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**CLEAN ENERGY AND DEVELOPMENT:
TOWARDS AN INVESTMENT FRAMEWORK**

Attached for the April 23, 2006, Development Committee Meeting is a paper entitled "Clean Energy and Development: Towards an Investment Framework," prepared by the staff of the World Bank. This item will be considered under Item I of the Provisional Agenda.

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**CLEAN ENERGY AND DEVELOPMENT:
TOWARDS AN INVESTMENT FRAMEWORK**

**Environmentally and Socially Sustainable Development Vice Presidency
Infrastructure Vice Presidency**

THE WORLD BANK

APRIL 5, 2006

ABBREVIATIONS AND ACRONYMS

AAA	Analytical and Advisory Activities	“G+5”	Brazil, China, India, Mexico and South Africa
AfDB	African Development Bank	JI	Joint Implementation
ADB	Asian Development Bank	IADB	Inter-American Development Bank
CAS	Country Assistance Strategy	IDB	Islamic Development Bank
CC	Climate Change	IEA	International Energy Agency
CCS	Clean Coal Systems	IF	Investment Framework
CCS	Carbon Capture and Storage	IFIs	International Financial Institutions
CDM	Clean Development Mechanism	IGBP	International Geosphere Biosphere Program
CEFV	Clean Energy Financing Vehicle	IGCC	Integrated Gasification Combined Cycle
CF	Carbon Finance	IIASA	International Institute for Applied Systems Analysis
CGIAR	Consultative Group on International Agricultural Research	IPCC	Intergovernmental Panel on Climate Change
CO ₂	Carbon Dioxide	ISDR	International Strategy for Disaster Reduction
CSD	Commission on Sustainable Development	INF	Infrastructure Vice Presidency
CSOs	Civil Society Organizations	MDGs	Millennium Development Goals
DALYs	Disability Adjusted Life Years	MIGA	Multilateral Investment Guarantee Agency
DCs	Developing Countries	NAPAs	National Action Plans for Adaptation
EE	Energy Efficiency	NGOs	Non-Governmental Organizations
EBRD	European Bank for Reconstruction and Development	NRM	Natural Resource Management
EFTA	European Free Trade Association	PPP	Public-Private Partnerships
EIB	European Investment Bank	PRS	Poverty Reduction Strategy
EIT	Economies in Transition	PROFOR	Program on Forests
ERU	Emissions Reduction Units	ODA	Overseas Development Assistance
ESCO	Energy Service Company	OECD	Organization for Economic Co-operation and Development
ESMAP	Energy Sector Management Assistance Program	RE	Renewable Energy
ESSD	Environmentally and Socially Sustainable Development Vice Presidency	RD&D	Research, Development, and Demonstration
ESW	Economic and Sector Work	UN	United Nations
EU	European Union	UNEP	United Nations Environment Program
GDP	Gross Domestic Product	UNFCCC	United Nations Framework Convention on Climate Change
GEF	Global Environment Facility	WBG	The World Bank Group
GHGs	Greenhouse Gases	WHO	The World Health Organization
GIIF	Global Index Insurance facility		

CLEAN ENERGY AND DEVELOPMENT: TOWARDS AN INVESTMENT FRAMEWORK

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CLEAN ENERGY AND DEVELOPMENT: TOWARDS AN INVESTMENT FRAMEWORK

EXECUTIVE SUMMARY

1. *This paper discusses the issues underlying the development of an Investment Framework for Clean Energy and Development*—responding to the request in the September 2005 Development Committee Communiqué and in the context of the Gleneagles Communiqué on Climate Change, Clean Energy and Sustainable Development (July 2005)—and outlines the key elements of an associated work program. The paper has been prepared for discussion at the Spring 2006 meetings of the Development Committee, and was preceded by consideration by the Bank Board’s Committee of the Whole on March 30, 2006.
2. *The paper takes a global perspective rather than a Bank-centric one, covering three interlocking and complementary issues:* (i) the need for, and investment requirements of, meeting modern energy needs for developing countries over the long term in a manner that provides attention to efficiency and local environmental considerations; (ii) the additional steps needed in the energy, transport, and industrial sectors to address climate change mitigation through the reduction of greenhouse gases; and (iii) the impact of climate change and the need for developing countries to adequately adapt to changes in climate and weather variability. These three issues are critical to the World Bank’s core mission of poverty reduction and the realization of many of the Millennium Development Goals, and build upon existing World Bank strategies.¹
3. *The global community today is working toward a potential “double dividend* by meeting the energy needs that are essential for economic growth and fighting poverty, while at the same time leaving a smaller environmental footprint. The paper recognizes that meeting developing countries’ energy needs is both an urgent and difficult challenge, which requires domestic policies that provide incentives for efficiency in energy production, delivery, and use and incentives for public and private resource mobilization. The report also recognizes that climate change can undermine development and that dealing with climate change will require the development and implementation of climate-friendly technologies as well as adapting to climate change. Consistent with the principle of “common yet differentiated responsibilities,” the report recognizes that funding for energy-related climate change must be additional.
4. *The paper concludes by outlining a two-track approach to further develop an Investment Framework*, which complements ongoing World Bank Group activities in energy sector reform, energy investment, implementing GEF projects, developing the carbon market, and developing and applying methodologies to address climate variability and change.

¹ Fuel for Thought, Energy Strategy, Water Resources Management Strategy, Infrastructure Action Plan, Environment Strategy, and The Role of the World Bank in Carbon Finance.

A. Clean Energy for Development²

5. ***Today's challenge: reliable, clean, and efficient energy.*** Developing countries must accelerate access to affordable and reliable modern energy services to decrease poverty and increase productivity, enhance competitiveness, and thus improve their economic growth prospects. Without access to modern, clean, and sustainable energy services, the poor are exposed to unhealthy air pollution and deprived of modern energy services, which provide lighting, cooking, heating, refrigeration, transportation, motive power, and electronic communication that are indispensable to increasing productivity, creating enterprises, employment, and incomes. Maintaining current policies and technology choices will have highly undesirable economic, social, and environmental outcomes.

6. ***Energy sector policy reform is urgently required to stimulate the investments needed for developing and transition economies to meet their energy needs.*** Much of the investment need is unmet because of policy constraints: addressing these problems through joint public and private participation and working across the spectrum of public and private interventions are required. Actions needed include removal of broad-based subsidies and targeting the poor who may need income support; establishment of credible legal and regulatory frameworks; development of enabling policy environments through regulatory interventions such as appliance energy efficiency standards, mandated utility demand side management programs, and mandatory energy audits; creation of market-based approaches such as emissions trading, energy service companies, energy performance contracts, and credit guarantees; and information dissemination regarding energy savings and clean energy options.

7. ***Strengthening energy security is essential to alleviate some of the macroeconomic concerns of developing countries*** by diversifying supply and rationalizing energy use. Improvements in the effectiveness of energy use should be assigned a high priority because of its three-fold impact of improving energy security, reducing costs and decreasing environmental impacts.

8. ***An extensive array of clean and efficient energy supply and demand technologies exists.*** On the supply side, technologies aim to enhance access to clean and efficient energy, improve energy security, and promote environmental protection at the local, regional and global level. They include new thermal power plants based on combined cycle and supercritical boilers; natural gas as a bridging fuel in the transition period until renewable energy technologies become commercially viable; new renewable energy technologies (solar, wind, small and large hydro, biomass/biofuels and geothermal sources); and nuclear fission. Energy supply technologies are complemented by end-use efficiency technologies in the transportation sector (including efficient gasoline/diesel engines); the buildings sector (insulation, advanced windows, new lighting technology, efficient space cooling and heating); the industrial sector (cogeneration, waste heat recovery, pre-heating, new efficient process technologies, efficient motors/drives, improved control systems); the agricultural sector (efficient irrigation pumps); and in municipalities and urban centers (district heating systems and combined heat and power).

² This report does not equate clean energy only with small-scale modern renewable energy technologies, but with a complete suite of clean and efficient production, supply and end-use technologies.

9. ***Low-cost, high impact approaches to providing clean energy should be addressed first.***

The first element is where investments and expenditures can be made in a “no regrets” format, that is, where clean energy investments are financially attractive under sound, commercially viable policies. An example is improving the efficiency in the production and use of energy. The second element would address promising new technologies that are not currently financially viable, but could be supported through taxes and subsidies that internalize the environmental costs of local and regional pollution. The third element would include a research and development program for promising new technologies that could yield commercially viable results within 10 to 25 years.

10. ***The IEA estimates that a total capital investment of \$8.1 trillion, equivalent to an average of \$300 billion per year (in 2005 dollars), is needed from 2003 to 2030 for the developing and transition economies to meet their energy needs,*** of which electricity comprises roughly 73 percent, oil 12 percent, natural gas 12 percent and coal 3 percent. Financing for the energy supply sector comes from three sources: internal cash generation, private financing, and public funding. One challenge in the energy sector is the electricity sub-sector where the current levels of investments are about 50 percent of the needs, that is, about \$80 billion per year out of \$160 billion per year. The extent to which the huge investment gap, especially in the electricity sector, can be funded in the future would depend on the pace of policy and regulatory reform, including the measures needed to attract private sector investment in developing countries and transition economies. End-use efficiency improvements in the transportation, industry, commercial and residential sectors can also have a significant impact on the clean energy investment requirements. Consultations with the private sector have confirmed that private investments in cleaner energy in developing countries will not occur without better risk management cover, especially in regulated industries.

B. Climate Change

11. ***Climate change presents an urgent and additional challenge.*** To reduce the threat of human-induced climate change to socio-economic sectors, human health, and ecological systems will require a significant reduction in the emissions of greenhouse gases globally. Emissions are estimated to be a factor of 1.6 to 3.5 above present levels by 2050. Most of the emissions come from industrialized countries and from a few large developing countries with rapidly expanding economies. Transformational policies and strategies will be needed to meet national expectations of secure, safe, and clean energy and to deal with the implications of climate change. The energy sector accounts for about 80 percent of greenhouse gas emissions and the agricultural sector for most of the remaining 20 percent. Decisions taken today on technologies and policy will have profound consequences on development paths for 40 to 60 years.

12. ***Addressing climate change will require mitigating greenhouse gases and adapting to the impacts of climate change now.*** The incremental costs of mitigating greenhouse gas emissions is estimated to range from less than \$10 billion per year to about \$200 billion per year depending on the stabilization target, the pathway to stabilization, and the underlying

development pathways of developing countries³. While the costs of adaptation are uncertain they are expected to be considerable, i.e., tens of billions of dollars per year, with developing countries being the impacted.

13. ***Technologies are currently available or will soon be available to reduce greenhouse emissions***, including ultra-efficient coal-fired power plants (e.g. integrated gasification combined cycle (IGCC) with carbon capture and storage), natural gas, advanced renewable energy technologies, nuclear, biological sequestration, (e.g., afforestation), reducing the rate of deforestation, waste management (e.g., capture of methane emissions), incineration of process by-product gases as well as highly efficient end-use technologies (e.g., buildings and vehicles). Research, development, and demonstration (RD&D) is needed to further improve certain technologies in several key areas, including IGCC with carbon capture and storage, zero- or low-emission vehicles, and nuclear energy.

14. ***Climate is a global public good***⁴. Because of the recognition of common yet differentiated responsibilities in the United Nations Framework Convention on Climate Change (UNFCCC) and because the industrialized countries are responsible for most of the anthropogenic greenhouse gases currently in the atmosphere, developing countries are not expected to bear the additional costs of a low-carbon economy. There are only three sources of funding for mitigating greenhouse gas emissions: voluntary actions, international grants, and trade. While all are potentially important, trade is likely to confer the biggest flow of funds (between \$20 and \$120 billion per year). An efficient trading system will require a long term, stable and predictable framework and accompanying regulatory system, which could be based upon targets, policies, and other measures⁵.

15. ***All countries are vulnerable to climate change and instability in weather patterns but the poorest countries and the poorest people within them are most vulnerable, being the most exposed and having the least means to adapt***. Climate variability is already a major impediment to reducing poverty and will become increasingly so given that a significant degree of climate change is inevitable. Immediate attention is needed for small island states and low lying coastal areas exposed to storms, but the longer term challenge is in the key sectors relating to agriculture and associated water resource management.

16. ***Adaptation will require the transfer of existing technologies, new technologies and the revision of planning standards and systems***. Priority funding is needed to (a) develop typologies of country cases to better understand options and costs; (b) establish better planning and screening tools especially for hydrological and biological resource management; and (c) agriculture needs to be “climate proofed” through the development of a new generation of drought and water resistant seeds and breeds. Much of the technology and knowledge needed for adaptation is either currently available or can be developed at relatively low cost. Given the

³ The IPCC estimated, in 1990 \$, that the average annual gross cost over the next 100 years of stabilizing at 450 ppm, 550ppm and 650 ppm of carbon dioxide, respectively could range from less than 40 billion per year up to 180 billion per year; less than 10 billion per year up to 80 billion per year, and close to zero and up to 40 billion per year.

⁴ Climate and the prevention of climate change can be viewed as global public goods

⁵ This paper acknowledges that the UNFCCC is the international body responsible for negotiating any regulatory framework. This is a technical paper, which can be used as an input to the negotiations.

probability of more extreme weather events, there is an urgent need to upscale emergency response mechanisms.

17. *The incremental annual costs to adapt to projected climate change are likely to lie in the \$10 billion to \$40 billion per year range*, of which about a third is associated with public finance. Most of the initial funding will come from the public sector including ODA, but it needs to be integrated in countries development planning and private investment plans. The challenge remains to identify genuine incremental costs of adaptation and to find financial mechanisms to channel additional resources to activities that effectively reduce climate vulnerabilities.

C. Financing Options

18. *New financing instrument options.* Even with an improved regulatory environment and the use of policy and political risk mitigation instruments, the challenge of financing incremental costs and reducing technology risks will be significant. These issues could be addressed by means of innovative financial instruments, which could complement existing World Bank Group and IFI instruments, among which the following hold promise:

- *Clean Energy Financing Vehicle (CEFV)* could provide a mechanism to transfer high efficiency technology to mitigate climate change. This financing vehicle could blend grants and carbon finance to provide funds to collateralize clean energy technologies. It could (i) buy down the costs of new technologies and energy infrastructure; and (ii) mitigate technology risks.
- *Power rehabilitation financing facility.* This mechanism could enable developing countries to rehabilitate inefficient plants without loss of power, with repayment provided from the increased efficiency and capacity of rehabilitated plants as well as any resulting carbon emissions reductions.
- *Project development fund.* Consultations with the private sector indicated a dearth of “Bankable” projects. Funds with public and private sector participation could be considered for project development.
- *Venture capital funds for technology adoption.* The private sector’s suggestion to introduce dedicated venture capital funding to provide financing for promising new and clean energy technologies and to assist their penetration in the marketplace is also worth analyzing.

D. Next Steps

19. Pending advice from the Development Committee, follow-up work, which would be carried out in collaboration with the other IFI’s, governments, finance and energy sectors, export credit agencies, and civil society, and include outreach and communications, would proceed on two parallel tracks, which involves country dialogues, financing analysis, and detailed research on adaptation.

- ***First track—activities to be completed by September 2006.*** The purpose would be to develop a more detailed proposal for financing facilities, for discussion at the World Bank Annual Meetings in September 2006. These would include: (1) analyzing the strengths, weaknesses, complementarity's, and utilization of existing World Bank Group and other IFI instruments to address clean energy for development, mitigation of greenhouse gas emissions, and adaptation to climate change; (2) completing the design or pre-feasibility studies for the proposed new financing instruments; (3) updating and refining, jointly with the IEA and others, alternative energy scenarios and financing needs; and (4) seeking alignment of different partnerships.
- ***Second track—activities to be developed over the next two years.*** The purpose would be to generate (1) new knowledge on technology options, and evaluate the environmental, social (including gender) and economic impact of climate change, and (2) proposed programs of action for selected countries including, as relevant, assessing and addressing any transitional costs.
- ***Outreach Program – over the next two years.*** The goal is to facilitate a dialogue and broad engagement among stakeholders, using existing multi-stakeholder platforms and partnerships. The outreach program will engage a variety of constituencies, including the business community, civil society, and legislators.

E. Questions for the Development Committee

20. Does the Development Committee Endorse:

- the importance of the three issues discussed in the paper to the Bank's mission of poverty alleviation, i.e., clean energy for development; the development of a low carbon economy; and adaptation to climate change?
- the balance in the paper among the three issues?
- the proposed two-track work program described in section D (Next Steps)?

CLEAN ENERGY AND DEVELOPMENT: TOWARDS AN INVESTMENT FRAMEWORK

BACKGROUND

1. ***The Purpose of this Paper is Twofold.*** First, to articulate the issues underlying the development of an Investment Framework for Clean Energy and Development in the context of the Gleneagles Communiqué on Climate Change, Clean Energy and Sustainable Development (July 2005); second, to outline the key elements of an associated strategic work program. The paper has been prepared for discussion at the Spring 2006 meetings of the Development Committee, preceded by consideration by the Bank Board's Committee of the Whole on March 30, 2006.
2. ***The Development Committee Communiqué requested this report on September, 2005,*** stating that they “welcomed efforts to follow up on the Gleneagles plan of action with early consultations to identify pragmatic investment and financing policy actions that can help further the goals of the United Nations Framework Convention on Climate Change. We look forward to a report for our next meeting on progress made in developing dialogue with partner countries and institutions and a future investment framework.”
3. ***An Investment Framework for Clean Energy and Development is intended to be a vehicle to accelerate investment*** so that developing countries can meet energy demands for growth and poverty alleviation in an environmentally sustainable way. The G8 invited the “G+5” countries (Brazil, China, India, Mexico and South Africa) to participate in the Gleneagles Summit to exchange views on this issue, and agreed on a Gleneagles Plan of Action on Climate Change, Clean Energy and Sustainable Development. This Plan of Action contains a wide range of specific commitments, including the G8 request to the International Energy Agency (IEA) and the World Bank to develop work programs and to collaborate with other IFIs in the design and implementation the Investment Framework.
4. ***Developing the Investment Framework is proceeding in two concurrent phases,*** each including a process of analysis, consultations, and consensus building with Governments, Regional Banks and other IFIs, the private sector, and civil society organizations. The first phase, which will be completed by the World Bank Annual Meetings in September 2006, will complement this paper by analyzing the strengths, weaknesses, complementarity's and utilization of existing World Bank Group and other IFI instruments to address clean energy for development, mitigation of greenhouse gas emissions, and adaptation to climate change and providing more detailed proposals for the financing facilities outlined in this paper. The second phase, which will have a two year time horizon, will comprise country analytical and program support and global level research, with particular emphasis on adaptation.
5. ***The structure of the Investment Framework.*** This paper takes a global perspective and is not Bank-centric. The framework consists of three elements. The ***first*** addresses the major challenge of meeting clean energy needs with no carbon constraints for all developing countries; the ***second*** addresses the issue of what additional actions would be needed to realize a low-

carbon economy and reduce greenhouse gas emissions; and the *third* addresses actions needed to adapt to climate change. The paper is written in three sections: Section I addresses both the challenge of securing clean energy for development with no carbon constraints, and then the additional challenge of realizing a low-carbon economy. Section II addresses the challenges of adapting to climate change. Section III outlines next steps. Both sections I and II discuss the challenges, the technology and policy options, strategies and sequencing of activities, scale of investment needs and sources of finance, and is accompanied by technical annexes presenting supporting information as well as results of consultations with the G+5 countries, other International Financial Institutions (IFIs),¹ and the private sector.

¹ While the World Bank has consulted with the IFIs and gained from their insights and expertise through a short comment period, this paper is primarily a product of the World Bank.

I. CLEAN ENERGY AND A LOW CARBON ECONOMY

A. The Challenge

6. *The global community today is working toward a potential “double dividend.* This means meeting the needs that are essential for economic growth and fighting poverty, while at the same time leaving a smaller environmental footprint. Strategies to support clean energy and a low carbon economy are essential to fulfill this promise.

7. **Developing countries and industrializing economies face major energy sector challenges:**

- ***Improving Energy Services for Economic Growth.*** Developing countries must accelerate access to affordable and reliable energy services to increase productivity, enhance competitiveness, and thus improve their growth prospects. At present, high costs and unreliable energy service, especially in the electricity sector, constrain economic activity in many developing countries. The poor performance of energy sectors generally is manifested by poor resource utilization, low asset yields, and commercial and technical inefficiency with high technical and financial losses.
- ***Providing Energy Services for A Better Quality of Life.*** Worldwide, nearly 2.4 billion people use traditional biomass fuels—wood, agricultural residues, and dung—for cooking and heating, and nearly 1.6 billion do not have access to electricity. Four out of five people without access to electricity live in rural areas. On a per capita basis, poor countries consume only five percent of the modern energy services consumed by OECD countries. Without access to modern and sustainable energy services, poor people are deprived of opportunities for economic development and improved living standards. This is because modern energy services provide lighting, cooking, heating, refrigeration, transportation, motive power, and electronic communication that are indispensable to increasing productivity, creating enterprises, employment, and incomes.
- ***Reducing local and regional pollution from energy production and use.*** Low grade fuels and poor environmental controls in households, power generation, transport, and industry are leading sources of severe urban air pollution in the fast-growing cities of developing countries. Levels of suspended particulates and sulfur dioxide are highest in areas where extensive coal burning occurs. The people that rely on traditional biomass fuels for cooking and heating suffer from indoor air pollution, which is the fourth leading cause of illness and death in these countries, with women and children disproportionately at risk. Indeed, more than 80 percent of all deaths in developing countries attributable to air pollution-induced lung infections are among children under five.¹

¹ Indoor air pollution is estimated to cause the death of 2 million people a year, primarily young children and women, accounting for about 4 percent of the global burden of disease. Urban air pollution, primarily transport-related, is responsible for upwards of 800,000 deaths globally each year.

- ***Strengthening energy security for macroeconomic stability.*** The energy sector is sometimes a source of macroeconomic problems in developing countries, for both energy importers and exporters. Subsidies for energy producers and consumers can become a large drain on the government budgets. In some countries, government borrowing and contingent liabilities for energy infrastructure are sources of fiscal instability. High and volatile oil prices are especially damaging to poor importing countries through their link to balance of payments, gross domestic product and per capita incomes. A sustained price increase of US\$10 per barrel would deliver an economic shock equivalent to a 1.47 percent loss of GDP for the poorest countries (those with GDP per capita of less than US\$300).

