump. HSBC is also committed to reducing the environmental impact of business travel. The firm has conducted an employee green travel survey and invested in video-conferencing technology. Going forward, the cost of carbon will be more explicitly factored in real estate capital expenditure projects and energy procurement decisions.

Other Climate-Related Investment Products

In September 2007, HSBC Corporate, Investment Banking and Markets (CIBM) launched the HSBC Global Climate Change Benchmark Index, encapsulating a family of four investable global climate change sub-indices. The Benchmark Index is designed to provide exposure to companies that are best positioned to profit in the face of climate change challenges. The sub-indices include:

- HSBC Climate Change Index
- HSBC Low Carbon Energy Production Index (including: solar, wind, biofuels, geothermal)
- HSBC Energy Efficiency & Energy Management Index (including: fuel efficient autos, energy efficient solutions and fuel cells)
- HSBC Water, Waste & Pollution Control Index (including: water recycling, waste technologies, environmental pollution control)

In November 2007, HSBC Investments launched a climate change fund that invests in clean energy, energy efficiency, water, waste and pollution control companies. The fund aims to outperform the HSBC Global Climate Change Index. Structured products based on the new fund and index family are also being developed by HSBC Global Markets in partnership with HSBC Investments.

HSBC's insurance broking division is developing risk consultancy services to help customers assess and manage their physical exposures to climate change. The division is also developing insurance products to facilitate the development of renewable energy projects and carbon markets.

HSBC has launched green marketing campaigns for its retail products in both the United Kingdom and the United States. Additionally, HSBC has conducted an international survey of public attitudes on climate change—the HSBC Climate Confidence Index. The firm's research shows more optimistic markets in Asia and Latin America, which could mean that new products, such as green mortgages, are launched first in emerging markets.

APPENDIX II: *Profile Key*

Board Oversight

Board Committee – Environmental Oversight: Board of Directors designates a board-level committee with explicit oversight of the company's environmental affairs.

Board Committee – Climate Change: Board designates a board-level committee with explicit oversight of the company's climate change policy and initiatives.

Board Member – Climate Change: Board designates a specific board member with explicit oversight of the company's climate change policy and initiatives.

Board Role: Board has taken specific actions to initiate, approve and/or monitor the company's environmental affairs and climate change initiatives.

Board Training: Board receives training and education addressing environmental, climate change and/or sustainability issues.

Management Execution

CEO Leadership/Statements: Chairman/CEO assumes leadership role in articulating the company's climate change strategy, including shareholder communications and participation in external initiatives.

Company Policy: Company produces a policy statement addressing climate change and/or broader sustainability issues.

Chief Environmental Officer: Company designates a corporate-level executive with explicit responsibility for managing environmental affairs.

> **Levels to CEO:** Company discloses the number of reporting levels between the chief environmental officer and CEO (0 = reports directly to CEO).

Climate Change Executive: Company designates a corporate-level executive with explicit responsibility for managing climate change policy and initiatives (may be same person as chief environmental officer).

Executive Committee: Company has executive-level committee, task force or working group to address climate change issues (including environmental/CSR/sustainability departments or committees).

ESG Factors in Risk Management/Financing: Company issues formal policy and governance procedures to incorporate environmental, social, and governance (ESG) factors in its risk management function and/or financing decisions.

Staff Training/Education: Staff receives training and education addressing environmental, climate change and/or sustainability issues.

External Initiatives: Company participates in external coalitions, working groups or initiatives to mobilize action on climate change and incorporation of ESG factors in financing decisions.

Investment Research: Company publishes research and analysis of climate-related issues for shareholders and/or clients.

Compensation Link: Company explicitly links executive officers' compensation to attainment of environmental and/or climate-related goals.

Public Disclosure

Annual Report: Company discusses climate change risks, opportunities and initiatives in most recent Annual Report (e.g., CEO letter to shareholders, front section or Management Discussion & Analysis).

Securities Filings Statement: Company discusses material climate change risks and opportunities in Form 10-K or equivalent securities filings.

Sustainability Report: Company publishes a Sustainability Report or equivalent public document that discusses climate change risks, opportunities and initiatives.

GRI Accordance: Company's Sustainability Report is "in accordance" with independent standards established by the Global Reporting Initiative (GRI).

Carbon Disclosure Project: The Carbon Disclosure Project (CDP) is a nonprofit organization that conducts an annual climate change survey on behalf of institutional investors.

Member: Company actively supports CDP survey and on-line data collection instrument.

2007 Signatory: Company signed letter requesting corporate responses to CDP5 survey.

CDP5 (2007): Company completed CDP5 survey and did (or did not) publicly release results.

CDP5 Risk Disclosure: Company assesses climate change-related risks in CDP5 response.

Public Policy Statements: Company expresses its views on climate change regulatory proposals and related public policy measures.

Emissions Accounting

GHG Emissions Inventory: Company conducts an inventory of GHG emissions from its operations.

Scope 1: Direct GHG emissions from combustion in company-owned or controlled sources (boilers, furnaces, vehicles, etc.)

Scope 2: Indirect GHG emissions from generation of electricity purchased for use by company facilities.

Scope 3: Other indirect GHG emissions from company activities (e.g., employee commuter travel; business travel by air, rail or motor vehicles; other indirect emissions from product use or supply chain).

Accounting Methods: Company do cuments accounting methods used for GHG emissions inventory.

Third party certification: Company employs third-party reviewer of GHG emissions data.

Certification Year: Most recent year of third-party review.

Emissions Savings and Offsets: Company seeks renewable energy purchases and/or energy efficiency savings to reduce GHG emissions and offset inventory totals.

2006% Renewable Energy: Percent of electricity derived from renewable energy sources in 2006.

Energy Efficiency Savings: Savings from energy efficiency measures (as calculated by company).

Certified CO2 Offsets: Certified emission reductions and credits to offset company GHG emissions.

Strategic Planning:

GHG Emissions Targets: Company sets targets to reduce GHG emissions or related energy use.

Emissions Trading: Company engages in voluntary or mandatory GHG emissions trading programs to offset its own emissions and/or provides emissions trading services to others.

Renewable Energy: Company purchases renewable energy for its own operations and/or finances/invests in the renewable energy sector.

Energy Efficiency: Company takes measures to improve energy efficiency of its own operations and/or finances/invests in energy efficiency measures available to clients.

Other Climate-Related Investment Products: Company offers climate-related investment and/or retail products.

APPENDIX III: *Published Climate Change Research*

General Issue Reports

Barclays

Credit risk impacts of a changing climate (October 2007, published with Acclimatise)

Citi

Climatic Consequences: An Update (April 2007)

Climatic Consequences (January 2007)

Crédit Agricole

The Economy and Climate Change (Part 2); Monthly Eclairages (September 2007)

The Economy and Climate Change (Part I); Monthly Eclairages (July 2007)

Deutsche Bank

Investing in Climate Change: An Asset Management Perspective (October 2007)

Goldman Sachs

Insuring the Planet (July 2007)

Japan and Brazil: Role Models for Energy Efficiency? (July 2007)

Europe's Green Comparative Advantage (February 2007)

Why the BRICs Dream Should Be Green (February 2007)

Things Are Heating Up: Economic Issues and Opportunities From Global Warming (February 2007)

Climate Change as a Catalyst for Competitive Advantage (December 2006)

Why the BRICS Dream Won't Be Green (October 2006)

US Investment Outlook: The Bigger Picture (October 2006)

Portfolio Strategy: The growing interest in environmental issues is important to both socially responsible and fundamental investors (August 2005)

JPMorgan Chase

Air Pollution: Business Risk or Competitive Advantage (May 2007)

Lehman Brothers

Business of Climate Change II (September 2007)

Business of Climate Change (February 2007)

Merrill Lynch

Combating Climate Change – Opportunities & Risks (April 2007)

Morgan Stanley

The Economics of Climate Change (October 2007)

Doing Good: Nostra Terra, Nostra Navis (Our Earth, Our Ship) (February 2007)

UBS

Climate Change: Beyond Whether (January 2007)

Q-Series: Reacting to Climate Change (June 2007)

Need to Know – Reacting to Climate Change (June 2007)

Renewable Energy / Clean Tech Reports

Citi

Investing in Solutions to Climate Change (June 2006)

Credit Suisse

Sun Rises on Solar Energy (November 2007)

Expert Tips on Sustainable Investments (August 2005)

Investment Ideas: Wind energy – lower growth, higher earnings? (September 2003)

Deutsche Bank

Bioenergies after the petroleum age (August 2005)

Boom Industry Solar Energy (May 2005)

Energy prospects after the petroleum age (December 2004)

Goldman Sachs

European Renewable Energy – sun, wind and grain (October 2006)

ASEAN palm oil initiations: Bullish on bio-diesel (October 2006)

Americas: Energy: Alternative Energy – Searching for renewable profits (October 2006)

US: Energy: Oil: Initiating coverage of ethanol producers Aventine and VeraSun (August 2006)

Asia: Alternative Energy: A breath of fresh air (April 2006)

Japan Technology: Solar Cell Industry Looks Attractive Toward 2010 (March 2006)

Global Alternative Energy (February 2004)

JPMorgan Chase

A Review of Biodiesel Industry Trends (September 2007)

Alternative Energy Strategy (June 2007)

Sasol – Coal to Liquid in the US (May 2007)

Engineering and Construction: Nuclear Power (May 2007)

Capturing the Gains from Carbon Capture (April 2007)

Merrill Lynch

China Leads the Charge in Asia (Renewable Energy – Asia Pacific, September 2007)