8. ***The demand for primary energy will increase significantly between now and 2050, especially in developing countries.***² The Intergovernmental Panel on Climate Change (IPCC) estimated that the demand for primary energy in developing countries and transition economies could increase by a factor of three to five by 2050. During this time period, all scenarios suggest that the main sources of primary energy will remain a combination of coal, oil, and gas, ranging from 60-80 percent in 2050. By 2050, the approximate distribution of projected demand for primary energy among developing countries and transition economy countries compared to developed countries will be about 80 percent to 20 percent, compared to about 53 percent and 47 percent in 2000. However, the per-capita use of energy will still be highest in developed countries.

9. ***Climate change presents an urgent and additional challenge.*** To reduce the threat of human-induced climate change will require a significant reduction in the emissions of greenhouse gases³ (GHGs) globally (Annex A). While OECD countries will remain the largest per capita emitters of greenhouse gases, the growth of carbon emissions in the next decades will come primarily from developing countries.⁴

10. ***The IPCC estimated that carbon dioxide emissions would increase by 2050 relative to 2000, globally by a factor of 1.6 to 3.5,*** and in developing countries by a factor of 2.3 to 5.2 in the absence of policies to address climate change and a transition to a low-carbon economy. Developing countries are currently following a carbon intensive development path, similar to the one followed by their developed country counterparts. And among the developing countries, the

² The IPCC estimated that the demand for primary energy globally, relative to 2000, will increase by a factor of 1.7-2.1 by 2030 and by a factor of 2.1-3.3 by 2050, and in developing countries and transition economies by a factor of 2.2-2.9 by 2030 and a factor of 3.0-5.0 by 2050. During this time period, all scenarios suggest that the main sources of primary energy will remain a combination of coal, oil and gas, ranging from 75-85 percent in 2030, and 60-80 percent in 2050.

³ The major greenhouse gases include carbon dioxide, methane, nitrous oxide and halogenated gases, e.g., HFC 23. Carbon dioxide is the single most important anthropogenic greenhouse gas: About 80 percent is produced from the combustion of fossil fuels, and about 20 percent from land-use changes, primarily from tropical deforestation. The major sources of anthropogenic methane arise from rice production, livestock, gas pipelines, coal mines and landfills. The major sources of nitrous oxide arise from combustion and agricultural practices. HFC-23 is an industrial process by-product.

⁴ Total aggregate energy emissions from non Economies in Transition (EIT) Annex I parties have increased by 9.2 percent (UNFCCC) between 1990 and 2003; CO₂ energy emissions in the EC increased by 3 percent, in the US by 17 percent, in Australia by 32 percent, in Canada by 27 percent and in Japan by 12 percent. (UNFCCC data). The G+5 emissions grew even faster.

highest carbon emissions will emanate from a few countries, particularly China and India because of their size and growth. Between 2020 and 2030 developing country emissions of carbon dioxide will exceed those of developed countries in aggregate but will still lag far behind on a per capita basis.

11. ***The way that energy and environmental challenges are addressed in the next two decades will, to a large degree, determine sustainable growth, environmental quality, and national security.*** Transformational policies and strategies will be needed to meet national expectations of secure, safe, and clean energy and to deal with the implications of climate change. The energy sector accounts for about 80 percent of GHGs and the agricultural sector for most of the remaining 20 percent. The widespread commercialization of energy efficiency technologies is an effective strategy to both reduce local and regional air pollutants and address climate change without affecting economic growth as well as addressing energy security concerns. Although energy intensities are declining due to structural changes and technological effects, much remains to be done in transforming energy efficiency markets. Decisions taken today on technologies and policy will have profound consequences on development paths for 40 to 60 years.⁵ Unfortunately, carbon intensive energy infrastructure and inefficient cities are being rapidly built and expanded, setting the capital stock for decades while new, cleaner, and more efficient technologies remain underutilized. In addition to the need to transform the energy sector, there needs to be a transformation in land management, with policies, practices, and technologies that decrease net emissions of greenhouse gases.

12. ***Developing countries, and poor people within developing countries, are the most vulnerable to climate change, which threatens to undermine their development.*** The Earth's climate is already changing because of human activities, primarily the combustion of fossil fuels, deforestation, and other land management practices and is projected to continue to change in the coming decades. The Earth has already warmed by about 0.7°C over the last 100 years and is projected to warm another 1.4-5.8°C during the next 100 years (IPCC, 2001) without internationally agreed policies to address climate change. The result will be warmer temperatures, more variable precipitation, and an increased incidence of extreme climatic events. When coupled with sea level rise, this will adversely impact agriculture, water resources, human settlements, human health, and ecological systems and will undermine economic development and the ability to achieve many of the Millennium Development Goals (MDGs). Section II of this paper on Adaptation outlines a work program on how to respond to this challenge.

13. ***It will be essential to ensure that the challenges of low carbon economy are dealt with without transitional costs imposed on the poor.*** While in the long run many of the changes suggested here will have strong macroeconomic benefits, in the short run, some may imply transitional costs as technology is being adapted and as price signals lead to structural changes. Any such cost should be absorbed as part of the total adjustment costs to be financed from global financing sources.

⁵ Unless new more efficient power plants are installed now, especially in the fast growing G+5, the path of higher carbon emissions from the power sector will be locked in for 40-60 years.

Box 1. G+5 Country Consultations – Clean Energy (Annex B)

Country consultations¹ with the G+5 clearly underscored the magnitude of the needs, opportunities, and limits of current assistance mechanisms for addressing energy supply security and access to modern energy services, as well as climate change mitigation. Increased energy supply security and access to modern energy services, especially for the rural poor, were identified as the primary energy sector concerns. Countries also recognized the importance of climate change management and of lowering the carbon intensity of growth to help stabilize atmospheric concentrations of greenhouse gases. They welcomed a dialogue with the Bank on how these domestic policy and shared global environment objectives could converge in complementary policies and plans at the national level. Understanding the energy and emissions profiles of alternative patterns of urban and industrial development were among the themes identified for additional targeted analytical work.

The country consultations identified a substantial diagnostic and analytical work program covering a broad spectrum of issues identified as priorities by the individual countries, including country-specific clean energy, energy security, and low carbon development pathways, technology options, and financing needs:

- **Brazil:** Scaling-up renewable energy development through expanded hydro and bioenergy; improvement of urban and industrial energy efficiency; natural gas development; and implementation of the forested areas strategy.
- **China:** Meeting energy needs while reducing environmental impacts; energy security and diversification; improved energy efficiency in the coal, industrial, and transport sector and built environment; energy sector market reforms; accelerated deployment leading efficient coal power technology; policy support for renewable energy targets.
- **India:** Strategies for long-term energy security (including gas and oil sector issues) and low carbon growth; industrial and transport energy efficiency; transmission and distribution loss reduction; coal-fired power rehabilitation; and large hydro power and natural gas sector development.
- **Mexico:** Energy diversification; energy efficiency improvement in buildings and industry; sustainable transport development; and scaling up low-carbon options including expanding renewable energy and industrial and refinery efficiency (such as cogeneration).
- **South Africa:** Energy efficiency improvements in the industrial, commercial and residential sectors and in coal power generation; renewable energy development and scaling up including hydro power development and expanding bioenergy; and carbon capture and storage best practices.

The Bank is further actively assisting all G+5 countries with CF capacity building and scaling up the CF/CDM operations

Work on related planned and new investment operations has also been reinforced and accelerated. In some countries, the Bank has already been supporting analytical work and preparing lending activities that are consistent with strengthening and modernizing their energy sectors. These programs also focus on low carbon development in energy supply and, where this is the case, there exists a baseline for expanded efforts consistent with the emerging long-term climate change management agenda. Country-specific consultation summaries and highlights of the emerging G+5 work program, which comprises an important part of the implementation of the Investment Framework initiative, are presented in Annex B.

¹ The first wave of consultations focused on the G+5 countries which include the largest developing countries and those with high rates of energy growth. Over the next months, these consultations will be broadened to include a much wider spectrum of countries, especially those particularly vulnerable to climate change.

B. Strategies for a Clean Energy Future

14. This section sets out the broad set of technologies, policies and measures needed to achieve clean energy for development and then a low-carbon economy. It presents a business-as-usual scenario and then the IEA reference scenario, which is a clean energy scenario without

carbon constraints. It then reviews the range of technologies currently available, or soon to be available, which can be used to produce clean energy and realize a low carbon economy, and concludes by describing a strategy to meet the challenge of clean energy (a mix of technologies and policies), and then the additional measures that would have to be taken to realize a low-carbon economy.

15. *The energy needs of the world and their impacts on carbon emissions were analyzed in terms of the following scenarios:*

- *Business-as-usual scenario* which assumes little change in the way that governments structure and regulate their energy markets from the current policies. A continuation of the low level of investment in energy supply and use in developing countries and transition economies relative to their needs would continue. This scenario therefore anticipates a continuation of the highly sub-standard technical efficiencies in the production, transportation, transformation, and use of energy among these countries. It also anticipates a major increase in pollution and carbon emissions under an expansion of fossil fuel technologies for energy production and use. Basically, this scenario is highly sub-optimal in economic, social and environmental terms.
- *The IEA reference scenario* is a non-carbon constrained scenario, which takes into account government policies and measures currently enacted and adopted—including those for the environment. Under this scenario, energy investment needs are implemented in accordance with these policies, with major gains in technical efficiency over time, but to varying degrees around the world as energy sectors and policy implementation are reformed more rapidly in some countries than in others. This scenario produces outcomes that are broadly positive in economic and social terms as well as local and regional environmental terms, but it imposes heavy financing requirements that require much greater policy reforms than achieved in most of these countries to date.⁶ The projected level of global carbon emissions from energy production and use in 2030 is about 60 percent higher than the current level.⁷

⁶ The “reference scenario” refers to the IEA base case scenario for energy demand from their 2004 “World Energy Outlook” in which investments are increased to meet demand while fully meeting existing environmental standards. The Bank is working with IEA on their update of this assessment during 2006. The 2004 reference scenario is based on the following assumptions: (a) the share of the world’s population relying on biomass for cooking and heating would decline in most developing regions under this scenario, but the total number of people would rise by about 10 percent, especially in Sub-Saharan Africa and South Asia; (b) 1.4 billion people would still lack electricity in 2030—although it appears a small reduction from the estimated 1.6 billion that currently lack electricity, it includes a substantial reduction when one considers the impact of population growth by 2030 while eliminating the access problem would require an additional \$20 billion per year; (c) crude oil prices were based on projections at that time of around \$21/bbl (in year 2000 dollars) until 2010, rising steadily to \$29/bbl by 2030 with natural gas prices moving in line with oil prices, whilst coal prices were projected to rise very slowly; (d) economic growth is projected to be about 3.7 percent per year, whilst primary energy consumption is projected to increase at 2.5 percent per year; (e) carbon dioxide emissions from all energy uses in developing countries and transition economies would increase by about 112 percent.

⁷ The IEA scenario until 2030 is similar to the IPCC A1T, B1 and B2 scenarios, which also project a 60 percent increase in carbon dioxide emissions between 2000 and 2030.

16. *Countries should move quickly from the business-as-usual scenario towards the reference scenario to support their economic growth and social development, as well as to reduce local pollution from energy supply and use.* Any delays in moving from the business-as-usual scenario to the reference scenario compound future problems. Financial problems would persist, leading to continued neglect in the maintenance of the existing capital stock. Technology options would be limited by lack of funds pushing decisions towards lower capital cost, higher operating cost options, thus perpetuating a legacy of inefficient systems with high emissions for decades to come.

17. *An extensive array of policies and technologies currently exist for energy supply and demand to enhance access to energy (Box 2), improve energy security, and promote environmental protection at the local, regional, and global level.* The sort of policies needed include:

- removal of broad-based subsidies, currently estimated to exceed \$250 billion per year, for all energy products to reflect the true cost of energy supply (see Box 3), while targeting subsidies to the poor who may need income support;
- establishment of a credible legal and regulatory framework that provides the stability on rules and prices that will induce investments into financially viable products;
- development of enabling policy environments through regulatory interventions such as appliance energy efficiency standards and labeling policies, mandated utility demand side management programs, mandatory energy audits, industrial energy efficiency norms, market access for clean energy generators, etc.;
- creation of market-based approaches such as emissions trading, energy service companies, risk mitigation instruments, energy performance contracts, credit guarantees, innovative clean energy and energy efficiency funds, etc.
- reduction of transaction costs at the supply and retail level; and
- information dissemination regarding energy savings and clean energy options.

Box 2. The World Bank Program on Energy Access and Poverty

The World Bank has been at the forefront of international support on energy access and poverty since the 1996 publication of its rural energy strategy. While major progress has been made, big gaps remain particularly in rural areas of Africa and South Asia. The Bank's program on energy access and poverty lies on three pillars. First, **direct lending for provision of energy services** and modern fuels to unserved households and enterprises, specifically through: (i) grid extension programs; (ii) off-grid renewable solutions; (iii) improved fuels for cooking; (iv) parallel support for productive uses of energy; and (v) innovative financing mechanisms such as Output-Based Aid approaches. Second, **lending that indirectly** supports energy access such as programs and policy reforms that focus on the overall energy sector and its institutions. The World Bank support in this area ranges from traditional energy generation and transmission projects that provide the basic infrastructure necessary to provide grid extension to the poor; to the upstream policy support to make institutions more responsive to the needs of the poor, including effective and targeted subsidies. Third, **analytical work on energy access and poverty**. In this third pillar of action, the World Bank continues to strengthen its knowledge in the area of energy access and poverty, to support the analytical work of client countries in this topic, and to participate and enhance partnerships devoted to the linkages between energy and poverty.

Box 3. Subsidies

Global subsidies to the power sector have been estimated to exceed \$200 billion per year prior to the increase in energy prices since 2003. In many countries subsidies are broad-based, rather than targeting the poor who may need the income support. As a result, price signals for energy use induce sub-optimal decisions regarding technology, further exacerbating the problem. Low consumer prices also undermine the financial viability of power companies, leading to high loss levels in their networks (typically in the 20-40 percent range compared to about 7 percent in OECD countries), poor maintenance of existing assets, and compromises in technology selections for new investments. In general, low capital cost generation options tend to be more polluting than high capital cost options, further deteriorating the local, regional, and global environment.

18. *A broad portfolio of technologies that support these policies will be required to address the challenge of clean energy and a low carbon economy in both developed and developing countries.* A wide range of energy production, supply, and end-use technologies are currently available to provide the clean energy needed for development as well as to achieve a low-carbon economy. (See Box 4).

1. Clean Energy for Economic Growth and Sustainable Development

19. *An approach is needed where the highest priorities are addressed first based on a set of screening criteria, with a particular emphasis on low-cost, high impact solutions.* The criteria for prioritizing investments included: (a) cost-effectiveness; (b) consistency with national sustainable development goals; and (c) obtaining multiple benefits, e.g., reduction in local and regional air pollution. The approach can be divided into three elements, which need to be addressed simultaneously:

- The first element is where investments and expenditures can be made in a “no regrets” format—that is, where clean energy investments are financially attractive under sound, commercially viable policies, e.g., in improving the efficiency in the use of energy as well as renovation and modernization of existing energy generation and some forms of renewable energy, especially off-grid;
- The second element would address promising new technologies that are not financially viable, but could be supported through taxes and subsidies that internalize the environmental costs of local and regional pollution; and
- The third element, a research and development program for promising new technologies that could yield commercially viable results within 10 to 25 years.

20. *As part of the longer term country specific adjustments needed to achieve clean energy, it is very likely that changes in energy (and transport) fiscal and regulatory policies will have to take place as well.* Many of these changes will result in major changes in relative sectoral prices and hence in economic structures. This could have fiscal impacts across government levels since the gains and losses from changes in subsidies and taxes will not necessarily be distributed evenly across government levels. Finally, these policy changes could also influence the functioning of power and energy markets. To make sure that these changes do not interfere with the expected growth and environmental payoffs of cleaner energy, additional research will have to be conducted for the main countries in which these changes are likely to be needed.

Box 4. Energy Production, Supply and End-Use Technologies

Energy production and supply technologies:

- New thermal power plants based on combined cycle, supercritical boilers, Integrated Gasification Combined Cycle (IGCC), etc, can have efficiencies that are significantly higher than the average fossil-fuel power plant efficiencies in the range of 30 percent in developing countries. The additional challenge of addressing climate change is to move to higher efficiency coal technologies, i.e., IGCC, with carbon capture and storage (CCS).¹ (Tables 1, 2 and 3, Annex C).
- Introduction of loss reduction in transmission and, more importantly, distribution systems through the better use of efficient transformers, improved metering, and higher voltage lines (Table 4, Annex C).
- Natural gas⁸ as a bridging fuel in the transition period until renewable energy technologies become commercially viable will provide clean and relatively low-carbon energy production.²
- Modern bio-energy can supplement the energy supply mix in both OECD and developing countries (Table 5, Annex C).
- New renewable energy (solar, wind, hydro, biomass, and geothermal sources) currently contribute only about 2 percent of total primary commercial energy, excluding traditional use of biomass for cooking and heating. They contributed 880 GW for power production including large-scale hydro (720GW) in 2004. (Table 5 and 6, Annex C). Aggressive policies to support low carbon energy technologies are needed for new renewable technologies share of commercial energy to rise significantly by 2030.
- Nuclear fission is an option supported by some countries, but shied away from others because of safety and long-term storage concerns as well as opposition from civil society (Table 7, Annex C).

End-use efficiency technologies (Annex D):

Improving end-use energy efficiency offers the greatest opportunity to address energy security, price, and environmental concerns. Non-pricing as well as pricing bottlenecks such as transaction costs, information availability and institutional constraints must be addressed. Efforts to capture such opportunities would be assigned the highest priority, as it enables meaningful near-term, as well as long-term solutions by focusing on such opportunities as:

- Transportation: Efficient gasoline/diesel engines, urban planning, urban mass transport systems, modal shifts to inter- and intra-city rail, and water transport;
- Buildings: Insulation, advanced windows, new lighting technology, efficient space cooling and heating, water heating, refrigeration and other appliances;
- Industry: Co-generation, waste heat recovery, pre-heating, new efficient process technologies, efficient motors/drives, and improved control systems.
- Municipalities/Urban Local Bodies: District heating systems, combined heat and power, efficient street lighting, efficient water pumping and sewage systems; and
- Agricultural: Efficient irrigation pumps.

¹ IGCC or Integrated Gasification Combined Cycle is not a commercially proven technology with only pilot plants in operation, as is Carbon Capture and Storage (CCS). An initial estimate suggests that the incremental cost of CCS coupled with IGCC would be equivalent to about \$35 per ton of carbon dioxide avoided but these costs should come down over time as the technologies mature and the size of the market increases (see Annex C, Tables 1, 2, and 3).

² This can be obtained through a number of policies: (i) increased gas utilization in countries with gas resources or major energy import requirements; (ii) promote international gas trade; (iii) increased access to gas, primarily for poor and middle income households in urban and semi-urban areas; (iv) development of competitive gas markets. In China and India, natural gas provides only 3 percent and 8 percent, respectively, of the energy supply and should be increased.

⁸ It is estimated that around 150 billion cubic meters of gas is flared annually (2004). This is more than the annual combined gas consumption in Germany and France. The Global Gas Flaring Reduction Partnership (GGFR) supports national governments and the petroleum industry in their efforts to progressively reduce flaring and venting of gas associated with the extraction of crude oil. Launched at the World Summit on Sustainable Development in August 2002, the GGFR public-private partnership brings around the table representatives of governments of oil-producing countries, state-owned companies and major international oil companies so that they can together overcome the barriers to reducing gas flaring and venting.

2. No-regrets Investments

21. *The first element is applying existing technologies or approaches that are viable financially and yield ancillary benefits.* These technologies have not been adopted on a wide scale so far because of poor pricing policies and an incomplete legal and regulatory reform agenda. The failure to reform the energy sector limits access to finance which, when coupled with a lack of concrete information on appropriate technologies/applications and their benefits, technical or financial risk perceptions, lack of suitable planning and assessment tools, inadequate supply and support infrastructure all help sustain the supply-demand gap in developing countries. Technical options include equipment to improve operations of existing coal or other thermal power generation, improvements in hydropower plant efficiency, insulation of buildings, district heating and a variety of existing technologies to improve efficiency of energy use (e.g., in the transport sector: Box 5), and some forms of renewable energy. More country specific energy sector work and policy analysis are needed to identify these barriers and recommend policy, financial and other solutions. Moreover, because of the uncertainty in energy prices, the rate of return on investments in energy efficiency must be substantially higher than for other lower-risk commercial deals. Hence the reluctance of many industries and commercial bodies to adopt what would appear at first to be viable technological improvements.⁹ Policy options include equitable ways of removing fossil fuel or electricity subsidies, mandating fuel efficiency standards, among others. Tables 4 and 6 of Annex C give examples of no-regrets options that range from industrial and commercial energy management systems to fuel efficient vehicles, highlighting the barriers to their implementation as well as priority research issues.¹⁰

Box 5: The Transport Sector

Energy consumption in the transportation sector is increasing rapidly in many parts of the world, especially in Asia. In this respect China's energy use for transportation is projected to grow by an average of 6.0 percent per year and in India, energy demand in the transportation sector is projected to grow at an average rate of 4.7 percent a year over the next 20 year period. The ten countries in the world with the highest private-vehicle future demand index are in Asia.

Incorporation of the more advanced vehicle, engine and fuel technologies, albeit with important implementation lags in many countries, would allow this projected growth to occur without a proportional increase in local and regional emissions. However, policies need to be applied to reduce these lags, and to control gross polluters before notable air quality improvements can be achieved, particularly in the large, and high growth, metropolitan areas. Stabilization in real terms of GHG emissions from the transport sector will require widespread enactment of vehicle fuel economy regulations following China's and EU's lead and fuel switching from gasoline towards diesel and alternative fuels.

Increasing Energy Efficiency in the road-transportation sector is crucial to limit GHG emissions growth. This will require a combination of technical measures that target individual vehicles together with regulatory, policy, and institutional sector development of the transport system as a whole. Long term policy changes in urban development and transport demand, including modal shift to mass and non-motorized transport.

⁹ This result is well known in the economic literature even when there is not risk aversion. Essentially the net present value of an investment must not only yield a net expected benefit but must overcome the loss of the option to wait for more information on prices. Energy prices being highly variable and uncertain in some markets increases the value of the option to wait.

¹⁰ The investment cost of these energy efficient options range from 10 to 50 percent more than conventional designs. The financial viability of these improvements in energy efficiency depends on the cost of the underlying fuel. Some investments may require removing fuel price subsidies, others may require access to longer term financing, while some may need policy or regulatory changes or access to better information to become commercially viable. However, rising energy prices and competitive tariffs, energy efficiency, new generation technologies, and better energy management practices will increasingly enter the set of viable options.

3. New technologies

22. ***The second element involves technologies though economically viable, are not yet financially viable.*** Many of these technologies are not being adopted for good commercial reasons, e.g., the external costs, such as damage cost of local or regional pollution, have not been reflected in markets or taxes and subsidies, or externality benefits are not being captured. In this case appropriate policy frameworks are essential. Even nuclear power may belong in this category when insurance costs need to be subsidized or liability limited by government. Tables 5, 6, and 7 in Annex C provide an overview of some of these technologies along with their research priorities and issues. Wide-spread adoption of supercritical coal technologies would substantially improve energy efficiency in developing countries which are using inefficient sub-critical power plants. Nevertheless, it is likely that the coal industry will require incentives or regulations (e.g., constraints on carbon emissions) to routinely build the 45-48 percent efficient ultra-super critical or integrated gasification combined cycle (IGCC) plants instead of conventional coal-fired power plants with 35-37 percent efficiency,¹¹ unless the prices of IGCC plants and their reliability improve significantly (Tables 1 and 3 in Annex C). Consultations with the private sector indicate a need for the introduction of dedicated venture capital funding to provide financing for promising new and clean energy technologies as there is often a gap between the development of new technologies and their adoption and penetration in the marketplace (discussed later).

4. Research and Development

23. ***The third element is advanced technologies that offer promise in the longer term but face many formidable barriers to implementation.*** Only with accelerated research, development and demonstration (RD&D) will new technologies move into the realm of commercial viability and adoption. However, at present there are limited shared objectives of coordinated technology development for a clean energy future. The level of investments in research and development in energy technologies in both the public and private sector is less in real terms than historically and is in general poorly coordinated within OECD, or between OECD and the advanced developing countries. Promising technologies range from relatively near-term options such as fuel cells, to carbon capture and storage¹², to hydrogen as an energy carrier¹³ to nuclear fusion¹⁴, as well as end-use efficiency options. Policies and incentives as well as associated financing, are necessary to support RD&D on efficient and clean energy technologies and encourage their accelerated deployment. Policies are needed to encourage private sector energy RD&D funding to focus on longer-term initiatives rather than meeting near term commercial goals. Increased levels of OECD public sector support for energy RD&D¹⁵ that are predictable and long-term will be

¹¹ These technologies could play an important role in the clean energy agenda if the prices come down over the decade, and will be vital, especially IGCC, for transitioning to a low-carbon economy

¹² The European Union (EU) and 13 countries have joined forces to further develop carbon capture and storage technologies

¹³ The International Partnership for the Hydrogen Economy was established in 2003, by 13 countries, as an international institution to accelerate the development of hydrogen and fuel cell technologies.

¹⁴ With the building of ITER (a multilateral cooperation between all nations involved in fusion research), fusion research and development is now moving from European integration to cooperation at the world level.

¹⁵ OECD Factbook 2005: Economic, Environmental and Social Statistics report that IEA countries energy R&D declined from about \$17 billion in 1980 to about \$9 billion in 2001 (in constant 2003 prices and exchange rates) - a real rate of decline of 3 percent per annum.

needed to overcome the technical challenges to bring promising advanced clean energy technology to the stage of commercial deployment. Furthermore, RD&D support should be broad-based as solutions could arise from any number of diverse alternatives. Country consultations with the G+5 point to the need to accelerate North-South transfer of advanced and low-carbon energy technologies, such as clean coal for China and India. They also want support to their own clean technology development efforts, such as bio-ethanol and biomass cogeneration (Box 6) and energy-efficient vehicles, offering potential for South-South and South-North technology transfer. Facilitation of such transfers of technology will require that attention be paid to institutional capacity building in client countries within Governments, academic institutions and private companies. Mechanisms for large scale transfer of technology, where markets are potentially large, should be facilitated through cooperation with equipment suppliers to decrease costs, while respecting intellectual property rights.

Box 6. Bioenergy

Modern bioenergy can reduce the carbon intensity of development and play a much larger role in supplementing the energy supply mix in both OECD and developing countries. Traditional biomass—wood, straw, dung—burned in inefficient stoves still provides the majority of household energy needs in developing countries, and the resulting air pollution remains one of the largest health burdens for the rural poor, especially among women and children. Modern biomass, including the use of municipal and industrial organic wastes, agricultural residues, and energy crops such as ethanol from sugarcane and fuelwood from dedicated short-rotation plantations, can provide a clean and secure source of energy and significantly lower the carbon intensity of energy consumption. Through fuel use, recycling, and composting of municipal organic wastes, methane emissions (with a high global warming potential) can also be avoided and provide Clean Development Mechanism (CDM) revenues to developing countries.

Liquid biofuels made from biomass are attracting increasing interest worldwide. Industrial countries see biofuels as a way of reducing GHG emissions from the transport sector, while developing countries see biofuels as a way to stimulate rural development, create jobs, and save foreign exchange. Recent surges in the world oil price have prompted a wide range of countries to consider biofuels programs. In the near term, ethanol from sugarcane is likely to offer the best chance of commercial viability, but even here the economic feasibility is highly dependent upon the price of sugar and oil¹⁶. Other feedstocks for producing ethanol increase the cost of production markedly and are unlikely to be financially viable without government support. Biodiesel remains expensive even against the backdrop of rising world oil prices, thus raising similar concerns over financial viability in the near term.

Brazil has shown that integrated production of ethanol from sugarcane has lowered its dependence on fossil fuels—ethanol currently accounts for more than 40 percent of the market—reduced GHG emissions, and benefited the rural economy. Through the active involvement of both the government and the private sector, Brazil has become the lowest-cost sugar and ethanol producer in the world. However, exports of biofuels are currently at a competitive disadvantage due to high import taxes compared to oil products. Other countries could potentially gain through technology transfer from the investments Brazil has made in this area.

24. *To provide the knowledge base for securing energy for economic growth and a low carbon world it is recommended that a global technology assessment be undertaken.* For this paper a preliminary assessment was made (Annex C) to better understand the role of existing and future technologies, costs of adoption, means by which costs could be reduced to become competitive, and the policies that would need to be adopted to facilitate the uptake of these

¹⁶ The world price of raw sugar has risen 80 percent in the last 12 months. Sugar sold at \$417 per ton in February 2006. As a result, the price of ethanol in Brazil has risen from \$0.25-0.28 per liter during the first half of 2005 to \$0.35-0.38 in the second half of 2005, and to \$0.58 per liter today (\$92 per barrel of ethanol, or \$115-130 per barrel of gasoline equivalent). In response, the government of Brazil lowered the mandated quantity of ethanol in gasoline from 25 percent to 20 percent.

technologies into the market place. The IEA and other international bodies, e.g., the IPCC and IIASA have already done pioneering work in this regard and there is much to build upon. As in the initial consultations for this investment framework, the private sector needs to be brought into this assessment. A more systematic understanding of the barriers to achieving efficiency gains is needed, especially in high growth countries where the cost of “unserved energy” remains very high. IIASA, with the support of a number of international organizations has recently proposed a “Global Energy Assessment: Confronting the Challenges of Energy for Sustainable Development”.

5. Additional Measures Needed to Reduce Greenhouse Gas Emissions and Achieve a Low Carbon Economy

25. ***Many of the technologies needed to achieve clean energy for development are important first steps in paving the way to address the challenge of reducing greenhouse gas emissions, i.e.,*** the higher the efficiency of thermal power plants, the greater the uptake of renewable energy technologies and nuclear power, and the greater the efficient use of energy in the industrial, buildings and transportation sectors, the lower the emissions of greenhouse gases. However, the mix of technologies that will be used to address clean energy for development in an un-constrained carbon world will not be adequate to significantly reduce greenhouse gas emissions and realize a low-carbon economy. Box 7 discusses some of the potential opportunities and challenges to produce clean energy and reduce greenhouse gas emissions in OECD, Russia, China, and India

26. ***To realize a low carbon economy will take an aggressive program on energy production and end-use efficiency improvements, significant penetration of renewable energy technologies and fuel switching, as well as:***

- ***Reducing the emissions of the more potent greenhouse gases such as HFC-23, nitrous oxide and methane.*** These are low-cost, high impact investments as these gases have a much greater impact per ton of gas than carbon dioxide¹⁷.
- ***Biological sequestration,*** which offers a major instrument to reduce net GHG emissions, while simultaneously helping to protect biodiversity and ecosystem services. Up to 20 percent of all GHG emissions currently arise from activities such as deforestation and land degradation. IPCC estimated that an ensemble of land-use activities, such as afforestation, reforestation, agro-forestry, reducing deforestation, and no- and low-till agriculture, could lead to a net uptake of 1-2 Gigatonne of carbon (GtC) per year over the next 50 years.¹⁸

¹⁷ For example over 100 million tones of carbon dioxide equivalent of HFC-23 can be mitigated through incineration at costs well below \$10 million.

¹⁸ The potential of the agricultural sector to sequester carbon is significant, especially in the forestry sector. Given the focus of this paper on the energy sector, biological sequestration is only mentioned briefly. Sustainable land management provides an opportunity for mitigation and adaptation efforts to converge by reducing emissions while protecting biodiversity and the ecosystem services upon which human livelihoods ultimately depend. Even small payments for improved land management can provide a stimulus in some of the most degraded land and impoverished communities. Expanding payments for ecological services on a much larger scale would have a major impact on rural production and poverty alleviation, and on biodiversity conservation. In this context, making avoided deforestation and improved land management eligible for carbon credits in the post-2012 era an important first step in providing financing for adaptation to climate change, as well as expanding efforts to mitigate climate change in the poorer developing countries.

- **Rapid market penetration of IGCC and carbon capture and storage¹⁹** technologies, given the projected reliance on coal-fired power plants for the next 20-30 years and the fact that these technologies can eliminate most of the emissions of carbon dioxide.

27. **Policy targets for renewable energy that exist in 45 countries today are one example of policies adopted to accelerate the use of energy technologies that do not emit greenhouse gases.**²⁰ The 28 percent annual growth of wind power capacity and the 60 percent annual growth of solar photovoltaic capacity in the past five years can be directly attributed to such policies.

Box 7. OECD, Russia, China, and India

OECD: *Over the next 25 years over a third of the power plants in OECD countries are due to be replaced, including nearly all of the coal-fired plants.* As these plants are replaced, the OECD countries have an important opportunity to change their power generation assets to lower carbon output options. However, to make a significant impact on reducing CO₂ emissions from coal-fired power plants, carbon capture and storage (CCS) would need to be adopted given that CO₂ emissions would be roughly six times less than those from supercritical coal-fired plants.

Russia: The only G8 member not part of the OECD, Russia has significant potential to improve the efficiency of the energy sector, both in the production of energy from coal- and gas-fired power plants and in the end-use sectors, particularly in buildings. Gas flaring and reform of the gas sector offer particular opportunities.

China: *China's rapid economic growth is placing constraints on its ability to produce the clean energy it needs for continued economic growth.* In 2005, China commissioned 66 GW of new power plants, of which 48 GW was coal-fired. Of the 48 GW of new coal-fired power plants, only 4 GW were small (<100MW) units with gross efficiency levels of about 29 percent. China is building larger coal-fired power plants (with efficiency levels of up to over 40 percent) as fast as local manufacturers can deliver them, and is planning to increase the role of hydro and nuclear in its energy mix. However, China has more than 4000 small units (50 MW or less), with a total capacity of about 87 GW, that continue to be operated at very low efficiencies despite government policies to the contrary. Barriers exist to the phasing-out of such plants and the rehabilitation of medium and larger units to improve their efficiencies. The objectives of economic growth and the role of energy are on a collision course with environmental concerns. China is forecast to experience 590,000 premature deaths per year from 2001-2020 due to urban air pollution primarily arising from the transportation and power sectors, nearly 30 times that of market economies. China quadrupled its urban infrastructure in the last 15 years and will double it again in the next 15 years. Rapid urbanization, coupled with increased use of private automobiles, has resulted in high levels of air pollution in many cities with adverse consequences for human health. The future could hold a much different scenario if China undertakes adjusts its energy program to: (i) adopts IGCC technology with carbon capture and storage (ii) rehabilitates the existing inefficient plants; (iii) increases use of natural gas; and (iv) aggressively implements its energy efficiency program. China has already committed to significantly improved fuel-efficiency standards for new cars, which when fully implemented in 2008, will make them as efficient as Japan and more efficient than the United States.

India: *While India is planning to increase the role of hydro, nuclear, and clean-coal technology within its energy mix, a smooth transition to cleaner sources of energy is complicated by severe shortages of power.* Load shedding has put a premium on getting generation plants on line as quickly as possible. This naturally favors an approach of focusing on reliable, conventional coal-fired units. BHEL of India has recently established a license for, super-critical technology so significant uptake of more efficient plants is expected to take place in the near future. However, the poor quality of coal available in India does not lend itself to move to adopting IGCC technology unless there is a breakthrough in R&D. Ultra-supercritical power plants with carbon capture and storage could make an equally significant impact on carbon emissions, but the capital costs of this option come with a high price penalty.

¹⁹ Tables 1 and 2 of Annex C offer a synopsis of the cost and carbon emissions implications and trade-offs for existing technologies. The cost of adding carbon capture and storage (CCS) to IGCC is significantly cheaper than adding it to a super-critical power plant.

²⁰ Policy targets for renewable energy exist in 10 developing countries, all 25 European Union (EU) countries, and many states/provinces in the United States and Canada. Most targets are for shares of electricity production, typically 5–30 percent, by the 2010–2012 timeframe. There is an EU-wide target of 21 percent of electricity production by 2010. China's Renewable Energy Law that became effective on January 1, 2006 sets a target of 15 percent of total power capacity by 2020.

C. Scale of Investment Needs and Sources of Finance

1. Financing Needs for Clean Energy for Development

28. *The IEA reference scenario requires an estimated total investment of \$8.1 trillion, equivalent to \$300 billion per year (in \$2005), from 2003 to 2030 for the developing and transition economies to meet their energy needs*, of which electricity comprises roughly 73 percent (\$210 billion), oil 12 percent, natural gas 12 percent, and coal 3 percent. The scenario is based on current policies for sector development, technical, and environmental standards and construction costs. The annual investment requirements for the power sector grow from about \$160 billion in the current decade to about \$280 billion from 2020 to 2030. The four largest economies (Brazil, China, India, and Russia) would account for nearly 50 percent of the annual investments under this scenario.

29. *Environmental policies and regulations can affect investment requirements.* Policies and regulations can increase energy investments and be technology forcing by requiring or encouraging the installation of technologies that are cleaner and more efficient albeit more capital intensive than other technologies (e.g. flue gas desulphurization to decrease SO_x emissions or scrubbers to remove particulates). Other policies and regulations, e.g., pricing and taxation policies, can indirectly lower the requirement for energy investment by reducing energy demand. Similarly, measures to mitigate greenhouse gas emissions can have an impact on the level and pattern of energy investments in many countries. These policies can significantly affect energy demand and supply, the demand for different fuels and, therefore, investment in energy supply infrastructure as well as investment for end-use energy efficiency improvements.

2. Financing of Investments Required for Clean Energy for Development

30. *Financing for the energy supply sector comes from three sources: internal cash generation, private financing and public funding.* The role of each of these sources has varied based on the state of development of the economy and viability of the sectors. Going forward this pattern of financing is expected to continue with private sector playing a progressively greater role in the reforming economies. Currently less than half of the energy supply-side investments for the developing countries and transition economies comes from internal cash generation. The remaining resource comes from public private sources in a rough proportion two to one. However there is wide divergence in these proportions between the low income, lower middle income, and upper middle income countries with the public sector playing a dominant role in low income countries (about 60 percent of the financing) and lower middle income countries (about 30 percent of the financing) and private sector playing an important role in the upper middle income countries (about 40 percent of the financing). The key challenge in the energy sector is the electricity sub-sector where the current levels of investments only fund about 50 percent of the needs of \$160 billion, i.e., about \$80 billion. With large fiscal constraints in most of the countries requiring the bulk of the investment resources, these investments would come from either internal cash generation or through greater private participation spurred by sector reform and viable tariffs. Any increase in investment levels is expected to be rather unevenly divided over the developing and transition economies and there could be substantial investment shortfalls in a number of countries. While over the short and medium term such shortfalls are expected to continue in most of the developing countries, these could be bridged in

countries which move towards sound commercial policies in the sector and achieve macroeconomic growth and stability (Box 8).

Box 8. World Bank Energy Program

The World Bank Group's four priorities for the energy sector are:

- ***Improve Access of the Poor to Modern Energy Services*** by reducing the cost and improving the quality of energy supplied to low-income households and social services and ensuring that energy subsidies are targeted at and reach the poor;
- ***Improve Macroeconomic and Fiscal Balances*** by rationalizing energy taxes and enhancing effective payment by all energy users to eliminate operating subsidies to state-owned enterprises, thus leveling the playing field for clean energy;
- ***Promote Good Governance and Private Sector Development*** by divesting assets to strategic investors in a socially responsible and corruption-free way, catalyzing private investments by liberalizing entry to energy markets, and strengthening the voice of consumers and communities, thus improving the investment climate for clean energy;
- ***Protect the Environment*** by removing market and regulatory barriers to renewable energy and energy efficiency investments and reducing gas flaring, reducing or eliminating local pollution, and facilitating carbon trading and joint investments to reduce GHG emissions.

To produce the greatest impact, the World Bank Group combines financing for energy supply reforms that meet these priorities with advice and knowledge transfer. It deploys its financing instruments following a hierarchy that is based on country creditworthiness and starts with loans, equity investments, and guarantees to catalyze private investment in the sector. Private investments take priority, but where private investment cannot be catalyzed or for investments that the private sector should not undertake, the World Bank Group provides sovereign-guaranteed loans and credits to state-owned energy suppliers for such investments. Free-standing technical assistance and advice is also provided as part of its support for these priorities.

The World Bank Group approach to energy sector interventions envisions efficient supply and use of energy that strengthens the economic growth of developing and transition economies by:

- freeing consumers from frequent and prolonged power cuts and liquid fuel shortages
- giving industrial enterprises a choice of suppliers providing reliable energy services
- allowing private ownership and financing a dominant role in energy supply
- ensuring that regulators operating in an objective, transparent, and nondiscriminatory manner oversee natural monopolies and promote competition in the energy sector
- reducing the average intensity of carbon dioxide emissions from energy production
- reducing the average energy consumption per unit of GDP

31. ***End-use efficiency improvements in the transportation, industry, commercial, and residential sectors can have a significant impact on the clean energy investment requirements.***

However, unlike investment in electricity supply and public transport services, the sources of financing for end-use efficiency are more dispersed and dominated by private sector and consumer financing, thus relieving pressure on public finances. The prime driver for energy efficiency improvements are well-designed and enforced regulations on efficiency standards and emissions levels, coupled with appropriate energy pricing policies.

32. Financing for energy efficiency investments will also be needed given the combined impacts on energy security in response to higher energy prices and to mitigate environmental impacts. Assuming that energy is appropriately priced, much of this funding is expected to come from the consumer and private sources. Public sources of funds may be required to address some of the market barriers like information gaps and to facilitate a buy-down in transaction

costs. Significant efficiency improvement in the production and use of energy especially electricity, could potentially reduce the investments gap for energy production by deferring the need for new capacity.

33. ***The extent to which the huge investment gap, especially in the electricity sector, can be funded in the future would depend mainly on the national investment climate.*** Much more funding can be raised on market terms for the countries under sound investment climates. To illustrate the influence of this fundamental point, the average financing demands of around \$300 billion per year under the IEA reference scenario were analyzed under three policy environments (Table 1), namely:

- Typical current policies for these countries with substantial pricing and tax distortions from sound commercial standards and political and regulatory risks for investment in infrastructure. This leads to a substantial shortfall in the available investment financing relative to needs.
- An improved policy environment with progress to removing pricing distortions and reducing non-commercial investment risks, under which more investment financing can be mobilized than under the first case, but not sufficiently to fully meet investment needs.
- Policies that support a sound commercial environment which does not constrain the financing that can be attracted from capital markets for economically justified investments. Under this environment, IEA's reference scenario could be fully funded.

34. ***The differences among the above three policy environments are reflected in the assumptions about the relative proportions of investment needs met from the three main funding sources, namely internal cash generation by energy suppliers, the private sector and the public sector.*** In a better policy environment, a greater proportion can be raised from internal cash generation and the private sector, and thus less is needed from the public sector. This would also lead to substantial reduction in subsidies to the electricity sector, thereby creating greater fiscal space for new investments. The above approach is applied to three groups²¹ of developing countries and transition economies to reflect the different investment climates and starting conditions for policy reform. The proportions of investment needs met from the main funding sources differs between these country groups, with less coming from internal cash and the private sector in the lower income groups. The results of this analysis are summarized in Table 1 below. They show the significant benefits available from improving the policy environment in terms of lessening the amount of financing needed from then public sector. The proportion needed from the public sector declines from 38 percent under the current policy case to just 11 percent under the sound policy case.

²¹ The basis for classifying these countries is per capita income used by the World Bank, namely low income countries (\$765 or less), lower middle income countries (between \$766 and \$3035), and upper middle income countries (between \$3036 and \$9385).