Wind Turbine Manufacturers: Here Comes Pricing Power (August 2007)

Coal Bed Methane: Another Green Solution (June 2007)

Biofuels - Still Excellent Growth Prospects (March 2007)

Buy the Emerging Global Wind Force (November 2006)

Morgan Stanley

Clean Energy: Sustainable Opportunities (October 2007)

Clean Coal: Opportunities Alstom, GE and Siemens (January 2006)

Wells Fargo

Identifying the Opportunities in Alternative Energy (2005)

Other Sector Specific Reports

ABN AMRO

Eco-Markets Equity Strategy Research Note, Global Markets Equity Strategy (January 2007)

Barclays

Equity Gilt Study (2007)

Citi

CAFE and the U.S. Auto Industry: A Growing Auto Investor Issue, 2012–2020 (October 2007)

Coal: Missing the Window (July 2007)

CO_2 – A New Auto Investor Issue for 2007 (January 2007)

Crédit Agricole

Carbon Impact (2006)

Deutsche Bank

Climate Change and Sectors: Some like it hot! (May 2007)

Airline CO_2 emissions: fuel for thought (April 2007)

Technology to clean up coal for the post-oil era (February 2007)

Goldman Sachs

Insurance: GS SUSTAIN: Integrating ESG (September 2007)

Introducing GS Sustain (June 2007)

Healthcare: Pharmaceuticals: Integrating ESG (May 2007)

Global Food & Beverages: Integrating ESG (February 2007)

Global Energy: Integrating ESG (February 2004, August 2005, October 2006)

Global Mining and Steel: Integrating ESG (July 2006)

European Utilities: Carbon crazy (April 2006)

European Utilities: Carbon – Putting the fizz into European power markets (February 2006)

Europe Media ESG (February 2006)

HBOS

The Climate Change Disclosures of European Electricity Utilities (May 2006)

ING

Food and Beverages: Climate change; food versus oil (December 2006)

European Utilities: Climate change; when hell freezes over (October 2006)

Merrill Lynch

Carbon Leaders: Quality Win-Win Stocks (September 2007)

Royal Bank of Canada

Climate Change: An Examination of its Effects Upon North American Industries & Regions (August 2002)

UBS

Q-Series: Climate and Materials (September 2007)

Regulatory Policy / Carbon Trading Reports

ABN AMRO
Beyond Kyoto (2005)

Citi
Carbon Trading: The Sky's the Limit (March 2007)

Crédit Agricole
Carbon Focus (April 2006)

Credit Suisse
CO_2 is a New Commodity (January 2007)

Deutsche Bank
Carbon Emissions: Bali Bearings—Reading the Roadmap to a Post-Kyoto Deal (December 2007)

EU energy policy: High time for action! (April 2007)

EU Emission Trading: Allocation battles intensifying (March 2007)

EU Emission Trading: Kyotonomics: pricing carbon over 2008–12 (April 2006)

The US's new energy policy – barely a start (December 2005)

Intesa Sanpaolo
Kyoto and its impact on investment in the power industry (September 2003)

JPMorgan Chase
All you wanted to know about carbon trading (August 2007: four volumes)

Trading Climate Change (May 2007)

Supreme Court Greenhouse Ruling (April 2007)

Carbon Dioxide: A Commodity Market Perspective (March 2007)

Global Utilities: Trading Climate Change (March 2007)

Royal Bank of Canada
Greenhouse Gas Emission Trading: An Examination of the Markets, and the Risks and Opportunities for RBC (June 2004)

TD Bank Financial Group
Market-based Solutions to Protect the Environment (March 2007)

Carbon Risk Model Reports

JPMorganChase
Introducing the JENI Beta Carbon Index (February 2007)

Royal Bank of Canada
Carbon Risk in Credit Risk Management project (2004)

Société Générale
CREAM-ing Carbon Risk: European Carbon Winners and Losers (June 2007)

Appendix IV: *Climate Specific Indices and Funds*

(Does not include renewable energy funds)

ABN AMRO Climate Change and Environment Index **(March 2007)**
"Tracks the performance of stock directly related to businesses that are addressing climate change and other environmental issues." Renewable energy companies make up 45% of the index. ABN AMRO has already launched a certificate to track the index.

ABN AMRO Low Carbon Accelerator Fund **(October 2006)**
Fund invests in a wide portfolio of companies entirely devoted to low carbon and energy efficiency. The fund focuses on carbon credits, solar energy, fuel cells, wind energy, and bio-fuels.

Barclays Capital Global Carbon Index **(December 2007)**
The world's first index tracking the performance of carbon credits from main greenhouse gas emissions trading systems, including the Kyoto Clean Development Mechanism and the EU ETS.

Credit Suisse Clariden Leu's CO2 Certificate **(2006)**
Enables investors to participate in the price movements of European emission rights.