Table 1. Sources of Investment Financing Under Different Policy Cases
(percent of total investment needs)

	Current policies case	Improved policies case	Sound commercial policies case
Internal cash	40%	45%	49%
Private sector	22%	30%	40%
Public sector	38%	25%	11%

35. *The IFIs can be an important source of finance, policy and technical advice to developing countries on these issues (Annexes E).* The IFIs have a particularly important role to play in assisting client country governments establish and maintain clear and comprehensive power sector legislative and regulatory systems (including in the area of intellectual property rights) to enable private participation (Box 9). The IFIs also contribute financially. Over the last five years the World Bank Group (WBG), the African Development Bank (AfDB), the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), European Investment Bank (EIB), and the Inter-American Development Bank (IADB) have invested over \$17 billion in projects that directly or indirectly contribute to lowering carbon emissions in the developing countries and the EIB has invested close to \$30 billion in similar projects in the EU, European Free Trade Association (EFTA), and the EU accession countries (Annexes E and F). This however is still a relatively small part of the overall resources required for clean energy.

Box 9. IFI Consultations (Annex E)

In the Gleneagles aftermath, the WBG, the IEA, and the Regional and Multilateral Development Banks (AfDB, ADB, EBRD, EIB, IADB, and the Islamic Development Bank (IDB)) have initiated an on-going consultation process. This is focused to date on (i) increasing lending effectiveness, (ii) sharing information on current and planned investment programs, (iii) defining financing gaps, (iv) assessing existing product lines, and (v) identifying needs and modalities for the development of new financial products, including in partnerships with the private sector. The consensus view among the IFIs is that the consultations are already proving valuable in mobilizing, producing, and sharing a body of work that in itself substantially advances their own engagement in clean energy.

All IFIs are now focusing more systematically on clean energy and low carbon systems and are stepping up initiatives to strengthen their technical capacity and better align energy sector and lending work. Reflecting on existing comparative advantages, the IFIs are also initiating shared sector analysis across the following areas:

- ADB is developing a transport strategy for reduced carbon emissions, with particular focus on the needs of the growing transport sectors in China and India;
- EBRD is focusing on the area of industrial sector energy efficiency, including the mainstreaming of its energy audit program;
- EIB is considering options for lowering the carbon intensity of water supply and sanitation; and
- IDB and AfDB are looking at cost-effective options for expanding smaller-scale renewable energy in the context of rural development and micro-enterprise initiatives and are assessing opportunities for expanding the use of biofuels for transportation.
- The WBG is advancing policy dialogue and coordinating the IFI Investment Framework efforts.

The primary focus of these efforts is to improve client country access to existing, economically viable opportunities as well as to help them identify technologies and measures that will become economically feasible, if additional resources are made available to manage incremental cost and risks.

36. *There are a number of shared challenges that the IFIs need to address*, including rationalizing risk management instruments; mainstreaming carbon finance; accessing sufficient grant, technical assistance, and concessional financing to support energy and transportation sector capacity building; and building a common platform for country dialogue. Importantly, the existing *risk-management* product base has to be expanded to provide for broader and more effective incremental risk management of high efficiency energy and infrastructure development. The consultations also underscored important regional differences in terms of clean energy priorities as well as in terms of existing IFI capacity to support clean energy and low carbon in general and energy efficiency in particular.

37. *Consultations with the private sector (Box 10 and Annex G) have confirmed that private investments in cleaner energy in developing countries will not occur without better risk management cover, especially in regulated industries.* The Multilateral Investment Guarantee (MIGA) and other risk management facilities can be important instruments in reducing non-commercial risks for private investors. But there is also a shared agreement on the need to: (i) better integrate existing instruments, including through blending and aggregation services within and across IFIs; and (ii) consider offering project-specific menus of products (guarantees, loans, equity, and technical assistance) in order to allow for more cost effective sharing of risk burdens. The industry further called for a stronger IFI role in strengthening national power sector planning as well as in underwriting some of the front-end costs of project preparation in order to reduce upstream barriers to entry in otherwise promising markets.

Box 10. Private Sector Recommendations from Consultations (Annex G)

Opportunities for the WBG and other public sector financiers to support reducing barriers to lower carbon technology deployment in the developing countries include:

- To assist developing countries in establishing and maintaining clear and comprehensive power sector legislative and regulatory systems to enable private participation.
- To focus on commercializing the technologies that are already proven, but are yet-to-be deployed.
- To mobilize grant or concessional financing to buy-down the higher costs of commercializing new energy technology.
- To blend finance among IFIs and with export credit agencies to extend loan tenors out to 15 years and beyond, lowering debt service and increasing the financial viability of large clean coal plants.
- To extend carbon finance or domestic environmental payments in support of new high efficiency coal plants and for re-powering of the existing fleet.
- To help client countries develop business plans and financing instruments to lower political risk and the economic and financial cost of outages to levels that make re-powering feasible.
- To consider a “one-stop” approach to the provision of risk mitigation packages and routinely integrate systematic political risk assessment within the upstream financial feasibility assessment.
- To work with client countries to ensure that investment in intellectual property embodied in lower carbon coal plants could be recovered at levels that would motivate ongoing investment in technology development and transfer.
- To consider a public-private partnership for project development, including bundling smaller projects to make them financially attractive.
- To consider possible private sector participation at the earliest stages of project design and financing in order to minimize transaction costs and increase the likelihood of private investment.
- Risk mitigation instruments are needed for project delivery investments in the carbon market.

3. Financing Needs to Reduce Greenhouse Gas Emissions and Achieve a Low-Carbon Economy

38. ***The baseline investment needs for clean energy would need to be supplemented with the incremental investment costs of achieving a lower carbon energy base.*** The cost estimates associated with mitigating carbon emissions vary widely: from a range of less than \$10 billion per year to over \$200 billion per year (\$2005) depending on assumptions and the carbon dioxide target.²² A central estimate for stabilizing at 550 ppm would be about \$60 billion per year (\$2005). The challenge to change the path of energy development (production and use) in both OECD and developing countries is formidable as no clean carbon technology package is financially viable at scale without some combination of internalizing environmental externalities into the price of energy, providing incentives for implementation and further cost-cutting research and development. The lack of financial viability in many developing countries' energy sectors is exacerbated by subsidies provided for fossil fuels as well as existing planning approaches which often do not appropriately value and integrate clean carbon technologies.²³ In a global strategy on energy, where the initial obligation to reduce GHG emissions rests with OECD countries²⁴, it is still important that the investments in developing countries be directed toward lower carbon and more efficient sources of energy. Most energy-related emissions from developing countries will come from a small number of countries whose economies are growing rapidly (in particular China and India because of the size of their economies, their rate of economic growth, and the relatively high reliance on coal to power their electricity needs) and will need assistance to adopt a lower carbon economy in the context of meeting their primary objectives of poverty alleviation and growth.²⁵

4. Financing Mechanisms to Reduce Greenhouse Gas Emissions and Achieve a Low Carbon Economy

39. ***Given the global public good nature of climate, the incremental actions (and costs) needed to drive a comprehensive approach to climate change will be derived from potentially three sources:*** (i) voluntary actions by individuals and firms on the basis of enlightened self-interest; (ii) public budgets and grant-based international finance such as those provided by the Global Environment Facility (GEF); and (iii) enlightened international public policy and

²² For example, the Intergovernmental Panel on Climate Change (IPCC) estimated, in 1990 US\$, that the average annual gross cost over the next 100 years of stabilizing at 450 ppm, 550ppm, and 650 ppm of carbon dioxide, respectively, could range from less than 40 billion per year to up to 180 billion per year; from less than 10 billion per year to up to 80 billion per year, and from close to zero to up to 40 billion per year. These figures do not take into the account the benefits of avoiding climate change or reducing local air pollution.

²³ For example, removing energy subsidies alone could cut global CO₂ emissions by between 4 and 18 percent, according to the IPCC.

²⁴ The United National Framework Convention on Climate Change embodies the concept of *common but differentiated responsibilities*, which place the initial responsibility for reducing greenhouse gas emissions on OECD and economies in transition.

²⁵ If China's economic growth continues at 8 percent per year and elasticity of electricity consumption is unity, on average China would need an increment of about 90 GW of new capacity per year. Assuming 60 percent is coal-fired plants, China would need 54GW per year of new coal plants. If China were to go fully to IGCC with carbon capture and storage technologies in order to almost completely eliminate carbon emissions it would cost about an extra \$14 billion per year.

regulatory frameworks that encourages an appropriate private sector response, e.g., an efficient and equitable carbon market..

40. ***Major challenges remain in moving the world towards low carbon economic structures and climate resilient growth patterns.*** Voluntary actions, while important, are unlikely to fill the gap (but will be assessed) and there may be a limited appetite for very large scale grants to cover the incremental costs of dealing with climate change. On the other hand, clear and predictable signals over the long term to the private sector that encompass the long term nature of capital acquisition and turnover accompanied by a professional and credible regulatory system could pave the way for considerable transfers of finance to developing countries. They would also enhance their acquisition of new generation technologies and provide stimulus to the private sector to invest in further research and development that could drive down the costs of technology. Estimates of potential resource transfers under such a system range in the tens of billions of dollars annually (discussed below). A high premium must be awarded to knowledge, both in terms of specific technologies and their cost trajectories, as well as to national and regional strategies.

41. ***An assessment is needed of the potential contribution of voluntary actions to lowering emissions.*** Many individuals driven by concerns over climate change will change their carbon intensity lifestyles. A number of companies are already at the forefront of environmental responsibility and some sectors (aluminum and cement for example) have had discussions on voluntary codes. Encouraging such approaches should be continued. Fora such as the OECD Roundtable on Sustainable Development; United Nations Environment Program (UNEP)'s work on standards; and trade and private sector associations can all play an important role. Assistance and encouragement to such initiatives should be welcomed as a low cost means for action. More recent bi-lateral technology agreements, e.g., the Asia-Pacific Partnership on Clean Development and Climate, show promise.

42. ***The existing multilateral institutions may not have all the instruments needed to provide the large amount of resources required for financing mitigation activities.*** Even though middle income countries, especially the G+5, will only borrow at the IFI's market rates for commercially viable investments, the IFIs need to mainstream climate concerns into their overall investment activities. Loans at commercial terms cannot be used to finance carbon emission reductions unless the underlying technology is financially viable—and for many of these cleaner technologies that is not the case today. Multilateral lending is constrained by limitations such as ceilings on individual country and project exposures, competing needs of resources from other development needs, and the need to comply with multiple policies parameters. At this time, carbon reducing technologies will only be deployed in large scale if the investments are supplemented by carbon finance or receive grant resources in parallel. Over the longer term, research and technological development is expected to drive down the costs of cleaner technologies, as can the economies of scale coming from wide scale adoption of these technologies. A good example of this is wind-power, where it is now economically viable in a number of countries.

43. ***Public expenditures and investments of OECD countries in developing countries will be needed to promote low carbon technologies that are not yet financially viable.*** These will need to be coupled with policy changes such as taxes and subsidies that internalize externalities

and policies that encourage energy efficiencies. These changes will need to be coupled with international carbon trading and finance that reward projects that reduce carbon emissions and, at the same time, provide credit for sectoral policies that reduce emissions. Without this assistance, technological transfer and change will not occur. While grant facilities exist, e.g. the GEF, their scale of funding has been small relative to the tens of billions of dollars per year in investment required if there is to be a significant impact of GHG emissions reductions. Commitments have averaged around \$150 million per year over the past eight years. In fact, the GEF's funding level has appropriately defined its strategic priority on barrier removal to renewable energy and energy efficiency market transformation, rather than immediate GHG abatement.

44. ***There are many innovative and pioneering ways by which finance could be mobilized:*** from the GEF established in 1990 and now operating as the financial mechanism of the United Nations Convention on Climate Change (UNFCCC) to new and emerging ideas of taxation of aviation fuels and other carbon taxes. All are possible but the underlying principle is that as a public good the hand of governments is needed in directing the flow of incremental funds. A combination of public finance and public policy lies at the heart of any funding approach. To date, two mechanisms have been established which reflect both approaches, i.e., the Global Environment Facility (Box 11) and carbon finance, facilitated by the Clean Development Mechanism (CDM) and Joint Implementation (JI) (Box 12), under the guidance of the UNFCCC.

Box 11. The Global Environment Facility

The Global Environment Facility (GEF) serves as the financial mechanism of the UN Framework Convention on Climate Change. To date it has provided around \$2 billion since 1990, mostly in grants, but increasingly using contingent financing instruments. The GEF has had four operational programs: (i) removal of barriers to energy efficiency and energy conservation; (ii) promoting the adoption of renewable energy by removing barriers and reducing implementation costs; (iii) reducing the long-term costs of low GHG-emitting energy technologies; and (iv) promoting environmentally sustainable transport.

The current draft of the programming document for the GEF-4 replenishment proposes the following strategic objectives: (i) promoting energy-efficient buildings and appliances; (ii) promoting industrial energy efficiency; (iii) promoting repowering of power plants; (iv) promoting grid electricity from renewable sources; (v) promoting renewable energy for rural energy services; (vi) supporting the deployment of new, low GHG-emitting energy technologies; and (vii) facilitating sustainable mobility in urban areas. Results will be measured by market development/transformation.

45. ***It is recommended that donors agree on a successful replenishment of the GEF commensurate with its strategic objectives.*** The GEF, which has been an effective instrument to address climate change, could complement the proposed new financing instruments, with the former financing barrier removal for market development and supporting technology innovations and the latter buying down the costs of new technology and scaling up investments in renewable energy and energy efficiency. The precise nature and scope of the relationship, as well as operational modalities would need to be further developed.

46. ***Regulatory and financial incentives are required for the projects and programs that entail higher incremental costs for commercialization.*** Here new technologies that are more efficient need to be added to the capital stock. But some of these technologies are not commercially viable today. Not only must the costs of these technologies be reduced through research and development and economies of scale but governments must actively encourage their adoption through incentives and national and international regulation. The incentives, such as

those offered through the carbon market²⁶ under the current (2008-2012) commitments under the Kyoto Protocol and through the Global Environment Facility, can play a role in converting some of the clean energy potential into investments.²⁷

47. ***To deal with the scale of investment needed in climate change it is imperative that a long term, stable, and predictable regulatory system be established.***²⁸ Ideally, a framework should be established that reaches out to 2050. Without a regulatory framework beyond 2012 it will be extremely difficult to attract private sector financing. The regulatory framework could be based upon a wide variety of principles, common policies, goals, and/or targets. In addition to GHG targets these could include energy efficiency improvement goals, consumption patterns, technology standards, etc. Whatever is decided, the framework should be long term, predictable, and credible. Such a regulatory framework would need to be backed by a robust institutional framework and funded at a level commensurate with the scale and seriousness of the issue and it needs to ensure that it meets the high standards expected of it by the corporate financial sector. Once fully operable, the role of public finance can be more easily identified—essentially providing the additional funding that would be genuinely focused on the public good dimensions and on those aspects of climate change management where private funding would be unlikely but where high external benefits could be secured.

48. ***Market mechanisms can play a pivotal role in a package of infrastructure investments, but market certainty is needed beyond 2012.*** It is critical however, that, as the carbon market is further developed, there is a need to: (i) determine how to expedite the review and approval process; (ii) expand eligible activities so that preventing deforestation is as eligible for reward as replanting after ruin; and (iii) reward good behavior such as planned investments in clean energy. Carbon finance could be the major driving force for technological change, especially when combined with loan or grant resources to cover the upfront investment costs.

49. ***Depending on the targets for emission reductions and the regulatory framework, over the long term carbon finance can be a source of tens of billions of dollars per year of supplemental investment for developing countries (Annex H).*** The advantage of carbon finance is that it will seek out the lowest and most effective projects and, if permitted by the rules, sectoral policies that abate the most carbon. It will also initiate innovation by project sponsors in reducing carbon emissions. However, the experience to date has shown that carbon finance alone cannot finance a massive scaling-up in carbon reducing investment because it cannot provide the up front resources needed to use new technologies such as super critical boilers or IGCC. Carbon finance provides a revenue stream that would need to be collateralized.

²⁶ The World Bank currently has about \$1.75 billion in carbon funds under management. Private investors and funds have also become more active with purchase of carbon emission reductions becoming the principal driving force in developing countries for lower emission technologies.

²⁷ For example, incentives under the Clean Development Mechanism framework of the Kyoto Protocol make the higher cost projects that would not normally be implemented under business-as-usual scenarios more attractive for investments.

²⁸ To date there has been no substantive discussion on whether such an international regulatory system is feasible or needed. Indeed, at present there are divergent views within the OECD on the need for a near-term international regulatory framework to limit greenhouse gas emissions, i.e., while most countries have ratified the Kyoto Protocol, the US and Australia have not.

Box 12. The Clean Development Mechanism and Joint Implementation

The Clean Development Mechanism (CDM) was established under the Koto Protocol in 1997. It seeks to create support for sustainable development and lower overall costs of emission reductions by creating a mechanism to transfer credits for emission reductions in developing countries to those countries with Kyoto targets through a market mechanism. The CDM is a nascent institution that suffers from a number of weaknesses : (i) its initial operations were guaranteed until only 2012 which is too short term given the long lead times for project preparation and the long term nature of capital stock turnover; (ii) when established few of the rules and methodologies for effective regulation of the system were in place further delaying early action; (iii) and, finally, the oversight and functioning of the regulatory system was largely by individuals inexperienced with market-based regulatory systems. These issues are gradually being resolved. Current estimates of the likely reliance on the CDM by Annex 1 countries to meet their Kyoto targets suggest that from 1 to 3 billion tCO₂e will be needed. This would suggest that \$10B to \$30B in payments will be made to the host countries for the emission reduction payments by 2012.

Joint Implementation (JI), which was also established under the Koto Protocol in 1997, provides for Annex I Parties to implement projects that reduce emissions, or remove carbon from the atmosphere, in other Annex I Parties, in return for emission reduction units (ERUs). The ERUs generated by JI projects can be used by Annex I Parties towards meeting their emissions targets under the Protocol.

5. Proposed New Financing Instruments

50. *Even with an improved regulatory environment and the use of policy and risk mitigation instruments, the challenge of financing incremental costs and reducing technology risks remains.* These could be addressed by innovative financial instruments that could: (i) buy down cost of new technology; (ii) mitigate technology risk; (iii) fund efficiency improvement of exiting assets; and (iv) strategically advance research in new clean technologies with the objective of accelerating their commercial application. The structure and operational aspects of such vehicles need considerable further work in order to ensure that it delivers the expected results, which will need to address the full technology pipeline, i.e., research, development, demonstration, scale-up, and commercialization.

51. *Several new financing instruments could be developed to simultaneously assist the clean energy and low-carbon economy agendas, including:*

- *A Clean Energy Financing Vehicle (CEFV) which could provide a mechanism to transfer high efficiency technology to mitigate climate change (Annex I).* This financing vehicle could blend grants and carbon finance to provide funds to collateralize clean energy technologies. It could: (i) buy down the costs of new technologies and energy infrastructure (production and use) and (ii) mitigate technology risks. Such a vehicle would finance the additional costs associated with moving to high efficiency technologies, largely in the electric power sector, that may not be justified solely on national grounds only, but would be cost effective within the context of a carbon constraint or GHG emissions target. Funding could be provided up-front to buy down the additional costs of securing new technologies. Funding could be provided on a concessional basis with the potential for repayment from carbon finance credits. One example of the types of activities that could be supported is the upgrading of inefficient thermal power plants where there are likely to be three flows of incremental benefits from such investments: (i) reduction in GHG emissions that could be secured through carbon credits; (ii) increased plant capacity; and

(iii) plant efficiency gains. Depending upon the price of carbon and the tenure of the regulatory framework these could provide between 10 and 25 percent of the capital cost²⁹. Box 13 summarizes estimated costs and benefits (including potential flows of carbon finance) from rehabilitation of thermal power plants and the costs and benefits from investing in sub-critical versus IGCC and CCS (Annex J). Funding for CEFV could be initially around \$20 to \$30 billion. Further work is needed to refine the concepts, funding modalities, and size of the CEFV and discuss with key governments their interest in such a fund. The fund would primarily be used by a small number of countries with high carbon emissions.

- ***A power rehabilitation financing facility could enable developing countries to rehabilitate inefficient plants without loss of power.*** Many rapidly growing countries are facing enormous constraints in delivering clean and reliable electricity. In many countries “blackouts” and “brownouts” are a daily occurrence. These failures of supply (or unserved energy) have very high consequences to economic growth and prosperity. In some cases the cost of “unserved energy” can be as high as ten times the production cost or at a level of \$1.00 per kWh. In such circumstances, developing countries have no choice but to operate inefficient plant as long as they can, even where conventional economics would suggest that rehabilitation of those plants is justified. It is worth considering whether a financing facility could be established that would provide an incentive for countries to take their power plants out of service for a limited duration in order for them to be rehabilitated and made more efficient. If, for example, temporarily installed standby generators (e.g., gas turbines) could provide electricity to compensate for loss of supply as plants are under rehabilitation this may act as an incentive for countries to upgrade their current power plants. Repayment could be provided from the increased efficiency and capacity of rehabilitated plants as well as any resulting carbon emissions reductions. The modalities for execution to be explored might include Public-Private Partnerships (PPP) and output-based aid approaches. It is proposed to undertake a feasibility study of such a financing instrument.
- ***Project Development Fund.*** Consultations with the private sector indicated a dearth of “Bankable” projects. Funds with public and private sector participation could be considered for project development.
- ***Venture capital funds for technology adoption.*** Consultations with the private sector indicate a need for the introduction of dedicated venture capital funding to provide financing for promising new and clean energy technologies. There is often a gap between the development of new technologies and their adoption and penetration in the marketplace. Further discussion is required with the private sector to better understand their needs in this regard. Nevertheless, further work on such a concept is warranted.

²⁹ For example, the present value of a 21 year carbon revenue flow (currently allowed under the CDM) from the renovation and modernization of an average coal-fired power plant would lie in the range of 10-25 percent of incremental investment needs (at a carbon price of between \$8 - \$15 per tonne of CO₂). In addition, power revenues arising from rehabilitation would likely payback the capital cost of renovation in 3-5 years.

Box 13. Estimated costs and benefits from rehabilitation of thermal power plants or shifting from high-efficiency sub-critical thermal plants to IGCC and CCS (Annex J)

- **Renovation and modernization** investments can normally be justified on the basis of fuel savings and from the sale of power alone. Carbon revenues add to the attractiveness of R&M measures, e.g., the present value of a 21-year carbon revenue stream from the R&M is in the range of 10-25% of the R&M investment (assumed to be \$350 per KW) assuming a carbon price of \$8-15/tCO₂.
- **High-efficiency sub-critical thermal power plant compared to IGCC plus CCS.** The economic viability of selecting to build an IGCC plus CCS plant rather than a high-efficiency sub-critical thermal plant is dependent upon the difference in the capital cost of construction, operating costs and the value of a carbon revenue stream. For example, depending on what assumptions are made (Annex J, Tables 3 and 5), the additional costs of the IGCC plus CCS plants could be fully repaid if there is a 21 year carbon revenue stream and the price of carbon is between \$25/tCO₂ and \$37/tCO₂ (Annex J, Tables 2 and 4). The current international price for carbon is about \$8/tCO₂, where-as the price of carbon within the European trading system is currently about \$33/tCO₂³⁰.

II. ADAPTATION TO CLIMATE CHANGE

A. The Challenge

52. *The Earth's climate is already changing because of human activities, primarily the combustion of fossil fuels and land management practices, and is projected to continue to change in the coming decades.* The Earth has already warmed by about 0.7°C in the last 100 years and is projected to warm another 1.4-5.8°C during the next 100 years. The result will be higher temperatures, more variable precipitation, and an increased incidence of extreme climatic events. When coupled with sea level rise, this will adversely impact natural and human systems and will undermine economic development and the ability to achieve many of the MDGs (Box 14).

Box 14. Projected Impacts of Climate Change

Human-induced climate change is projected to:

- Decrease water availability and water quality in many arid and semi-arid regions and increase risk of floods and droughts in many regions.
- Decrease the reliability of hydropower and biomass production in some regions.
- Increase the incidence of vector- (e.g., malaria and dengue) and water-borne (e.g., cholera) diseases, as well as heat stress mortality, threats nutrition in developing countries, increase in extreme weather event deaths.
- Decrease agricultural productivity for almost any warming in the tropics and sub-tropics and adverse impacts on fisheries.
- Adversely effect ecological systems, especially coral reefs, and exacerbate the loss of biodiversity.

³⁰ This difference in price reflects the different marginal abatement costs within the EU compared to those in developing countries.

53. ***Even with a successful mitigation program, a significant degree of climate change is a foregone conclusion.*** Unless significant efforts are made to mitigate greenhouse gas emissions, it is likely that the atmospheric concentration of carbon dioxide will rise well above 550 ppm, resulting in an increase in mean surface temperature of several degrees Celsius. Even with aggressive mitigation actions stabilization of greenhouse gases will take time and there is a large inertia in the Earth's climate system which will ensure that climate change will continue through this century.

54. ***All countries are vulnerable to climate change and instability in weather patterns but the poorest countries and the poorest people within them are most vulnerable, having the least means to adapt.*** The challenge of adaptation in developing countries is difficult because of: (i) increased exposure to climate impacts compared to most developed countries; (ii) restricted human capital and technological capacities; and (iii) limited access to credit market and to international markets. The combination of these factors makes the challenge of adapting to climate change considerably more difficult.

55. ***Most of the steps needed to adapt to a future climate are compatible with those necessary to reduce vulnerabilities to current climates.*** This suggests that adaptation to climate change should be tackled as a comprehensive 'climate risk management' approach that starts with tackling the vulnerabilities to current climate extremes while looking ahead to future climates. However, increasing resilience against future climates brings additional costs that many developing countries are unable to bear, or unwilling to bear as they see this costs as being imposed by actions beyond their control. The challenge remains to identify genuine incremental costs of adaptation and to find financial mechanisms to ensure that additional resources are directed to activities that effectively reduce climate vulnerabilities.

56. ***Developing countries, and poor people within developing countries, are already suffering the greatest impact from climate related disasters, which threaten to undermine their development.*** During the 1990s, an average of 200 million people per year from developing countries were affected by climate related disasters, whereas only a million or so people from developed countries were affected. Injury, death, loss of housing, and loss of employment meant that each drought, flood, or storm eroded the capacities of whole communities to improve their livelihoods and set back the fight against poverty. The growth rate of people affected in developing countries by climate related disasters appears to have doubled this decade. Almost 90 percent of the people affected by climate related disasters are from the populous G+5 countries (predominantly China and India—Table 1). However, climate change is likely to change this pattern. The G+5 have significant technical resources, large areas in which to change land use practices, and high economic growth rates that can move many people away from the most vulnerable regions. Climate change will have its greatest impacts in the poorest regions of the world that are already marginal and where people have the fewest resources to respond to climate change. In Africa these problems are particularly severe.

57. ***Climate disasters are only one element of the impact of climate and aggregated statistics are not good indicators of the impacts on the poor within countries.*** Developing countries often have economies that are heavily dependent on agriculture, forestry, and natural ecosystems where the chronic impacts of climate variability and change are likely to be the greatest. Climate models forecast an increasing probability of El Nino events, which have been

observed to have become more frequent, persistent, and intense since the mid-1970s. Such events have been closely correlated with weather-related famines in the Horn of Africa for at least the past 200 years. Single El Niño events can lead to reduction in GDP of several percentage points and it has been estimated that in both Ecuador and Ethiopia an additional 10 percent of the population are in poverty as a consequence of the impacts of El Niño events.

Table 2. Millions Of People Affected by Weather/Climate Related Disasters 1990 to Mid 2004

	Drought	Flood	Wind	Extreme temperature	Wild Fires	Famine	Wave / Surge	Grand Total
China	163.50	1,383.50	242.05	0.01	0.00	-	0.00	1,789.05
India	391.18	381.81	36.81	0.01	0.00	0.00	0.00	809.81
Bangladesh	-	74.43	23.91	0.09	-	-	0.01	98.43
Ethiopia	55.79	1.01	-	-	0.00	19.17	-	75.96
Iran	62.00	2.26	0.01	-	-	-	-	64.27
Philippines	3.98	5.56	33.77	-	0.00	-	0.01	43.32
Thailand	13.50	17.88	2.93	-	-	-	0.00	34.31
Viet Nam	6.70	19.32	5.85	-	-	-	-	31.86
Pakistan	2.27	24.79	0.67	0.00	-	-	-	27.73
Zimbabwe	26.36	0.31	0.00	-	-	-	-	26.67
Malawi	21.33	1.63	-	-	-	-	-	22.96
Korea Dem Rep	-	9.77	0.64	-	-	10.03	0.03	20.46
Sudan	12.61	3.74	0.00	-	0.00	2.60	-	18.95
Kenya	15.26	2.09	-	-	-	0.00	-	17.35
Cambodia	0.95	9.49	-	-	-	5.90	-	16.34
Australia	7.00	0.06	3.94	4.60	0.06	-	-	15.66
South Africa	15.30	0.09	0.12	0.00	0.01	-	-	15.52
Brazil	11.50	0.66	0.02	0.00	0.01	-	-	12.19
Tanzania	10.60	0.41	0.00	-	-	-	-	11.01
Mozambique	4.48	3.43	2.53	-	-	0.50	-	10.94

Light grey shading developing countries (LDC to UMIC); darker grey African. From the EM-DAT data base maintained by the Centre for the Epidemiology of Disasters, Brussels.

58. *Models of agricultural production suggest serious losses by mid century with huge differential effects between developed and developing countries.* For example, even if carbon dioxide could be stabilized at 550ppm, developing countries are projected to lose between 15 to 25 percent of their wheat productivity (mostly in Africa) while in developed countries productivity will rise by 10 to 30 percent (mostly North America and Russia)³¹.

59. *Mitigating the impacts of climate change and adapting to future climates³² in Africa represents a major challenge.* Climate change represents a significant threat to the development goals of Africa. One third of the people in Africa live in drought prone areas. At the opposite side of the spectrum, floods are recurrent in some countries and even countries located in dry areas are not flood-safe. The World Health Organization (WHO) has estimated that the impact of existing changes in climate has lead to the loss of 2 million DALYs (Disability Adjusted Life Years) per year in Africa, which is twice the rate of other developing regions and 300 times the losses in developed countries. Also 40 percent of the population of West Africa lives in coastal

³¹ Fischer et al. (2005) draw upon IIASA and FAO models to conclude that over the next few decades the reductions in hunger that should follow global economic development will be partially counteracted by climate change, delaying significant improvement such as those sought in the MDGs by 2050 and beyond.

³² For a recent comprehensive review see Nyong, A. (2005) Impacts of climate change in the tropics: The African experience. Avoiding dangerous climate change. A Scientific Symposium on Stabilization of Greenhouse Gases, Met Office, Exeter, United Kingdom.

cities and a continuous urban megalopolis with more than 50 million people is expected to develop along the 500 km of low lying coast between Accra (Ghana) and the Niger delta.

60. *A major challenge is to reduce the vulnerability of socio-economic and ecological systems to natural climate variability and long-term climate change.* The first challenge is to reduce the vulnerability of climate sensitive sectors, e.g., agriculture and water resources, to today's climate variability and then to "climate-proof" all future development activities. This will require developing and implementing "best practice" guidelines for screening investments in climate sensitive sectors, and then integrating climate concerns into national and sectoral economic planning.

Box 15. G+5 Country Consultations – Adaptation (Annex B)

In the course of the G+5 consultations, governments sought to broaden the dialogue beyond the narrower discussion of clean energy development: identifying and managing the risks that climate change poses for development. Here Governments stressed the importance of adapting to climate change, which they saw as already significant and disruptive at the national level. Some G+5 governments put adaptation and the management of climate change risk as their highest priority, while all felt that a better understanding of the domestic implications of increasing climate variability, and increasing their capacity to plan effectively, needed to be a fundamental element of the Investment Framework (Annex B). Areas for cooperation include

- **Brazil:** capacity-building for climate risks management, including current climate variability and extreme weather events, with focus on measurement, forecasting, and analysis of climatic trends and extreme events; analysis of climate vulnerability in rural areas in the Amazon.
- **China:** National Climate Change Response Strategy; region-specific climate risks and adaptation strategies; climate vulnerability reduction with focus on offsetting water shortages and agricultural productivity decline.
- **India:** Development and implementation of a climate risk management approach at policy and project levels; enhancing adaptation and reducing vulnerability through better integration of climate risk issues into relevant sector programs.
- **Mexico:** Improved capacity to manage climate risks, including extreme weather events; promoting a shared vision and effective strategy on vulnerability and impacts assessment.
- **South Africa:** climate vulnerability reduction in the public health sector, the natural resource management sectors (water resource management and contingency planning, new forestry, agriculture and rangeland, biodiversity), and amongst the poor; integration of climate change into economy-wide modeling capacity at National Treasury and key economic research institutions; development of national integrated capacity for long-term research and monitoring of climate change impacts on the rural economy; and scaling up agriculture risk management initiatives and sustainable land management practices.

In specific country responses three issues recurred. Countries sought to improve their ability to cope with current climate variability which they recognized as a burden to development. They also sought better projections of climate change and its impacts and further exploration of the potential of early warning systems to reduce damage from extreme climate events. Finally, activities that link clean energy and adaptation were often raised. These include better design and use of water storage systems for power and irrigation and the better management of forested lands to reduce emissions while maintaining the services, such as soil stabilization, coastal protection, biofuels, and forest products that contribute significantly to more resilience livelihoods.

61. *Given that adaptation concerns go well beyond the G+5 countries to all developing countries, the WBG intends to consult with a broad and diverse group of poorer countries whose populations and development prospects are threatened by climate change in the next phase of the dialogue.* These consultations should lead to expanded assessment of adaptation needs and help provide insight into how to incorporate climate risk management into

development planning and the needs for incremental resources to cope with the genuine incremental costs of adaptation.

B. Strategies to Adapt to Climate Change

62. ***The G+5 countries include the largest populations vulnerable to climate change, but adaptation actions must extend to all developing countries.*** The vast majority of people affected by climate related disasters live in China & India but hundreds of millions of people in smaller countries are affected by climate related disasters each decade and even more are threatened by poverty traps arising from vulnerability to climate extremes. The countries where the highest percentage of their population is affected by climate-related disasters include Zimbabwe, Malawi, Samoa, China, Cambodia, and Swaziland. Ultimately, support for adaptation actions will have to be available for all vulnerable countries; however, some priority areas can be recognized already. Low lying Small Island States are particularly vulnerable as are nations in the path of major wind storms. However, drought and flood affect the largest numbers of people and lead to chronic impoverishment. This is particularly true for Africa where current climate variability is extreme, rainfed agriculture remains the foundation of many economies, and the infrastructure, capacity and resources needed to manage these challenges is weak.

63. ***While adaptation activities are, to a large degree, site specific and depend upon each country's circumstances, actions can be better informed by global knowledge and research.*** Adaptation actions must also be integrated into national and/or regional plans of development. The actions listed below provide a combination of national and global actions.

64. ***Adaptation will require a mix of transfer of existing technology, new technologies, and the revision of planning standards and systems.*** Many of the technologies to cope with the climates of the future already exist. More drought resistant crops are probably grown in nearby drier areas; flood control technology can be imported from regions already coping with flooding. However, these technologies must still be transferred and people accustomed to their use. In some regions new technologies, such as new lines of drought resistant crops or innovative construction techniques for wind resistant and cool housing, will be needed. Relatively simple transfers of technology, such as new tillage systems or new crop adoption, can take several decades (FAO 1996).³³ But much of adaptation is about rethinking how we do things. What should be the standards for new constructions; can we identify and modify existing infrastructure most at risk; how can the allocation of water resources be better achieved to meet ever increasing demands from human, industrial, irrigation, energy and natural uses?

65. ***South-South technology transfer can play a major role in adaptation.*** While high technology activities such as gene technology and advanced materials may eventually play a significant role in adapting the world to future climates, many of the immediate gains will be made by refining and transferring existing knowledge. The knowledge shared must blend traditional knowledge with the most recent scientific discoveries. Currently a number of bodies play different roles; the International Geosphere Biosphere Program (IGBP) brings together scientific efforts, Intergovernmental Panel on Climate Change (IPCC) assesses the state of

³³ Global climate change and agricultural production: direct and indirect effects of changing hydrological soil and plant physiological processes/edited by Fakhri Bazzaz, Wim Sombroek. <http://www.fao.org/docrep/W5183E/w5183e00.htm#Contents>

knowledge, CGIAR advances knowledge in agriculture in developing countries, and national agencies and Non-Governmental Organizations (NGOs) seek to deliver new ideas into existing knowledge systems. There is a need to develop stronger global systems of assessing and sharing knowledge about responses to climate variability.

66. ***Many of the challenges to achieving greater adaptation to climate change are institutional.*** It is generally accepted that adaptation needs to be mainstreamed into national planning and finance agendas. If climate variability, current and future, is factored into planning decisions not only can vulnerabilities be reduced, but the costs of actions can also be reduced. This can only be achieved if adaptation is on the agendas of multiple ministries. Ministries responsible for resource management, environment and infrastructure standards and design need to supply the technical support for broader planning and financial decision making. While adaptation to climate change remains primarily the responsibility for environmental and meteorological agencies progress will be limited.

67. ***While technology has a significant role to play in adaptation, there is an immediate need and opportunity to better implement knowledge and technologies that already exist.*** Thus, what is needed is a mixture of knowledge sharing, technology transfer, and collective learning of better systems to manage our livelihoods in the face a changing climate. The approach can be divided into four elements, which need to be addressed simultaneously:

- ***Development of information and tools.*** *First, there is an urgent need to develop information and tools to reduce the uncertainties associated with evaluating the impacts of climate change and assist in planning, and to explore risk insurance and disaster relief instruments to reduce the financial costs to developing countries of climate related events.* Capacity building is needed to assist countries to assess vulnerabilities to current climates and to seek to understand the causes of those vulnerabilities. In-depth country and sector studies are needed to assess the vulnerability to climate change and to design and cost out response mechanisms. These studies should assess the capacity to enforce policy on zoning in urban areas, the effectiveness of early warning systems, the need to improve infrastructure at the margin, such as reinforcing flood controls, protecting natural barriers such as mangroves, hillside trees, and vegetation, and the potential and feasibility of improving agricultural practices, including water conservation.
- ***Disaster preparedness.*** *Second, is to improve disaster preparedness through proactive actions.* Climate related disasters will continue to occur even with the best adaptation to climate change. An immediate, no-regrets option is to further enhance risk identification, risk reduction, and risk sharing (i.e. proactive strategies) while at the same time improving our capacity to respond to disasters. A core priority should be the recovery phase to minimize the long-term impacts of a disaster and to seize opportunities to promote more appropriate zoning, infrastructure and if necessary institutions. New insurance instruments such as the Global Index Insurance facility (GIIF) may play a significant role by creating assured sources of funds for recovery and rebuilding along with incentives to reduce vulnerabilities. The World Bank will continue its collaboration with United Nations (UN) agencies and other IFIs, in the context of the International Strategy for Disaster Reduction (ISDR) System, to

develop knowledge, institutional capacity, and instruments to facilitate better preparedness for an increase in extreme weather events.

- ***Implementation of existing, cost-effective technologies and infrastructure. Third, is to address technologies that have not been adopted because of barriers or lack of finance, such as changing agricultural systems to be more resilient to weather shock, and building multipurpose water storage/hydropower infrastructure.*** With increased rainfall variability and reduced buffering of seasonal flows by snow packs and glaciers more infrastructures such as dams and water distribution systems will be needed to maintain and expand irrigation systems. Many countries have developed only a fraction of their potential hydropower resources, resources that can be developed through multipurpose infrastructure that will also serve to control flooding, guard against drought, and provide water for irrigation and cities. Such hydro development must take into account environmental and social impacts, especially the resettling of people.
- ***Research and Development. Fourth, is the development of new technologies and planning systems.*** One priority is to develop crops that are drought, temperature, salinity and pest tolerant in order to reduce the vulnerability of the agricultural sector, especially for tropical and sub-tropical crops. The Consultative Group on International Agricultural Research (CGIAR), which provides public good research, has already begun working in these areas. The CGIAR should now be requested to prepare a major climate change program for all key cropping and livestock systems and should set a medium term target and budget to deliver a new generation of seeds and breeds and knowledge within the next ten to fifteen years. A second priority area is desalinization and water saving technologies to address the issue of water scarcity. Coastal protection works provide another challenge. It is not feasible to consider many thousands of kilometers of hard structures that might be necessary to protect coastal areas against increased storm surge. However, a combination of hard structures, coastal modification (e.g. beach shaping), and natural barriers such as mangroves can dramatically reduce the impacts of sea level rise and increased storm intensity. There is a need for a technological learning process on efficient ways of achieving such protection coupled with better evaluation of the assets and livelihoods at risk.

C. The Scale of Investment Needs and Sources of Financing

68. ***All developing countries will need financial and technical assistance to adapt to climate change, especially the least developed nations.*** Urgent action is needed to climate-proof development because, as with energy investments, decisions taken today about infrastructure, production systems and institutions determine the vulnerability of those systems for many decades to come. The overall annual costs to adapt to projected climate change, i.e., climate-proof development, are likely to lie in the \$10 billion to \$40 billion per year range of which about a third is associated with public finance (Annex K).

69. ***Initially public finance is likely to be the main driver of adaptation.*** Many of the activities will need to be embedded in development programs, ensuring that future development

investments are sufficiently "climate proofed". For future investments, and as noted above, we would recommend the development of an action plan (and budget) that would seek to both prepare better standards and investment in potential high payoff research and development. The private sector in some highly exposed areas, such as coastal tourism, might be expected to be an early collaborator.

70. ***Private sector investment is threatened by climate change.*** Investment in development is dominated by private investment and a portion of this investment is vulnerable to climate risk. At this stage few private investors feel they have the information to effectively factor future climate risks into decision making. Many of the initial analyses show that adaptive actions are often cost effective; e.g. improving the flood resistance of buildings and roads or the capacity of canals and water storage. It is important that the capacity of the private sector to deal with climate variability is improved quickly. The nature of climate risk is little different from many other risks in investing in developing countries. Where adaptive actions are available and recognized there is a need for new financial instruments which might include:

- grants and concessional finance for early movers in adaptation;
- new insurance instruments that focus on projected climates and discourage inappropriate practices. These instruments will have to be established against a background of increasing concern about the large scale impact of climate change events on the private and commercial insurance portfolio; and
- GEF resources, which have been little used for adaptation (Box 16). The new adaptation funds will increase resources but they will need to be used to maximize their catalytic value through critical knowledge development, sharing and piloting.

Box 16. The GEF and CDM

Until recently GEF has financing has focused on funding the incremental costs of projects to deliver global environmental benefits such as emission reductions and biodiversity maintenance. Adaptation actions were seen as primarily as being of local benefit although a \$50M pilot of adaptation actions was launched in 2003. At CoP 7 the UNFCCC requested that GEF manage two adaptation funds separately from its main trust fund. The Least Developed Countries Fund focuses on meeting the immediate needs as identified through National Action Plans for Adaptation (NAPAs) while the Special Climate Change Fund is available for the adaptation needs of a wider range of developing countries. Total resources through donors are expected to be in the tens to hundreds of millions per year.

The UNFCCC also established a direct link between the CDM and adaptation through the Adaptation Fund that will receive a 2 percent tax on most CDM projects. It is difficult to estimate the size of this Fund as it depends on the degree to which the CDM is used in meeting commitments to the Kyoto Protocol. It could range from a few tens of millions over the first commitment period to up to \$1B.

71. ***Some specific innovative approaches that should be considered:*** Work to date suggests both an interest and commitment of the private re-insurance industry to work hand in hand with the IFIs, including:

- how best to combine public investment in risk-reducing infrastructure (for example to reduce flood risk) with mechanisms to encourage catastrophic insurance through the private sector, and

- with agricultural risk instruments (for weather and price), which appear promising and should be expanded.

72. ***Ultimately new financing instruments similar to those for clean energy will need to be explored for adaptation.*** Most developing countries will seek, and require, assistance to meet the additional costs imposed by the need to adapt to climate change. This will include some technology transfer, but in many cases simply more application of existing technology is needed; for example more water storage; more coastal protection; higher capacities in flood mitigation; and higher standards in building design. Whether these costs require a new finance vehicle or whether they can be dealt with through existing mechanisms such as the GEF, Overseas Development Administration (ODA) and concessional finance through IFIs remains to be determined. Many innovative ideas within the private sector will need to be initially facilitated through public funding; these include risk sharing and bundling of small projects to achieve economies of scale and access to international mechanisms such as re-insurance. Finally new technologies in agriculture, irrigation, building, etc. would be enhanced by the existence of venture capital for technology adaptation, just as in the clean energy sector. A major challenge over the next two years is to better scope the various ways to meet these financing needs.