Credit Suisse Global Warming Index **(2007)**
Focused on 40 renewable energy and carbon controlling stocks.

Deutsche Bank DWS Klimawandel **(Climate Protection Fund)**
A retail fund that focuses on companies offering climate change mitigation and adaptation products and services

Deutsche Bank DWS Climate Change Fund
Invests globally in clean technology, energy efficiency and environmental management companies (launched by DWS Scudder, Deutsche Bank Asset Management's U.S. retail asset management division)

HSBC Global Climate Change Benchmark Index **(September 2007)**
The Benchmark Index is designed to provide exposure to companies that are best positioned to profit in the face of climate change challenges. The fund includes sub-indices:

Climate Change Index
Low Carbon Energy Production Index
Energy Efficiency and Energy Management Index
Water, Waste and Pollution

HSBC's Climate Change Fund **(November 2007)**
Aims to outperform the Global Climate Change Benchmark Index

ING Climate Focus Fund **(2007)**
The fund is managed by ING Investment Managementand offers investors exposure to various sectors such as waste management, clean water and renewable energy.

JPMorgan Environmental Index-Carbon BETA **(2007)**
The first high-grade corporate bond index designed to address the risks of climate change. A collaboration between JPMorgan and Innovest Strategic Investment Advisors, JENI-Carbon Beta is designed to enable credit investors to make return-driven investment decisions that systematically take the risks and opportunities created by climate change into account.

Merrill Lynch Carbon Leaders Europe Index **(October 2007)**
Offers exposure to low carbon footprint stocks, and two biofuels indices. Carbon data provided by Trucost.

Santander/Instituto de Credito Oficial Fondo de Carbono para la Empresa Española (FC2E) **(2005)**

The purpose of the fund is to support Spanish companies in their compliance with the targets established under the Kyoto Protocol by financing CDM and JI projects and purchasing the carbon credits generated by these projects.

UBS Global Warming Index **(April 2007)**

The index is a tradable benchmark for global investments in the weather derivatives market.

UBS Climate Change Strategy Certificate **(February 2007)**

An actively managed basket of around 20-25 stocks, was launched in February 2007 and includes companies developing solutions in renewable energy and energy efficiency.

UBS World Emissions Index **(November 2006)**

Index-linked products offered by the UBS Investment Bank allow clients to participate in this index's performance, which is linked to tradable derivative instruments referencing emissions allowances.

Appendix V: External Initiatives

The 3C Initiative

The 3C Initiative is a global opinion group consisting of 46 companies that demand an integration of climate issues into the world of markets and trade facilitated by means of a global framework coming into force in 2013. The 3C (standing for Combat Climate Change) has launched a call to action with recommendations on policy priorities for the world's politicians. These recommendations are based on an analysis of how to reduce emissions cost-effectively throughout the global economy. **www.combatclimatechange.org**

ABI Energia

ABI Energia is a consortium of Italian banks focused on sustainable energy. **http://www.abienergia.it/energia/default.jsp**

AGE

AGE is an initiative of the German Ministry for the Environment, Nature Conservation and Nuclear Safety to establish an emissions trading scheme in Germany.

The Bali Communiqué

On 30th November 2007, the business leaders of 150 global companies published a communiqué to world leaders calling for a comprehensive, legally binding United Nations framework to tackle climate change. The initiative is being led by The Prince of Wales's UK and EU Corporate Leaders Groups on Climate Change, which are developed and run by the University of Cambridge Programme for Industry. **http://www.balicommunique.com/**

Canadian Bankers Association's Environmental Issues Specialist Group

The Canadian Bankers Association Environmental Issues Specialist Group, comprised of representatives from Canadian banks, examines and comments on environmental legislation as it relates to lending practices, bankruptcy and realization, and liability issues. **http://www.cba.ca/en/default.asp**

Canadian Business for Social Responsibility (CBSR)

Founded in 1995, CBSR is a business-led, non-profit CSR consultancy and peer-to-peer learning organization that provides its members with counsel and customized advisory services as they formulate business decisions related to CSR issues. CBSR actively defines CSR in Canada through original research on CSR market trends, sector-specific programming, and information dissemination to multiple societal and industry segments. **www.cbsr.ca**

Carbon Markets Association (CMA)

CMA, formerly known as London Climate Change Services, is a City trade association representing the UK's service providers to the Global Carbon Market. The association was formed to represent businesses of the UK services sector working to reduce carbon emissions through the market mechanisms of the United Nations Kyoto Protocol. CMA has more than 40 company members, including carbon funds, project developers, consultants, lawyers, investment banking divisions, accountants, verifiers, traders, brokers, accountants, IT firms and engineers. **www.carbonmarketsassociation.net**

Ceres

Ceres is a national network of investors, environmental organizations and other public interest groups working with companies and investors to address sustainability challenges such as global climate change. **www.ceres.org**

The Climate Group

The Climate Group is an independent, nonprofit organization dedicated to advancing business and government leadership on climate change. The group, which is based the UK, the USA and Australia, was founded in 2004 by a diverse group of governments, companies, and other supporters. **www.theclimategroup.org**

Clinton Climate Initiative (CCI)

CCI was launched by President Bill Clinton in August 2006 with the mission of applying the Foundation's business-oriented approach to the fight against climate change. In its first phase, CCI is working with the C40 Large Cities Climate Leadership Group, an association of large cities dedicated to tackling climate change, to develop and implement a range of actions that will accelerate greenhouse gas emissions reductions.
http://www.clintonfoundation.org/cf-pgm-cci-home.htm

Clinton Foundation – Energy Efficiency Building Retrofit Program

The Clinton Foundation's Energy Efficiency Building Retrofit Program brings together four of the world's largest energy service companies (ESCOs), five of the world's largest banks, and sixteen of the world's largest cities in an initiative designed to reduce energy consumption in existing buildings. ABN AMRO, Citi, Deutsche Bank, JPMorgan Chase, and UBS have agreed to finance the first generation of retrofit projects. Sixteen cities have committed to work with the Foundation and its expert partners to develop programs to audit their buildings and to implement retrofits that improve their energy efficiency.
http://www.clintonfoundation.org/051607-nr-cf-pr-cci-president-clinton-announces-landmark-program-to-reduce-energy-use-in-buildings-worldwide.htm

Confederation of British Industry (CBI) – Climate Change Task Force

The CBI is the UK's leading business organization, speaking for some 240,000 businesses that together employ around a third of the private sector workforce. After ten months of intensive work by 18 Chairman and Chief Executives from some of the UK's biggest companies, the task force released a report stating that "British businesses are committed to do what it takes to tackle climate

change but the UK effort will only succeed if it becomes an urgent, shared national priority for companies, consumers and the government." **www.cbi.org.uk/climate**

Conference Board of Canada – Business Council for Sustainability

The Business Council for Sustainability is a network of senior executives from Canadian companies whose responsibilities include environmental management and sustainability performance. **http://www.conferenceboard.ca/BCS/Default.asp**

Corporate Leaders Group on Climate Change (CLG)

CLG brings together business leaders from major UK and international companies who believe that there is an urgent need to develop new and longer-term policies for tackling climate change. The first output from the group was a letter to the Prime Minister in the run up to the G8 Summit in Gleneagles. The group is currently working in partnership with the UK Government towards strengthening domestic and international progress on reducing greenhouse gas emissions. They are also working to engage other British businesses, the UK public and governments and businesses internationally to back this effort. **http://www.cpi.cam.ac.uk/programmes/energy_and_climate_change/corporate_leaders_group_on_cli.aspx**

Deutsche Energie-Agentur GmbH (dena)

The Deutsche Energie-Agentur GmbH (the German Energy Agency) is the competence centre for energy efficiency and renewable energies. Its objectives include the environmentally friendly production, conversion and use of energy, and the development of sustainable energy systems with a greater emphasis on renewable energy sources. **www.dena.de/**

Enterprises pour l'Environnement (EpE)

EpE is a coalition of forty leading companies operating in France united by a commitment to the environment and to sustainable development. **http://www.environnement.ccip.fr/acteurs/epe.htm**

Environment Canada

Through Environment Canada's Corporate Environmental Innovation (CEI) initiative, Environment Canada has engaged an informal Network of North American expert organizations working on linking environmental performance to financial value. The Network aims to identify the connection between environmental performance and business value, including shareholder value in the North American context, and to make this connection more relevant to financial sector audiences. **www.ec.gc.ca**

Environmental Bankers Association (EBA)

EBA is an association that assists the financial services industry in developing environmental risk management policies and procedures. **www.envirobank.org/entryscreen.php**

EPA Climate Leaders

EPA's Climate Leaders is an industry-government partnership that works with companies to develop long-term comprehensive climate change strategies. Partners set a corporate-wide greenhouse gas (GHG) reduction goal and inventory their emissions to measure progress. **www.epa.gov/stateply**

EPA Energy Star

ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy to encourage energy efficient products and practices. ENERGY STAR works with more than 9,000 public and private sector organizations to improve the energy and financial performance of their business, manufacture products to meet ENERGY STAR specifications, sell ENERGY STAR labeled products, promote ENERGY STAR qualified products or homes as a utility or state funds administrator, and build ENERGY STAR qualified homes. **www.energystar.gov**

EPA Green Power Partners

The Green Power Partnership is a voluntary program that encourages organizations to buy green power. Partner organizations voluntarily purchase green power annually and are required to submit a yearly report to verify the status of their green power purchases. **www.epa.gov/greenpower/**