III. NEXT STEPS

73. ***A strategic work program, including outreach and communications, to take this forward will follow a two-phase strategy:*** (i) under the first phase, which will be completed by the Annual meetings, several specific proposals will be ready for consideration; and (ii) as a second phase, a longer term program of country level activities and global research, would be carried out concurrently and would be ready by the G-8 Summit in Japan in 2008. During this time (both phases), the World Bank will be consulting and collaborating with a broad range of stakeholders, including the IFIs, IEA, governments, export credit agencies, the private sector (energy and finance), and civil society organizations (CSOs). We would also work closely with the UNFCCC to ensure full alignment of efforts. Regional Development Banks will also be reporting on their programs at their respective Annual Meetings.

74. ***This proposed work program significantly expands and complements current ongoing activities*** in energy sector reform, energy investments, implementing GEF projects, developing the carbon market, and developing and applying methodologies to address climate variability and change.

75. ***Actions by September 2006 would focus on: (a) improving the quality of the estimates of mitigation and adaptation costs; (b) assess how existing financial mechanisms could be used to help support the implementation of low carbon technologies to address these needs and, where gaps exist, work through the details associated with establishing the financial vehicles to close those gaps; and (c) expand our outreach to a broader base of stakeholders. Specifically:***

- Undertake a multi-country analysis of the lessons learned from policies that enabled bridging the gap between investment needs and sources of funds, including the role of both public and private resources.
- Review and update carbon emission scenarios modeled by a wide range of experts to improve and narrow our understanding of expected mitigation costs.
- Review the World Bank Group and other IFIs existing financial instruments to judge their suitability and complementarity to support the financing needs for transitioning to a low carbon economy. The review will analyze the strengths, weaknesses, complementarities, and utilization of existing instruments to address clean energy for development, mitigation of greenhouse gas emissions, and adaptation to climate change. This would be the reference base for assessing and carrying out the work on the proposed new financing instruments and the expected role of the Bank to foster a low carbon energy scenario.
- Complete a proposal of the Clean Energy Financing Vehicle.
- Complete a pre-feasibility study of a Power Rehabilitation Facility and for a technology fund, including a market assessment.
- Complete a pre-feasibility level design for a Project Development Fund.
- Analyze the expected role of the Bank to foster a low carbon energy scenario, focusing on the knowledge sharing, analytical work, policy reform agenda, and changes needed to support low carbon investments.
- Consultations with partners of the main global partnerships and trust fund involved in the energy sector GEF, Energy Sector Management Assistance Program (ESMAP), Program on Forests (PROFOR), and the Global Gas Flaring Reduction to promote alignment with the work program.

76. The longer term program of country level activities and global research would begin immediately and would have a two year time horizon. The actions on clean energy and mitigation of climate change would include:

- Draw on the leadership of IEA in technology issues (RD&D) to feed specific information and advice into country case studies.
- Deepen the country case studies in the “Plus 5” countries regarding energy for supporting growth, climate change mitigation and improved use of financial instruments.
- Undertake selected country studies beyond the Plus-5 countries to include others that place high priority on energy access, economic growth, and climate mitigation as appropriate. An analysis of the specific policy, investment, and technical assistance

needs of these countries will be undertaken on their demand as part of the Poverty Reduction Strategy (PRS) and Country Assistance Strategy (CAS) discussions.

- Country work programs to assess the costs of any transitional social and/or fiscal costs associated with changes in economic structures resulting from adaptation, climate mitigation and regulatory policy changes.
- A Global Energy Technology Assessment likely under the auspices of the proposed IIASA “Global Energy Assessment.”
- Research Program on the Economics of Climate Change, the scope of which will depend on the scope and findings of ongoing parallel activities where initial results are expected over the next 9 months, e.g., IEA, the Stern Review on the Economics of Climate Change, and the IPCC.
- Reconstruction of the international knowledge base on taxes, subsidies, overall pricing practices and energy affordability, low carbon investment options, financial vehicles, and reform agenda, on a much more quantitative and country-specific basis than is currently available.
- Development of a strategy to deal with the issues associated with technology transfer and intellectual property rights, with a view to decrease costs and accelerate implementation of new technologies.
- Further development of risk management instruments.

77. ***The actions on adaptation would include:***

- Develop a systematic approach to screening of public investment for the impacts of climate change. This will require a systematic assessment of projected climate change; its impacts on economies, livelihoods, and natural systems; and the differential impacts on vulnerable groups within society such as poor people, women, and children. Project portfolios need to be reviewed for their vulnerability to climate change (an initial screening tool has been developed and has been used to assess the vulnerability of the World Bank portfolio of projects).
- Major effort to increase knowledge on the costs and benefits of specific actions for adaptation to *existing capital stocks* by undertaking a series of country and/or regional assessments in order to climate proof vulnerable countries and vulnerable populations. A program is needed to identify the *existing stock of capital* that should receive priority for strengthening against climate change.
- Develop and adopt a new generation of planning tools and best practice standards and approaches for both natural and built capital that reflect the emerging conditions of climate uncertainty, especially applicable to water resource management, urban planning, and infrastructure investment, as well as to land use, land use management, and forestry rehabilitation. Since no IFI has developed such standards this offers a

tremendous opportunity for collaboration amongst those organizations as well as with the relevant United Nations organizations and the private sector.

- The World Bank, through its proposed Global Program for Mainstreaming Hazard Risk Management, will continue its collaboration with UN agencies and other IFIs, in the context of the International Strategy for Disaster Reduction (ISDR) System, to develop knowledge, institutional capacity, and instruments to facilitate better preparedness for an increase in weather variability and extreme weather events.
- Work with the CGIAR system and other research organizations to develop a research program to climate proof agriculture (drought, heat tolerant, saline resistant, and water tolerant crops) and water resources, especially in the more climate vulnerable parts of the world.

78. ***The Outreach Program will over the next two years (Annex L):***

- Use existing multi-stakeholder platforms and partnerships, engaging the business community, civil society, legislators, opinion leaders, media, and the scientific community.
- Act as an honest broker, facilitating dialogue and broader engagement on the technical and knowledge dimensions (R&D, technology development, and innovative financial vehicles), complementing the UNFCCC intergovernmental process.
- Focus on the long term, but showcasing wins in the short term on the energy agenda (innovative market-oriented solutions), reducing greenhouse gas emissions, and adapting to climate variability and change.

Some key actions in the short term (2006) include:

- Media launch of the IF paper and multi-stakeholder seminar during Spring Meetings;
- Outreach event for governments and other stakeholders participating in the CSD;
- Multi-stakeholder Globe/COM+ Climate Change Dialogue in St. Petersburg, prior to the G-8 Summit;
- NHK (Japanese Public TV) documentary on Climate Change and BBC documentary on energy for development;
- Multi-stakeholder side event during Annual Meetings in Singapore; and
- Regular and continuous internal communication for Bank Group staff.

ANNEXES

CLEAN ENERGY AND DEVELOPMENT: TOWARDS AN INVESTMENT FRAMEWORK

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ANNEX A. THE CHALLENGE OF CLIMATE CHANGE

1. The basis for the Investment Framework on clean energy is the current scientific consensus that human activities, primarily the combustion of fossil fuels and land-use changes, e.g., deforestation, have increased the atmospheric concentrations of greenhouse gases¹, which in turn have altered and will continue to alter the Earth's climate with adverse consequences for agricultural productivity, water resources, human settlements, human health, and ecological systems. Developing countries and poor people in developing countries are the most vulnerable to climate change, which is a major threat to sustainable economic development and poverty alleviation. Table A.1 summarizes the projections of global mean surface temperature change at various concentrations of greenhouse gases in the atmosphere.²

Table A.1. Pathways to Stabilize the Atmospheric Concentration of Carbon Dioxide and Implications for Changes in Global Mean Surface Temperature

<i>Stabilization level (ppm)</i>	<i>Date for global emissions peak</i>	<i>Date for global emissions to fall below current levels</i>	<i>Temperature change by 2100 (C)*</i>	<i>Equilibrium temperature change (C)</i>
450	2005-2015	Before 2040	1.2—2.3 (1.8)	1.5—3.9 (2.7)
550	2020-2030	2030-2100	1.7—2.8 (2.3)	2.0—5.1 (3.4)
650	2030-2045	2055-2145	1.8—3.2 (2.7)	2.4—6.1 (4.1)
750	2050-2060	2080-2180	1.9—3.4 (2.7)	2.8—7.0 (4.6)
1000	2065-2090	2135-2270	2.0—3.5 (2.8)	3.5—8.7 (5.8)

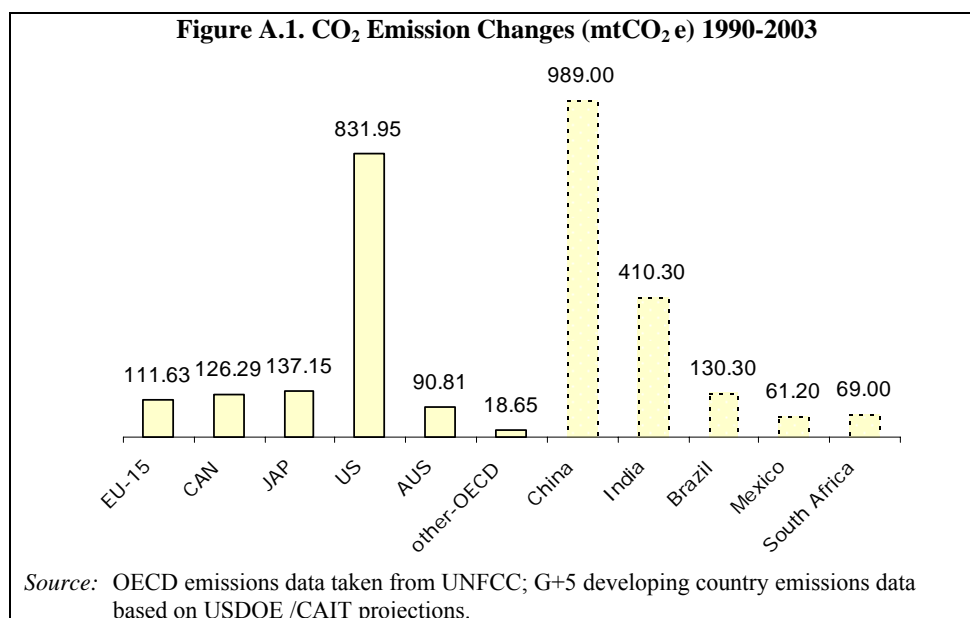
2. At each higher level of stabilized carbon, the consequences from the higher temperatures, increased variability of temperature and precipitation, and the increase in the incidence of extreme weather events will be more severe, resulting in higher costs to economies from the impact of climate change and higher expenditures on adaptation. To achieve each of these levels requires substantial levels of investment on mitigation, especially for a CO₂ equivalent stabilization target of 450ppm or lower.

¹ The major greenhouse gases include carbon dioxide, methane, nitrous oxide, tropospheric ozone and halogenated gases, e.g., HFC 23. Carbon dioxide is the most important anthropogenic greenhouse gas, produced primarily from the combustion of fossil fuels and land-use changes, e.g., deforestation.

² International bodies, particularly the Intergovernmental Panel on Climate Change (IPCC), have been consolidating the scientific understanding that underpins international collaboration for around two decades. The projections in Table D.1 reflect this research. They however mask changes in the distribution of climate. Continental areas are expected to warm by more than the average (2.2 – 6.2°C by 2100) and some of the largest changes will be seen in the Arctic (3.6 – 11.4°C by 2100). These changes will also be accompanied by changing patterns of rainfall and more extreme weather events (heat waves, droughts, floods).

Note: These temperature changes are relative to 1990 (taken from the Synthesis Report of the Third Assessment Report of the IPCC, 2001). Therefore, an additional 0.6°C would have to be added to these numbers to be relative to pre-industrial levels. These calculations include not only changes in carbon dioxide but also include increases in non-carbon dioxide greenhouse gases, assuming they follow the SRES A1B scenario until 2100 and are constant thereafter.

3. Rather than decline, however, global emissions are increasing.³ Despite the Kyoto Protocol coming into force, emissions have increased in OECD countries and are growing rapidly in developing countries, especially the G+5 (Figure A.1). Because of global economic growth, the world is experiencing a boom in energy use dominated by use of fossil fuels, including coal-power generation, of unprecedented proportions.



4. The World Energy Outlook (2004) predicts that carbon dioxide emissions will increase by 63 percent over 2002 levels by 2030, comparable to the IEA reference scenario and the mid-range of IPCC projections.⁴ In addition, the emissions of GHGs such as methane, nitrous oxide, and tropospheric ozone precursors (oxides of nitrogen, non-methane hydrocarbons, and carbon monoxide) are all projected to increase. This means that, in the absence of urgent and strenuous actions to reduce GHG emissions in the next 20 years, the world will almost certainly be committed to a warming of between 0.5°C and 2°C relative to today by 2050, i.e., about 1.1°C and 2.6°C above pre-industrial levels.⁵

³ Total aggregate energy emissions from non EIT Annex I parties have increased by 9.2 percent (UNFCCC) between 1990 and 2003. CO₂ energy emissions in the EC increased by 3 percent, in the US by 17 percent, in Australia by 32 percent, in Canada by 27 percent, and in Japan by 12 percent (UNFCCC data).

⁴ IPCC projected an increase in energy emissions of between 47 percent and 112 percent between 2000 and 2030, and an increase in total emissions of between 29 percent and 103 percent when taking emissions from land management and deforestation into account.

⁵ Scientists generally agree that to avoid a significant anthropogenic perturbation to the climate system requires limiting the change in global mean temperature to 2°C above pre-industrial levels, and the rate of change in global mean temperature to less than 0.2°C per decade. Recent probability analysis suggests that: (i) to limit warming to 2°C above pre-industrial levels with a relatively high certainty requires the equivalent concentration of carbon dioxide to stay below 400ppm; (ii) stabilization of the equivalent concentration of carbon dioxide at 450ppm would imply a medium likelihood of staying below 2°C above pre-industrial levels; and (iii) if the equivalent concentration of carbon dioxide were to rise to 550ppm, it is unlikely that warming would stay below 2°C above pre-industrial levels.

ANNEX B. COUNTRY NOTES AND EMERGING INVESTMENT FRAMEWORK WORK PROGRAM

1. Following on the G8 request to the World Bank Group (WBG) to prepare an investment framework for clean energy and development, including investment and financing, a working group comprised of WBG regional sector managers and energy and environment specialists began the process of consultations with the G+5 countries—Brazil, China, India, Mexico, and South Africa. These consultations involved country representatives (executive directors) and their staff in WBG Headquarters and, subsequently, field-based consultations around the themes of clean energy development and climate change risk and management. While varying in specific emphasis from country to country, the consultations resulted in better understanding of the countries' strategic priorities and an outline of where incremental support from the WBG and others could be most useful.

A. Brazil

2. Brazil's emissions are low relative to industrial economies—the country accounts for only 1.3 percent of global CO₂ emissions. However, relative to Latin America, Brazil represents 25 percent of CO₂ emissions, and the country is the second largest source of fossil fuel-based CO₂ emissions in that region. Land use change and forestry account for 75 percent of total CO₂ emissions. About 2.3 million hectares of forests are lost in Brazil every year.

3. The expected impacts from climate change for Brazil include wetter than normal summers along the Southern coast, drier conditions in the Amazon region, increased occurrence of floods, landslides and forest fires, reduced fish catch, possible secondary health effects via vector borne diseases and reduced air quality, the reduction in the reliability of hydropower, and reduced biomass production and agriculture productivity. In this context, the most compelling, urgent issues for Brazil are:

- The implementation of a strategy for forested areas which balances developmental objectives with forest maintenance and regeneration.
- The further exploitation of Brazil's hydro potential, and the international recognition that hydro, subject to reasonable national environmental and social standards, is a renewable clean energy source as agreed at the 2002 World Summit on Sustainable Development.
- The realization of energy efficiency savings including through programs such as Procel and Compet, and measures to reduce energy theft.
- Industrial scale bagasse and ethanol production and research into biodiesel.
- Carbon trading as an important financial tool to help promote clean energy and other development issues (e.g., waste management)—a bridge to a post-2012 climate management regime is needed to maintain the carbon market.

- The development of financial products to help stimulate cleaner technologies and mitigate risks (debt finance, credit guarantees, and disaster insurance).
- The improvement of Brazil's capacity to deal with climate risks, including extreme weather events.

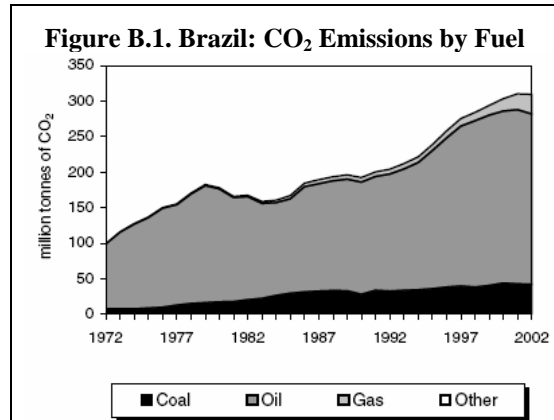
1. Country Context and Challenges

4. In 2002 total CO₂ emissions from fuel combustion in Brazil amounted to 309 million tons (Figure B.1.). In the period 1990-2002 there was an increase of 61 percent in total CO₂ emissions, and a 36 percent increase in CO₂ emissions per capita.

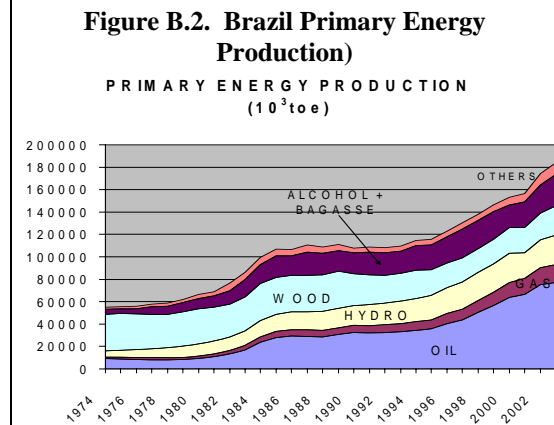
5. **Energy.** Brazil is unique in that approximately 44 percent of the country's primary energy supply comes from renewable sources such as hydropower and biomass (Figure B.3.). However, forecasts predict that this percentage is expected to decrease in the near future (34 percent for 2010, 31 percent for 2020), mostly due to the growth in the share of fossil fuels in the energy supply matrix.

6. Hydroelectricity represents 85 percent of Brazil's power generation. However, Brazil has developed only 41 percent of its hydropower potential. There is an estimated 260,000 MW of potential capacity available for the near future.

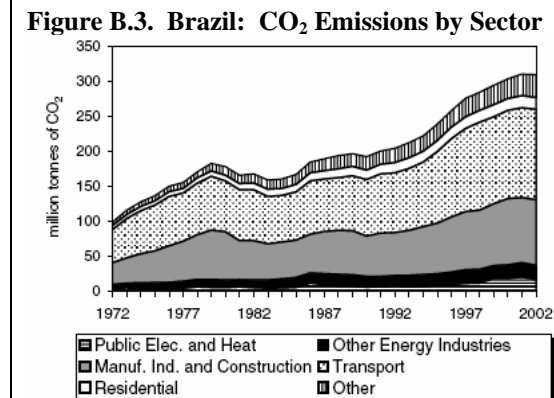
7. **Transport.** The transport sector is important in the economy, and in 2002 accounted for 53 percent of total CO₂ emissions from oil (See Figure B.3). The greatest share of indirect greenhouse gases was due to the road transport sub-sector. However, such emissions have had a significant reduction as a result of technological improvements in the vehicle fleet. The fuel mix for vehicle transportation is as follows: diesel 57 percent, gasoline 36 percent (all gasoline commercialized in Brazil has 25 percent of ethanol in the mix, which means that ethanol has an extra 9 percent share), ethanol 5 percent, and natural gas 2 percent.



Source: OECD



Source:



Source: OECD

8. Brazil is the world's largest producer and consumer of fuel ethanol from sugar-cane as a transportation fuel. Between 1975 and 2004, the ethanol program substituted about 230 billion liters of gasoline. More recently, Brazil has authorized that biodiesel be added to diesel fuel, as part of the Brazilian strategy for the Green Fuel Matrix Program.

9. ***Agrobusiness and Renewable Technologies.*** Brazil is a modern and efficient agricultural producer and could play a major role as an exporter of renewable technologies (bagasse¹-cogeneration, ethanol production) to other countries. The country is a world leader in industrial scale bagasse-cogeneration and ethanol production from molasses, cane juice, and in the future, potentially from the cellulose in the surplus bagasse. Another potential agrobusiness area is biodiesel production.

10. ***Land Use Change and Forestry.*** Forest conversion for agricultural activities has meant deforestation of native vegetation and forest regrowth on abandoned lands. Deforestation results in CO₂ emissions, and regrowth, in the removal of CO₂ from the atmosphere. In addition, changes in the carbon content of soils, as a result of land use changes, also affect CO₂ emissions and removals. Planted forests in the country, specifically industrial forests, is an expanding activity, which increases the biomass stock and has an impact on CO₂ emissions and removals, with a predominance of the latter.

2. Government Strategy and Opportunities

11. Although Brazil does not have commitments to reduce emissions of greenhouse gases under the Kyoto Protocol, there are many programs being implemented in the country that result in a considerable reduction of emissions and contribute to the ultimate objective of the U.N. Framework Convention on Climate Change. Some of these initiatives are responsible for the fact that Brazil has a relatively green energy matrix, with low levels of greenhouse gas emissions per unit of energy produced or consumed. One of these initiatives is the National Alcohol Program—Proalcool. As a result of this program, over the period 1975-2000 CO₂ emissions in the order of 400 million tons were avoided. Other programs have attempted to reduce energy waste—e.g. Procel (National Electrical Energy Conservation Program) and Conpet (National Program for the Rational Use of Natural Gas and Oil Products).