Equator Principles

The Equator Principles is a set of environmental and social benchmarks for managing environmental and social issues in development project finance in the emerging markets. Once adopted by banks and other financial institutions, the Equator Principles commit the adoptees not to finance projects that fail to follow the processes defined by the Principles. The Equator Principles were developed by private sector banks – led by ABN AMRO, Citigroup, Barclays and WestLB – and were launched in June 2003. **www.equator-principles.com**

European Carbon Investors and Services (ECIS)

The ECIS is a trade association formed to represent the 'market' perspective on emissions trading and climate investments to policymakers worldwide. **http://www.greenstream.net/default.asp?docId=13120**

The EXCEL Partnership

EXCEL is a partnership of major Canadian corporations that are committed to sustainable development leadership through the continuous improvement of economic, environmental and social performance. **www.excelpartnership.ca**

Extractive Industries Transparency Initiative (EITI)

The EITI is a coalition of governments, companies, civil society groups, investors and international organizations aimed to strengthen governance by improving transparency and accountability in the extractives sector. The EITI, which was announced by UK Prime Minister Tony Blair at the September 2002 World Summit on Sustainable Development in Johannesburg, is an effort to increase transparency over payments by companies to governments and to government-linked entities, as well as transparency over revenues by those host country governments. **www.eitransparency.org**

Forum für Zukunftsenergien (Forum for Future Energies)

The Forum für Zukunftsenergien is a 250-member association dedicated to renewable and non-renewable energies as well as the rational and economical use of energy in order to promote a secure, cost-effective power supply that conserves resources and the environment. The Forum is independent from political parties and industries, providing a platform for interdisciplinary dialogue involving different interest groups and for the discussion of possibly conflicting points of view and opinions. **http://www.zukunftsenergien.de/hp2/eu-project/organizer.htm**

G8 Gleneagles CEO Roundtable on Climate Change

The G8 Gleneagles CEO Roundtable on Climate Change, first formed at the World Economic Forum's 2005 Annual Meeting in Davos, prepared a statement in response to an invitation from Prime Minister Tony Blair to provide business's perspectives on climate change in advance of the G-8 Summit that took place in Gleneagles, Scotland, in early July 2005. The group of roughly 40 CEOs wrote the leaders of the G8 urging them to take action on climate change.

Global Roundtable on Climate Change

The Global Roundtable on Climate Change, coordinated by the Earth Institute at Columbia University, brings together high-level, critical stakeholders from all regions of the world — including senior executives from the private sector and leaders of international governmental and non-

governmental organizations — to discuss and explore areas of potential consensus regarding core scientific, technological, and economic issues critical to shaping sound public policies on climate change. **www.earthinstitute.columbia.edu/grocc**

The Heinz Center Business Council

Established in December 1995, The H. John Heinz III Center for Science, Economics and the Environment is a nonprofit, nonpartisan institution dedicated to improving the scientific and economic foundation for environmental policy. The Heinz Center Business Council is a strategic partnership opportunity for leaders in global industry and regional business who are concerned about environmental issues that affect the economy and the world in which we live. **www.heinzctr.org**

Institutional Investors Group on Climate Change (IGCC)

IIGCC is a forum for collaboration between pension funds and other institutional investors on issues related to climate change. IIGCC seeks to: a) promote better understanding of the implications of climate change amongst our members and other institutional investors; b) encourage companies and markets in which IIGCC members invest to address any material risks and opportunities to their businesses associated with climate change and a shift to a lower carbon economy. IIGCC seeks to occupy the overlap between "interested investor" (aware of the implications of climate change) and "responsible investor" (acting to manage the risks climate change poses our investments). IIGCC does not seek to become a "campaigning investor" (advocating immediate or otherwise radical changes in energy and economic activity). **www.iigcc.org**

International Emissions Trading Association (IETA)

IETA is a non-profit business organization created in June 1999 to establish a functional international framework for trading in greenhouse gas emission reductions. IETA is dedicated to ensuring that the objectives of the United National convention on Climate Change and ultimately climate protection are met through the establishment of effective systems for trading in greenhouse gas emissions by business, in an economically efficient manner while maintaining society equity and environmental integrity. **www.ieta.org**

Investor Network on Climate Risk (INCR)

INCR is a $4 trillion network of investors that promotes better understanding of the financial risks and opportunities posed by climate change. **www.incr.com**

Investors and Business for U.S. Climate Action

On March 19, 2007 more than 60 leading investors, asset managers and companies released a climate policy call to action requesting prompt tangible action by US lawmakers to tackle global climate change. **www.ceres.org/pub/docs/FAQ.pdf**

Klima-Partner 2007

Klima-Partner 2007 is an association formed to promote the development of climate-neutral products and services. **www.klimaneutral-partner.de**