12. In 2002 Brazil proposed the “Brazilian Energy Initiative” under the Global Sustainable Development Summit, in Johannesburg, which called on countries to commit to increasing the share of new sources of renewable energy by 10 percent of their domestic energy supply. Programs such as Prodeem (Energy Development Program for States and Municipalities) have been introduced in Brazil to promote new renewables.

13. Other programs being implemented in Brazil correspond to the other commitments assumed by the country under Article 4.1 (g) of the UNFCCC, such as the promotion of research, capacity building and activities of systematic observation related to climate change, support and cooperation in the area of education, training, and public awareness of the issue.

¹ Bagasse is the fiber waste produced after sugar cane is processed and the sucrose is extracted.

3. Country Dialogue

14. Brazil is fully committed to being an active partner in the G8-sponsored initiative and views it as a complement to the Kyoto Protocol and the UNFCCC process. Under the G8 initiative, new and incremental resources for Brazil could be used to: (i) assess potential climate change opportunities and risks, and (ii) finance research, development, and commercialization of clean, climate friendly energy technologies.

15. Brazilian government representatives are well aware of climate change issues. An interministerial committee has been created to coordinate the implementation of the Kyoto Protocol and numerous departments and experts are working on various aspects of mitigation and adaptation. As the pioneer of the Clean Development Mechanism (CDM), Brazil can play an important leadership role in future negotiations on these issues.

16. A World Bank Group mission visited Brazil from 17-27 October 2005. The objectives of this mission were:

- **Immediate.** To initiate a dialogue with Brazil on the G-8 clean energy and climate change initiative, brief Brazilian Government and private sector representatives on the G-8 proposed role of the World Bank Group and some immediate milestones over the next few months, and seek their views on the needs and priorities for addressing climate change. Brazilian officials were informed that the results of this process would feed into an investment framework prepared by the World Bank Group for discussion with the Ministers of Finance at the IMF-World Bank meetings in April 2006.
- **Medium-Term.** To develop a process for regular and intense Government of Brazil/World Bank Group engagement on clean energy for development and climate risk management activities of both national and global scope. To explore areas where the Government of Brazil might wish to see more specific engagement through lending, grant (e.g., Global Environment Facility), and advisory activities of the World Bank Group.

17. The World Bank Group team met with representatives from Government (Ministry of Finance, Ministry of Mines and Energy, Ministry of Science and Technology, Ministry of Environment, Ministry of Planning, Ministry of Development, Industry and Trade, Ministry of Agriculture, Casa Civil); important agencies (electricity and oil and gas regulators, Caixa Econômica Federal, National Institute of Meteorology; Eletrobrás, Petrobrás, BNDES, CMV); and private sector and non-governmental associations (National Forum on Climate Change, UNICA). Agreed follow-up steps include:

- Deepening the process for determining Brazil's priority analytical work and concepts for the preparation of the Investment Framework for clean energy and development.

- Preparing new proposals for GEF for Brazil to (i) address energy efficiency and (ii) improve the provision of energy to rural communities.
- Discussing the prospects for World Bank Group engagement in the climate change and energy sectors with government during the upcoming CAS progress review meeting.

4. Main Proposals

18. Based on the key issues and challenges Brazil faces, the most important opportunities and strategic questions for near term action include:

- ***Clean Development Mechanism (CDM) and the Future of Carbon Trading.*** Brazil has been a pioneer in the carbon market and includes CDM as an important tool to reach its development objectives. However, it is concerned with the uncertainty of the post-2012 period and the high transactions costs of the CDM, both of which are having a negative effect on the infant carbon market. Brazil can play a major role in helping to shape opinion on the necessity and design of a future carbon trading regime in order to provide longer-term market signals. *What can be done to improve the transparency, regulatory certainty, and lower the transaction costs of the current CDM system?*
- ***Technology Development and Trade.*** In addition to the transfer of clean technologies from industrial to developing countries, South-South and even South-North trade is particularly important from Brazil's perspective. There are a number of climate-friendly products and processes in which Brazil is a world leader—development of such technologies and trade fit well into Brazil's priorities of spurring innovation and competitiveness. *What are the most promising markets for exports of existing products and technology (ethanol, bagasse, flexfuel cars, etc.). What are Brazil's proposals for funding R&D and commercialization of new leading edge technologies?*
- ***Clean Energy Development.*** Among the sectors where large reductions in greenhouse gas emissions may be possible at moderate incremental costs are:
 - Energy Efficiency
 - *Electric power.* Refurbishment of existing, older power plants (both thermal and hydro) and transmission and distribution loss reduction (including theft).
 - *Industrial energy efficiency.* Investments in lighting, motors, pumps, and boilers, in addition to co-generation.
 - *Urban transport.* Expanded public transport and improved fleet usage for both passengers and freight.

- *Buildings.* Improved efficiency in residential and commercial buildings through improved design, materials, and systems.
 - *Water and sanitation utilities.* Improved electricity use in water and wastewater companies.
 - *Gas utilities.* Expand financing for natural gas use to replace older, less efficient appliances and displace more polluting and more GHG-intensive fossil fuels.
- *Waste Management.* Solid waste management, including landfill gas recovery, composting, and biogas from animal husbandry.
- *Gas Flaring and Industrial Gases.* Reduce greenhouse gas by-products from production processes.
- In addition, there are various promising renewable energy options for Brazil to develop:
 - *Hydropower.* Brazil depends on hydro for a large percentage of its electricity and plans to continue to rely on hydro to meet future power needs. Hydro, irrespective of size, is renewable and is preferable to many of the alternatives for electricity generation. The hydro option, including large-scale, should be discussed in the context of clean energy options under the G8 climate change initiative. *Under what design conditions can large hydro maximize net positive GHG effects?*
 - *Bagasse and Ethanol.* Brazil is a worldwide leader in ethanol production with great potential to export products, technology, and know-how to other countries. Removing barriers to ethanol trade is important for Brazil and other low-cost ethanol producers. What are the key factors that make bagasse and ethanol technology replicable?
 - *Bioenergy for Isolated Areas.* There is strong government interest in developing bioenergy for remote areas, including biogas systems, biomass cogeneration, and straight vegetable oil. What are the technical barriers and costs of these technologies to be used in isolated areas?
 - *Wind.* Brazil has a large amount of world-class wind resources, particularly in the Northeast. Some 1,400 MW of wind contracts have been signed under PROINFA and at least 200 MW of wind projects are now under construction. What are the constraints to further wind development and the lowering of wind technology costs in Brazil?
 - *Biodiesel.* Biodiesel is viewed by the Government as a potentially important energy source; however, its development is still in its early stages. What is the cost-effectiveness of biodiesel at present in Brazil and what alternatives are available?

- ***Deforestation and Reforestation.*** It is a declared government objective to reduce deforestation and to promote reforestation. *What market-based incentives could be used to increase incentives for reforestation and reduce deforestation? To what extent would the inclusion of “avoided deforestation” within the carbon trading regime help to reduce deforestation? What are the most cost-effective opportunities for reforestation in the short-medium term? Should the World Bank play a greater role in agriculture, forestry, transport, energy and environment in the Amazon and Center-West regions?*
- ***Adaptation.*** Improving Brazil’s ability to deal with current climate variability is an important step to coping with potential future climate change impacts. An immediate focus on measurement, forecasting, and analysis of climatic trends, especially extreme events like droughts, floods, and storms, would be beneficial. Also, it would be useful to: (i) improve understanding of the risks that Brazil faces in terms of potential climate impacts (including those associated with current climate variability and global climate change); (ii) analyze the most vulnerable sectors and localities; and (iii) design a screening tool and analysis for proposed new infrastructure investments. *What are expected to be potential extreme weather events in the short run and longer range climate change impacts in Brazil? What are the needs for micro-mapping, institution building, measurement and data rescue? What structural and non-structural measures should Brazil undertake to prepare for the increased probability of severe climatic events in the shorter term? How should these effects be included in the sensitivity analysis of agricultural activities and new infrastructure?*

B. China

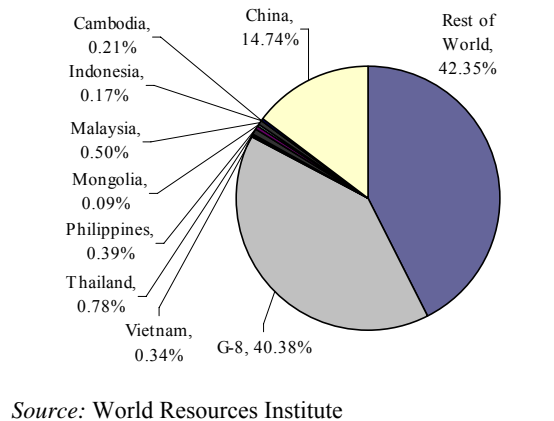
19. With a rapidly growing and highly fossil-fuel-dependent economy, China is critical in the global efforts to reduce green house gas (GHG) emissions. China is the second largest emitter of CO₂ of the world and could surpass the United States, which is the current leader, by 2030. With its long coastlines and vast spans of arid and semi-arid lands, China is also vulnerable to the negative impacts of climate change. The sheer size and speed of China’s economic growth suggest that China cannot follow the traditional growth pattern and must adopt highly proactive energy sector policies to avoid potentially large risks from (i) elevated health and environmental damages due to high dependence on coal and oil; (ii) energy supply disruptions as dependence on imported oil continues to grow; and (iii) the undermining of China’s long-term goal of becoming a prosperous and harmonious society. Actions taken to address the climate change challenge will generate large national benefits by improving ambient air quality, reducing acid deposition, and in mitigating damages caused by climate change.

1. Country Context and Key Challenges

20. ***Greenhouse gas (GHG) Emissions in Perspective.*** While on per capita basis China’s GHG emissions are still low—only 1/6 of the emissions in the United States—in total quantity China has become the world’s second largest GHG emitter (see Figure B.4).

In 2000, China emitted around 2.8 billion tons CO₂ equivalent (tCO₂e), second only to the United States, which emitted around 5.8 billion tons CO₂ equivalent (World Bank, Little Green Data Book). China accounts for 15 percent of the world total GHG emissions and 1/3 of the developing countries' contribution. Fossil fuels contribute about 80 percent of the total GHG emissions in China and coal accounts for 80 percent of total energy sector emissions.

Figure B.4. China: Countries' and Country Groups' Share in Global GHG Emissions, 2000



21. Trends, Projections, and Impacts.

Due to China's current drastic increase in energy consumption (over 50 percent between 2000 and 2004), CO₂ emissions have been increasing at a substantially faster pace—10-15 percent per year—than in other parts of the world, including North America and Europe. China is expected to become the world's largest GHG emitter before 2030. In addition to its global impacts, climate change is expected to intensify already serious water shortages in northern China and is predicted to reduce food production by 10 percent between 2030 and 2050.

22. Reliance on Coal. No other major economy is as reliant on coal as China. The current consumption of about 1.8 billion metric tons of coal per year is the main cause of China's serious urban air pollution and widespread acid rain problems as well as its contribution to about 80 percent of China's GHG emissions. The consensus is that coal will remain dominant in China's energy mix in the next two decades, highlighting the importance of promoting low-environmental-impact coal mining and utilization technologies. An extensive national energy study completed in 2002 by China's Energy Research Institute suggests that, in the best-case scenario, the share of coal in primary energy mix would decrease from 70 percent to 60 percent between 2000 and 2020. In fact, total coal consumption could exceed 1466 million tons of coal equivalent by the end of 2006.

23. Industrial Development. No other major economy is as industry-driven as China. Dubbed the "world's workshop," China has seen rapid expansion of its manufacturing industry. The share of manufacturing in GDP grew from 37 percent to 44 percent between 1990 and 2002. However, China is yet to become an energy-efficient manufacturer. On a value-added basis, the energy intensity of China's economy is about three and six times that of the US and Japan respectively. While distortion of currency exchange rates may explain some of the gaps, the main culprits for China's poor energy performance are the high share of industry in GDP and the low energy efficiency of industrial production. China's basic materials industries, most of them the largest in the world, use 20 to 120 percent more energy per unit physical output compared to the international best practices (see Table B.1).

Table B.1. Energy Use Per Unit Output, China vs. International Best Practice

	<i>Steel</i>	<i>Cement</i>	<i>Nitrogen Fertilizer</i>	<i>Paper</i>	<i>Electric Motors</i>	<i>Coal-fired Boilers</i>	<i>Heavy Trucks</i>	<i>Coal-fired Power</i>
International Best Practice	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
China Good Practice	1.21	1.45	1.31	2.20	1.11	1.15	2.25	1.19

Source: State Development and Reform Commission, Mid- to Long-term Energy Conservation Plan, 2004.

24. **Rapid Urbanization.** China is undergoing rapid urbanization at an unprecedented scale. The urban building stock has quadrupled in the last 15 years and is expected to more than double in the next 15 years. New buildings need energy to cool and heat and improving the thermal integrity of the buildings and the energy efficiency of space conditioning systems are critical to prompt a large spike of building energy consumption in the coming decades. Average apartment buildings in northern China need two times the amount of energy for heating as countries with similar climates in North America and Western Europe. Fast urbanization also entails enormous increase in landfill wastes, a significant source of methane emissions. The sheer speed of city-creation in China calls for smart urban planning that can significantly affect urban-transport energy use in the long term.

25. **Growing Transport Contributions to GHG Emissions.** Although transport contributes only to about 7 percent of CO₂ emissions in China currently (compared to more than 30 percent in the US), it is a growing source of GHG emissions in China. In particular, private motorization is growing much faster than GDP, contributing to a significant increase in the share of transport in emissions as well as a growing demand for fuel. China accounted for one third of the increase in world oil consumption in the last five years and imported oil now accounts for about 33 percent of China's oil consumption. This dependency is projected to grow to 50-60 percent by 2020 as the automobile fleet is expected to grow by six times.

26. **Impacts of Climate Change.** Climate change is expected to have significant impacts on water resources, agriculture, terrestrial ecosystems, coastal zones, and marine ecosystems. Projections indicate intensified water shortages in northern China and an increased incidence of extreme hot temperature events and of consequent flooding and droughts. In addition, forecasts indicate an overall decreasing trend for yields of major crops such as wheat, rice, and maize, and a change in the distribution of major crops due to climate change. In coastal areas, the sea level rise has become much more obvious in recent years, contributing to growing seawater intrusion into river mouths and adverse effects on the quality of the fresh water supply.

2. Government Strategy and Future Opportunities

27. **Recent Policies and Trends.** The climate change challenges are well understood in China. The Government has made commendable efforts in market reforms of the energy sector as well as in policy support for energy efficiency and renewable energy technologies. China is liberalizing coal, oil and electricity institutions and prices, modernizing its thermal power and industrial energy technologies, pursuing a vigorous energy efficiency program,

and has pledged to meet 10 percent of its primary energy needs from renewable sources by 2020. However, many of the Government's policy interventions in the energy sector have been reactive and incremental due to concerns about interruptions of growth and undue financial costs. In addition, inefficient and polluting small-scale production facilities in steel- and cement- making have surged in the latest boom even though policies to trim their numbers were in place since the early 1990s. Between 2002 and 2004, small and inefficient units (<200MW) accounted for 36 percent of newly installed coal-fired capacity, making their share in total coal-fired capacity at nearly 40 percent. Such examples of lost opportunities in new capital investments extend to buildings, district heating systems, and the automobile industry.

28. ***Window of Opportunity.*** There is a window of opportunity for China to become a leader in clean development in the coming decades by seizing the opportunities afforded by the great expansion of production assets and building stock to make maximum use of best proven technologies and international best practices. In order to attain a much higher level of economy-wide energy efficiency by 2020, China must put maximum emphasis on the energy efficiency aspects of the new investments in the next 15 years, during which two thirds of the 2020 economy will be created. As the largest developing economy with an already substantial and growing market power, China could begin blazing a clean development path by becoming a world leader in the application of advanced thermal power technologies, deployment of large scale renewable energy technology, manufacturing energy efficiency, automobile fuel economy, and building energy efficiency. China has considerable small hydro and wind development potential. In part through private sector investments, a large number of small hydro and wind power projects are under development. There is also a larger opportunity to displace coal utilization with expanded use of natural gas and private investments are helping to expand gas distribution networks. The prevailing coal mining practice in China calls for increased efforts to improve management of the entire coal supply chain and minimize environmental impact and human fatality. In the meantime, market reforms in the energy sector must be deepened and accelerated to ensure that the new investments achieve their full energy efficiency potentials.

29. ***Clean Development Mechanism (CDM).*** The CDM is one of three instruments available under the Kyoto Protocol by which OECD countries can purchase emission reductions generated in developing countries through a market mechanism. According to World Bank estimates, China could capture about half of the international CDM market for CO₂ reduction. In addition, CDM projects facilitating emission reductions (ERs) from the destruction of powerful industrial gases, such as HFC-23, have the potential to generate between 400-550 million tCO₂ e of ERs until 2012 and could generate up to one-third of the total international requirements.²

² HFC-23 (Trifluoromethane) is one of the three most potent greenhouse gases targeted under the Kyoto Protocol. It has 11,700 times the global warming potential of carbon dioxide. It is a byproduct in the manufacture of HCFC-22, a chemical widely used as a chemical feedstock and as a refrigerant. HFC23 has marginal economic value; therefore, it is usually being released to the atmosphere during production. There are no regulatory requirements to obligate its capture and disposal in countries. China is the world's largest source of HFC-23 emissions.

3. Follow Up Action and Bank Assistance

30. The World Bank Group has forged a close partnership with key counterparts in China and it is engaged in analytical and advisory assistance, investment projects (including IBRD and GEF financing), as well as carbon financing in a range of areas with direct relevance to China's response to the clean energy and climate change challenges. Reducing China's reliance on coal has been a major theme of the policy dialogue and has been supported by the Bank/GEF lending and advisory activities to improve energy efficiency, increase natural gas use, and scale up renewable energy market. The Bank has provided assistance in the formulation of the recently passed China Renewable Energy Law, helped assess the opportunities for China's participation in the CDM market, and assisted in designing the policy and institutional framework for CDM market development and the establishment and capitalization of the Clean Development Fund in the context of the HFC-23 Emission Reduction Project.

31. The Bank has helped mobilize GEF grants of \$230 million (GEF Council approved) for climate change mitigation through innovative measures and also helped bring new generation and transmission technologies to China through some \$6.2 billion in IBRD lending. In addition, the Bank is engaged in development of urban transportation strategies to promote sustainable transport, including proposed GEF support for sustainable transport policies and investments, and has initiated several carbon finance (CF) projects in the energy, industry, and waste management sectors. The matrix at the end of this Annex summarizes the main directions of the Bank's on-going partnership with China in the area of clean energy and climate change. Strengthening this partnership is an important element of the Bank's next Country Partnership Strategy in China.

C. India

32. In the context of clean energy for development and climate change, India's situation is globally unique. In absolute terms, with about 4.2 percent of the world's total fossil fuel-related CO₂ emissions, India is the fifth-largest emitter in the world behind the United States, China, Russia, and Japan, with emissions growing rapidly. On a per capita basis, however, its GHG emissions are still very low by international benchmarks. Its challenge—and the challenge of the international community looking to support it in clean energy development and climate risk management—is not to reduce emissions per se, as to lower the carbon intensity of its development path. Furthermore, India is one of the most vulnerable countries in the world to the impacts of global climate change and might soon face the need for increased adaptation expenditure. In this context, the World Bank Group sees its role in helping India address both clean energy growth and adaptation needs in a balanced fashion, with the overall maximum benefit to the country long-term economic and social development goals.

1. Country Context and Key Challenges

33. In India, GHG emissions per unit of GDP are very high - about 4 times greater than in high income countries—suggesting the existence of significant opportunities for

reducing carbon intensity of current economic activity and future economic and social development path. GHG and other emissions per unit of energy (kWh) produced are high, pointing to the need to shift the balance of production towards cleaner sources. Industry is the fastest growing emitter of GHG in India (NATCOM 2004) as well as a sector with significant near-to-medium term potential for increasing energy efficiency and using cleaner technologies and fuels (see Table B.2).

34. India's power generation, the largest source of GHG emissions, is mostly coal based, taking advantage of country's vast coal reserves—GHG intensive thermal, mostly coal-fueled, power plants produce more than 80 percent of electricity. Given that half of the population still lack reliable access to basic electricity services and many industries suffer output losses because of unreliable power supply, increasing power generation and extending transmission and distribution networks remains a top priority. About 150000 MW capacity additions is planned for the next decade by both private and public sector. Significant reductions in GHG intensity can come from reforming the power sector, particularly reducing extensive subsidies and cross-subsidies and high transmission and distribution (T&D) losses. Currently, the annual T&D losses are about the size of the annual capacity addition. Another opportunity to reduce the GHG intensity of the power sector is to shift the balance of production towards more diversified and cleaner sources. The latter include a mix of large and small hydro and other forms of renewable energy, greater use of clean coal and gas technologies, and rehabilitation of existing thermal production to increase efficiency and reduce emissions. Close to one-fifth of India's total electricity generation now comes from hydro sources and this share is planned (by GoI) to increase.

35. In sum, India has significant opportunities to accelerate its growth, increase electricity access, and meet various energy needs while lowering the carbon intensity of its development path. This can be achieved by improving the efficiency of energy production, distribution, and use, changing the primary energy mix towards less carbon-intensive sources, and benefiting from leapfrogging to new advanced technologies that are also climate-friendly. There are also significant opportunities for reducing pollution intensity (i.e. carbon emissions per unit of output), in the industry sector as well as some opportunities in the transport and municipal sectors. There is likely a scope for supporting locally-beneficial activities in the agriculture and forest sectors that increase carbon sequestration; albeit more research is needed on this issue. The role of the Bank in this respect, as we see it, is to help India realize these opportunities regardless of the source of

Table B.2. India: Contribution to GHG emissions by sector

<i>Sector</i>	<i>Percent</i>
Energy production & transformation	35
Agriculture	28
Industry, including	20
Industrial combustion	12
Other industrial processes	8
Transport	8
Residential sector	5
Land Use, Land use change and Forestry	2
Others (including waste)	1

Source: NATCOM, MoEF, 2004*

*India's Initial National Communication (NATCOM) to the UNFCCC was implemented and executed by the Ministry of Environment and Forests, Government of India, funded by the Global Environment Facility under its enabling activities program through the United Nations Development Program, New Delhi. The data has been drawn from a variety of official GOI sources as well as industry association and stakeholder reports. The full report is available on the web at: <http://www.natcomindia.org/flashmain.htm>. Information on the specific data sources for the emissions inventory is presented at the following website:

<http://www.natcomindia.org/datasources.htm>.

financing, but in parallel facilitate access to grant, concessional, and commercial financing as a means to begin capturing the benefits of “low carbon” development.