The London Accord

The London Accord is a co-operative research initiative supported by leading investment banks and research houses, major institutional investors and key NGOs and academics. The project will bring the insights and rigor of financial analysis to the implications of climate change for investors and corporate decision makers. **www.london-accord.co.uk**

Massachusetts Institute of Technology Joint Program on the Science and Policy of Global Change

The MIT Joint Program on the Science and Policy of Global Change was founded in 1991 as an interdisciplinary organization that conducts research, independent policy analysis, and public communication on issues of global environmental change. **www.mit.edu/globalchange**

Pew Center on Global Climate Change's Business Environmental Leadership Council (BELC)

The Pew Center is a nonprofit that brings together business leaders, policy makers, scientists, and other experts with the mission to provide credible information, straight answers, and innovative solutions in the effort to address global climate change. The Business Environmental Leadership Council, a Pew Center initiative, is the largest U.S.-based association of corporations focused on addressing the challenges of climate change, with 44 members representing $2.8 trillion in market capitalization and over 3.8 million employees. The council includes representatives from a variety of sectors. **www.pewclimate.org/companies_leading_the_way_belc**

Renewable Energy and Energy Efficiency Program (REEEP)

REEEP is a global public-private partnership that was launched by the United Kingdom along with other partners at the Johannesburg World Summit on Sustainable Development in August 2002. By providing opportunities for concerted collaboration among its partners, REEEP aims to accelerate the marketplace for renewable energy and energy efficiency. **www.reeep.org**

Roundtable on Sustainable Palm Oil

RSPO is a global multi-stakeholder initiative on sustainable palm oil formally established under Article 60 of the Swiss Civil Code in April 2004. The principal objective of RSPO is "to promote the growth and use of sustainable palm oil through co-operation within the supply chain and open dialogue between its stakeholders". The nonprofit association includes members representing major players along the palm oil supply chain, namely the oil palm growers, palm oil processors and traders, consumer goods manufacturers, retailers, banks and investors, environmental/nature conservation NGOs and social/development NGOs. **www.rspo.org**

Sustainable Energy Europe

The Sustainable Energy Europe 2005-2008 Campaign is a European Commission initiative in the framework of the Intelligent Energy - Europe (2003-2006) program, which aims to raise public awareness and promote sustainable energy production and use among individuals and organizations, private companies and public authorities, professional and energy agencies, industry associations and NGOs across Europe. **www.sustenergy.org**

United Nations Environment Program Finance Initiative (UNEP FI)

UNEP FI is a global partnership between the United Nations Environment Programme (UNEP) and the private financial sector. UNEP FI works closely with over 160 financial institutions who are signatories to the UNEP FI Statements, and a range of partner organizations to develop and promote linkages between the environment, sustainability and financial performance. Through regional activities, a comprehensive work programme, training programs and research, UNEP FI carries out its mission to identify, promote, and realize the adoption of best environmental and sustainability practice at all levels of financial institution operations. **www.unepfi.org**

United Nations Principles for Responsible Investment

The United Nations Principles for Responsible Investment (PRI) is an investor initiative in partnership with UNEP Finance Initiative (UNEPFI) and the UN Global Compact which focuses on integrating environmental, social and governance [ESG] factors into investment decisions. The PRI encourages major pension funds, investment managers and service providers in the investment industry to integrate ESG risks and opportunities into investment decisions. PRI was launched by former UN Secretary General Kofi Annan and is supported by UN SG Ban Ki-moon. Since its launch on the 27th April 2006, the PRI has been adopted by more than 240 signatories representing over US$ 10 trillion in assets under management. www.**unpri.org**

U.S. Green Buildings Council

The U.S. Green Building Council (USGBC) is a non-profit organization committed to expanding sustainable building practices. USGBC is composed of more than 12,000 organizations from across the building industry that are working to advance structures that are environmentally responsible, profitable, and healthy places to live and work. Members includes building owners and end-users, real estate developers, facility managers, architects, designers, engineers, general contractors, subcontractors, product and building system manufacturers, government agencies, and nonprofits. **www.usgbc.org**

World Business Council on Sustainable Development

The World Business Council for Sustainable Development (WBCSD) is a CEO-led, global association of some 200 companies dealing exclusively with business and sustainable development. Energy and Climate is one of the four key areas of focus for the organization. **www.wbcsd.org**

World Resources Institute – Climate Northeast Working Group

The Climate Northeast partnership, a project of the World Resources Institute, builds strategies for companies to thrive in a carbon-constrained economy. Partners develop greenhouse gas inventories, share energy management practices and invest in clean energy technologies. These corporate actions shape multi-sector policy approaches for a safe climate and sound business future in the Northeast. **www.earthinstitute.columbia.edu/grocc/**

World Resources Institute's (WRI) Corporate Council

The Corporate Council is a partnership between WRI and the corporate sector. In return for financial contributions to the organization, council members receive help from WRI in identifying environmental trends relevant to their industry. WRI also leads discussions on current issues, and provides cutting-edge information on business ideas for council members. **archive.wri.org/partners/funders_cc.cfm**

Appendix VI: Carbon Trading Glossary

Annex B Countries: The 39 emissions-capped countries listed in Annex B of the Kyoto Protocol.

Annex I Countries: The 36 countries and economies in transition listed in Annex I of the UNFCCC. Belarus and Turkey are listed in Annex I but not Annex B; and Croatia, Liechtenstein, Monaco and Slovenia are listed in Annex B but not Annex I. In practice, however, Annex I of the UNFCCC and Annex B of the Kyoto Protocol are often used interchangeably.

Annex II Countries: All original OECD member countries plus the European Union.

Assigned Amount: The quantity of greenhouse gases that an Annex I country can release during a Kyoto Protocol commitment period.

Assigned Allocation Unit (AAU): Fraction of the assigned amount equaling one metric tonne of greenhouse gas in carbon dioxide equivalent.

Carbon Dioxide Equivalent (CO2e): The universal unit of measurement used to indicate the global warming potential of each of the six greenhouse gases. Carbon dioxide is the reference gas against which the other greenhouse gases are measured.

Certified Emission Reductions (CERs): A unit of greenhouse gas emission reductions issued pursuant to the Clean Development Mechanism of the Kyoto Protocol, and measured in metric tons of carbon dioxide equivalent.

Clean Development Mechanism (CDM): The mechanism provided by Article 12 of the Kyoto Protocol, designed to assist developing countries in achieving sustainable development by permitting industrialized countries to finance projects for reducing greenhouse gas emission in developing countries and receive credit for doing so.

Emission Reduction Units (ERUs): A unit of emission reductions issued pursuant to Joint Implementation. This unit is equal to one metric ton of carbon dioxide equivalent.

European Union Emissions Trading Scheme (EU ETS): Trading Scheme within the European Union. The first compliance phase is from 2005 to 2007, while the second compliance phase continues from 2008 to 2012.

Joint Implementation (JI): Mechanism provided by Article 6 of the Kyoto Protocol, whereby a country included in Annex I of the UNFCCC and the Kyoto Protocol may acquire Emission Reduction Units when it helps to finance projects that reduce net emissions in another industrialized country (including countries with economies in transition).

Kyoto Protocol: The Kyoto Protocol originated at COP-3 to the UNFCCC in Kyoto, Japan, December 1997. It specifies emission obligations for the Annex B countries and defines the three so-called Kyoto mechanisms: JI, CDM and emissions trading. It entered into force on 16 February 2005.

Renewable Energy Certificates: Also known as RECs, green tags, green energy certificates, or tradable renewable certificates, certificates represent the technology and environmental attributes of electricity generated from renewable sources. Renewable energy credits are usually sold in 1 Megawatt-hour (MWh) units. A certificate can be sold separately from the MWh of electricity with which it is associated. This flexibility enables customers to offset a percentage of their annual electricity use with certificates generated elsewhere.

Verified Emission Reductions (VERs): Emission reduction credits generated by small-scale projects, which are assessed and verified by third party organizations rather than through the UNFCCC.

About the Authors

The authors of this report are members of RiskMetrics' Climate Change Research Team. Doug Cogan leads this team and has more than 20 years of experience in studying investment responses to climate change. Prior to joining RiskMetrics Group, he worked with the Investor Responsibility Research Center and Institutional Shareholder Services, where he wrote several other publications for Ceres and the Investor Network on Climate Risk, including two prior editions of *Corporate Governance and Climate Change: Making the Connection*. His co-authors on this report are climate change senior analyst Megan Good and research analyst Emily McAteer, who conducted the primary research, prepared the company profiles and helped draft the Summary Report.

About RiskMetrics Group

RiskMetrics Group helps investors and other financial market participants better understand and manage the risk inherent in their portfolios so they can make more informed investment decisions. The firm covers a broad spectrum of risk to include considerations in corporate governance, compliance, accounting, legal, transactional, environmental and social risks. The firm's goal is to improve financial markets by bringing transparency, expertise and access to all market participants. RiskMetrics Group offers advanced tools to help investment managers engage and assess corporate commitment to social responsibility, environmental stewardship and climate change as a material risk and growth opportunity. For more information, visit www.riskmetrics.com.

About Ceres

Ceres is a national coalition of investors, environmental groups, and other public interest organizations working with companies to address sustainability challenges such as climate change. Ceres also directs the Investor Network on Climate Risk, a group of 60 institutional investors from the U.S. and Europe managing over $4 trillion of assets. INCR was launched at the Institutional Investor Summit on Climate Risk at United Nations Headquarters in 2003. The purpose of INCR is to promote better understanding of the risks of climate change among institutional investors. For more information, visit www.ceres.org and www.incr.com.

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