36. India is also facing an important adaptation challenge. India’s current adaptation challenge lies in the rapid onset of increased variability in its climate and the vast number of people that are at risk, i.e. the level of vulnerability (in both relative and absolute terms) and potential impacts are higher than ever before. The prospect of significant warming in parts of the country and permanent changes in rain patterns are also sources of medium-term risk for India. The impact of increased climate variability and change on the agriculture/water resources nexus is of key concern. In the longer term, intensification of cyclones and sea level rise will be major challenges since India has a long coastal line and low lying coastal areas where extensive urban and other development is taking place. A focus on adaptation would therefore require the development and implementation of a climate risk management approach that support a much more proactive consideration of climate issues in India’s development strategy, more generally, and development-oriented projects, more specifically. An adaptation strategy, therefore, implies some level of actions and adjustments across most of the basic pillars of development, from agriculture and water resources to infrastructure planning and development.

2. Government Strategy and Opportunities

37. The Government of India (GoI) strategic approach to supporting clean energy development and climate change management is to reconcile the objectives of rapid growth, lower carbon intensity, and greater adaptive capacity to climate risks in a mutually reinforcing manner. In this process, GoI attaches a central role to transfer, development, dissemination, and commercialization of advanced clean energy and industrial technologies.

38. The priority near-to-medium terms opportunities are seen in:

- T&D loss reduction
- Coal power generation R&M
- Large hydro power
- Industry EE and fuel switch

39. Important longer term opportunities, which need to be paid attention today, are;

- Renewable energy
- Sustainable transport
- Natural gas sector development

40. ***Financing Instruments.*** GoI is interested in scaling-up access to GEF resources and promoting CF/CDM opportunities. It is also interested in using these instruments in a strategic and complementary manner. Testing and facilitating the uptake of new low carbon technologies, in particular, is expected to have a large downstream impact on reducing carbon intensity of India's economy.

41. India represents one of the largest potential markets for low-cost carbon-reducing investments. It is currently one of the three largest potential suppliers of CDM credits to buyers around the world. Estimates suggest that India has the potential to capture 10 percent of the global carbon market during the first commitment period of the Kyoto Protocol (2008—2012) and receive up to \$150 million per year in carbon revenues. Most of these measures/projects also produce benefits that further India's national development and environmental objectives, which the application of global environmental financing instruments can help facilitate.

42. The Bank-supported National Strategy Study for CDM Implementation in India, prepared by MoEF, estimates that about 400 million ton of CO₂ potential in the country can be realized through the year 2012 in the energy, industry, municipal, and transport sectors (excluding agriculture/NRM) at costs below or close to \$10/ton, although this estimated figure varies widely by source. This reduction is capable of offsetting the projected increase in total CO₂ emissions in India by 2012, as compared to 2004 (assuming 5 percent increase per year in line with the recent trend). Available estimates of GHG mitigation potential in the NRM and agriculture sector are even larger, but need to be taken with caution and verified by further analysis. Using an average cost of \$5/tCO₂, this implies the financial need of \$2 billion through 2012 to help India realize all win-win and low-cost options (without counting the agriculture/NRM sectors)—an amount that greatly exceeds the funding available through both CF and GEF. This is a very rough and preliminary estimate, which requires additional studies, but it is indicative of the significant financial gap that exists at the moment. Thus, identifying additional funding sources and instruments to support the implementation of the low cost measures across all relevant sectors appears to be a priority for helping GoI to realize the inherent benefits of a lower carbon development path.

43. Given vulnerability of the water and agriculture sectors to climate variability, adaptation is also seen as a top priority, as evidenced by a request to the Bank for a major analytical work and technical assistance for developing the adaptation program.

3. Brief Synopsis of Country Dialogue

44. Country dialogue is quite rich and has been further expanding since the Gleneagles summit. To date, particular progress has been achieved in the area of Carbon Finance (CF), with a rapidly building project pipeline and development of a robust plan to use future resources in a more strategic manner. India acceded to the Kyoto Protocol in August 2002 and one of the objectives of acceding was to fulfill prerequisites for implementation of the Clean Development Mechanism (CDM) projects, in accordance with national sustainable priorities. So far the large majority of CF operations have been prepared by project sponsors on a stand-alone basis, foregoing the large potential CF

benefits of claiming emissions reductions from the Government investment program. By late 2005, a CF strategy was developed and discussed with MoEF and DEA. It calls for 1) launching an active business development process in sectors with high potential such as energy (coal power rehabilitation, hydro, transmission, etc.), waste management, and energy efficient in the urban and industrial sectors (cement, fertilizer, HFC23, and N₂O), and 2) scaling up the minimum size of CF operations to 1 million tCO₂e³, except for the Community Development Carbon Fund (CDCF) and the BioCarbon Fund (500,000 tCO₂e). The focus will be on operations that can be replicated across sectors or states in India.

45. Nevertheless, the level of awareness of CF opportunities at the State and sub-regional level remains very uneven. The Bank and other multilaterals operating in the country (i.e. ABD, UNDP, UNEP, GTZ, etc.) are implementing a program of grant support for in-country capacity building and CF operation development activities

46. Energy sector dialogue has long focused on helping reduce T&D losses (via distribution reform and transmission operations), supporting renewable energy, and—more recently—re-engaging in large-scale hydro projects. One of the promising recent developments is a large-scale engagement in more efficient and cleaner use of coal. India's program to renovate and modernize (R&M) coal-fired power stations has immense potential to reduce carbon intensity. However, the program has fallen short of planned targets and even when the R&M projects have been implemented these have focused on capacity augmentation and life extension rather than energy efficiency. To this end, the Bank has worked with power sector institutions to identify barriers to identification and implementation of rehabilitation projects. A proposed program that would reduce barriers while optimizing rehab projects for energy (and therefore carbon) efficiency has been accepted by GEF on a preliminary basis, and funding is now reserved for this program within the GEF pipeline. The Bank is now refining, in discussion with the Government and with relevant institutions, the prospective technical and institutional approach, including whether or not IBRD lending will be needed as part of the financing structure. Agreement on program design is sought by February 2006. The Bank is also exploring opportunities to re-engage in the India's oil and gas sectors.

47. Another important emerging area of engagement on low carbon development is urban air quality management, which offers an opportunity to utilize synergy between the objectives of (i) improved air quality, public health, and cities' image, (ii) better environmental performance and compliance by industry, and (iii) reduced carbon intensity. These synergies and opportunities are particularly significant in rapidly growing—on a massive scale—industrial townships and clusters. Similar opportunities in the urban transport sector have been the focus of an active dialogue over the past several months with respect to developing, with GEF support, a sustainable urban transport program.

48. ***Strategy for Partnering With GEF.*** Following the adoption of the new GEF Resource Allocation Framework, the Bank has prepared and shared with GoI a draft

³ TCO₂e: Metric ton of emissions reduction of GHG measured in equivalent Carbon Dioxide units

strategy note, outlining an approach to increasing the scale and effectiveness of the use of GEF resources in India. The note proposes a shift from ad hoc projects to a small number of relatively large programmatic operations, addressing key global environment concerns. A principal pillar of the proposed strategy is to develop a long-term multi-focal GEF-India Country Partnership Program for Low Carbon Development, which would cover all climate-change related GEF focal areas. If agreed, this would be an important instrument to advance the dialogue and progress on energy efficiency, renewable energy, and sustainable modes of transport.

49. Over the past two years, the Bank has also been engaged in a new area of adaptation to climate change, by supporting a pilot study on adaptation to drought risks in Andhra Pradesh and a major national study on reducing vulnerability of the water and agriculture sectors to climate risks.

50. A mission to discuss an overall approach to strengthening Bank support to climate change management—led by Sector Manager, Environment, and including environment, energy and transport staff—took place in December 2005. Meetings were held with high level GoI officials from DEA, Ministry of Finance (with participation by Country Director), Ministry of Environment and Forests, and the Planning Commission. GoI confirmed its interest in collaborating with the Bank on low-carbon development through a program of both AAAs and lending operations (outlined below) as well as acknowledged the importance of continuing the dialogue and technical assistance on the adaptation issues.

4. Follow Up Action and Bank Assistance

51. The Bank plans to deliver the assistance program outlined below as well as continue and deepen the climate change dialogue with GoI, building on the findings of the AAA work and lessons from lending operations:

- Facilitating Clean Energy Development:
 - AAAs:
 - Low carbon long-term energy security (including gas and oil sector issues) and
 - Strategies for low carbon growth (multi-sectoral, including industrial EE, sequestration opportunities, etc.).
 - Lending:
 - Coal R&M (with GEF/CF);
 - Urban Air Quality Management Project (with GEF/CF);

- GEF CPP for Low Carbon Development (multi-focal including support to energy efficiency, renewable applications and sustainable transport);
 - IFC investments in hydropower, wind, off-grid solar PV, and biomass projects;
 - Scaling-up CF program;
 - Large hydro project(s);
 - Transmission project(s); and
 - Power sector/distribution reform projects.
- Two –prong approach to supporting adaptation:
 - *Analytical and Advisory Activities* to identify and realize opportunities for enhancing adaptation and reducing vulnerability through a better integration of climate risk issues into relevant sector programs.
 - *Specific innovative climate risk adaptation-projects* that (with some support from global financial instruments such as CCIG, GEF, etc,) that help with:
 - basic climate data management and dissemination;
 - development and deployment of climate decision-making tools, including capacity development for integrated analysis at local level;
 - pilot projects designed to test institutional mechanisms for managing and deploying more climate-resilient economic practices (such as the pilot Drought Adaptation Initiative in AP proposed as a follow-up to the AP Drought study).

D. Mexico

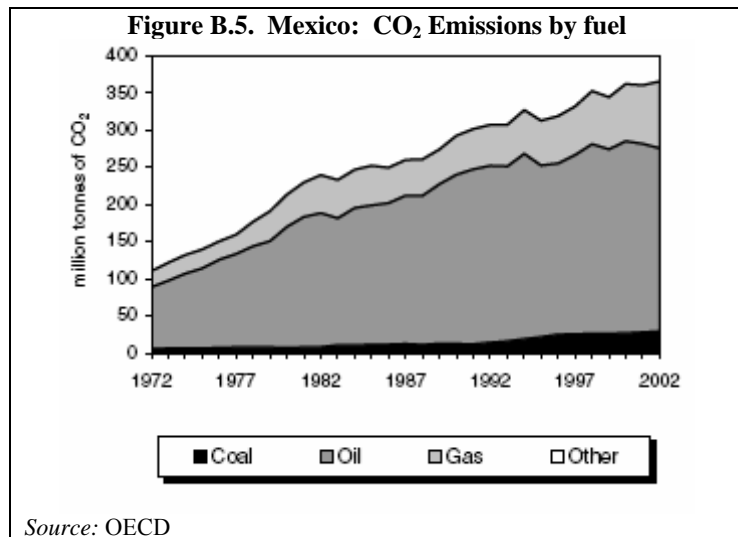
52. Mexico is the largest source of fossil fuel-based greenhouse gas emissions in Latin America. With 673 million tons of greenhouse gas emissions in 2000, the country occupies the 14th place in the world, accounting for 3 percent of global emissions.

53. The expected impacts from climate change for Mexico range from accelerated desertification, increased occurrence of fires and droughts, higher temperatures, and changes in the intensity and in the seasonality of rains to more intense hurricanes and floods, reduction of the water supply, and increase in the sea level. In this context, the most compelling, urgent issues for Mexico are:

- **To increase the country's capacity to deal with climate risks**, including extreme weather events, such as the El Niño, which appear to have been occurring more frequently and more intensely since the eighties, as compared with previous periods. Droughts and forest fires in 1982-1983 have caused considerable damage in Mexico and Central America and the extended drought registered during the last decade seems to be the result of general climate changes. These phenomena are particularly critical in a country with the 4th greatest biodiversity in the world.
- **To unleash the potential for energy efficiency savings**, including the expansion of financial markets serving the nascent Energy Service Company (ESCO) industry, and the adoption of performance monitoring measures in CFE and PEMEX.
- **To develop industrial and refinery cogeneration**, as stimulated through regulatory changes designed to make such investments more attractive.
- **To expand renewable energy** through a combination of technology, knowledge, and resource transfer.
- **To use carbon trading as an important financial tool** to help promote clean energy and other development issues.
- **To integrate environmental considerations and costs** into planning and modeling across sectors, especially energy and transport.

1. Country Context and Challenges

54. In 2002 total CO₂ emissions from fuel combustion in Mexico amounted to 365 million tons (see Figure B.5). In the period 1990-2002, there was an increase of 25 percent in total CO₂ emissions and of 1.4 percent in the CO₂ emissions on per capita basis. It is projected that by 2010 Mexico's CO₂ emissions will amount to approximately 879 million tons.



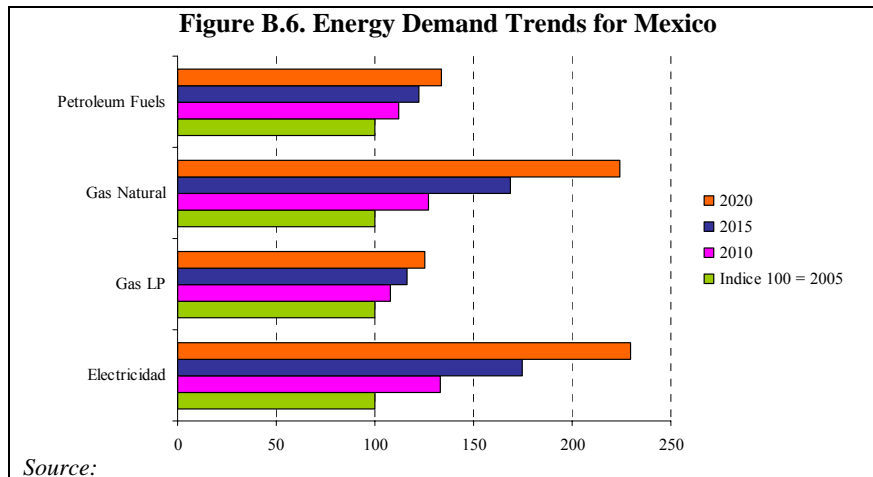
55. **Energy.** These trends partly reflect the energy matrix of the country. Mexico is a rich country in terms of natural resources. It is one of the world's most important oil producers, with the eighth largest oil reserves, and it also has substantial natural gas reserves. Fossil fuels are therefore Mexico's main energy source with over 90 percent of total energy supply, as presented in Table B.3.

56. In the next ten years the demand for electricity is expected to increase around 75 percent, the demand for natural gas—69 percent, the demand for LNG—16 percent, and the demand for oil—34 percent. As a consequence, assuming an annual GDP growth rate of 4.5 percent, CO₂ emissions should reach 879 million tons by 2010.

Table B.3. Mexico: National Energy Balance 2004

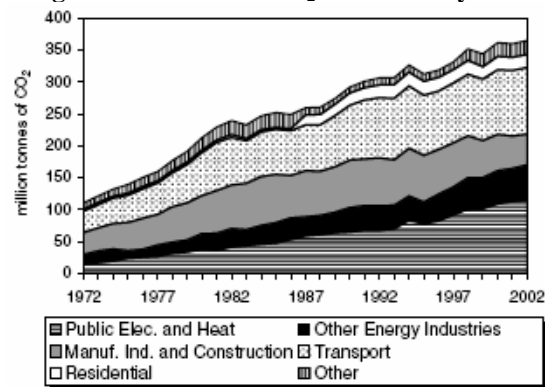
<i>Primary Energy Sources</i>	<i>PJ</i>
Coal	198.85
Fossil fuels	9,359.64
Crude oil	7,432.56
Condensed	178.34
Not associated gas	564.51
Associated gas	1,184.23
Electricity	421.81
Nuclear	100.63
Hydro	254.39
Geothermal	66.72
Wind	0.06
Biomass	350.47
Bagasse	92.06
Firewood	258.41
TOTAL	10,330.77

Source: Sistema de Información Energética



57. **Transport.** The transport system in Mexico is of great economic importance, and in 1999 more than 2,766 million passengers and 726 million tons of cargo were transported through the system. Over the years, the traffic volume has significantly increased and this is reflected in the gradual expansion of the share of emissions originated in transport—in 2002, transport represented over 40 percent of total CO₂ emissions from oil (See Figure B.7).

Figure B.7. Mexico: CO₂ Emissions by sector



Source: OECD.

58. Aiming to limit transport sector emissions and increase efficiency, various regulations have been introduced, establishing limits for emissions from gas-fueled vehicles, diesel-fuel vehicles, etc. Another set of regulations have aimed at fostering natural gas as an alternative fuel.

59. ***Vulnerability and Adaptation.*** There has been an increasing interest in the assessment of the vulnerability of Mexico to climate variability and climate change and of possible adaptation measures. As was mentioned in the First National Communication on Climate Change to the UNFCCC, Mexico is very vulnerable to climate change. The 1982-83 droughts and forest fires registered in Mexico and Central America caused damages estimated at more than US\$ 600 million. Mexico also experienced an extended drought over the last decade, which appears to be the result of climate changes. Moreover, the El Niño- La Niña events also seem to have become more frequent and more intense.

60. For real adaptation to climate change, the element of water is perhaps the most important one, given its scarcity in Mexico and its impact on agricultural activities and on the environment in general. It will be necessary to find a substitute for the agricultural irrigation mechanisms that are currently used. Urban areas will have to adapt by finding forms of recycling or re-using water. Sea water desalinization could also become necessary in the long run. Plans for territorial reorganization could be implemented in order to improve land use and reduce the vulnerability of populations to meteorological phenomena stemming from climate change. A second line of measures to reduce vulnerability would be to establish meteorological warning centers and decision-making systems.

2. Government Strategy and Opportunities

61. With the presentation of the Second National Communication to the UNFCCC, the Mexican Government underlines its commitment to inform about its advances to mitigate greenhouse gas emissions. In the past decade, Mexico has attempted to pursue a national development policy consistent with greenhouse gas emissions mitigation efforts. The government strategy has included:

- Sink enhancement policies in forest areas, aiming at the conservation of fixed carbon, such as through the establishment of protected natural areas, sustainable management of forests and rainforests, and programs for improvement of land use in agriculture.
- The use of climate forecasting for agricultural activities.
- Mitigation policies in the energy sector, including the substitution of fossil fuels, the development of renewables, and energy efficiency programs.
- Studies for presenting projects to the CDM (Clean Development Mechanism).

62. The contribution of Mexico has been important in the area of international agreements. An accelerated schedule was applied to eliminate most of the consumption of substances that deplete the ozone layer (and the concomitant impact on atmospheric

radiative forcing) by the year 2000, with support from the Multilateral Fund of the Montreal Protocol and with the participation of the country's different industrial sectors. Mexico also participates in the Forum on Climate Change and in the OECD Working Group on Agriculture and Climate Change. In addition, using U.S. EPA (Environmental Protection Agency) funds, greenhouse gas emissions inventories were updated, the forestry programs were analyzed, and a project in the dynamics of land use in the tropical rainforest in Chiapas was carried out.

3. Country Dialogue

63. Mexico is fully committed to being an active partner in the G8-sponsored climate change initiative. This activity complements the Kyoto Protocol and the UNFCCC process, which has established the principle of "common but differentiated responsibilities." Under this initiative, resources will be required for Mexico to: (i) assess potential climate change opportunities and risks and (ii) finance transfer and dissemination of climate friendly technologies.

64. Mexican government representatives have a high and increasing understanding of climate change issues. A standing inter-ministerial committee headed by SEMARNAT (Ministry of Environment) coordinates Mexico's overall response to climate change; given the increasing awareness of macroeconomic and fiscal implications of climate change, it may be appropriate to incorporate Hacienda (Ministry of Finance) in this committee. Implementation of the Kyoto Protocol is handled through the National Clean Development Mechanism Office (the Designated National Authority, which is organized as a inter-secretarial committee denominated "Mexican Committee for Emissions Reduction and GHG Capture Projects" that includes the participation of the following Secretariats: Environment and Natural Resources, Energy, Economy, Agriculture and Livestock, Rural Development, Fisheries, and Communications and Transport. Experts under the coordination of the Instituto Nacional de Ecología (INE) are working on various mitigation and adaptation plans. As an important voice within the G-77 for a balanced approach to meeting environment and development imperatives, Mexico can play an important leadership role in future negotiations on these issues.

65. A World Bank Group mission visited Mexico from October 24-28, 2005. The objectives of this mission were:

- ***Immediate.*** To initiate a dialogue with Mexico on the G-8 initiative, brief Mexican Government and private sector representatives on the G-8 proposed role of the World Bank Group and some immediate milestones over the next six months, and seek their views on the needs and priorities. The results of this process have fed into an Investment Framework prepared by the Government of Mexico with the support of the World Bank Group for discussion with the Ministers of Finance at the IMF-World Bank Board meetings in April 2006.
- ***Medium-Term.*** To develop a process for regular and intense Government of Mexico/World Bank Group engagement on clean energy for development and

climate risk management activities of both national and global scope. To explore areas where the Government of Mexico might wish to see more specific engagement through lending and equity investment, grant (GEF), carbon finance, and advisory activities of the World Bank Group.

66. The World Bank Group team met with representatives from the Federal Government (Presidencia, Ministry of Finance, Ministry of Energy, Ministry of Environment, National Ecology Institute - INE); important parastatal entities (CFE, FIDE and PEMEX); the Government of the Federal District (Mexico City); and private sector associations (aluminum, chemicals, and water utilities). Agreed follow-up actions include:

- Designation of the Inter-Ministerial Climate Change Committee as the Mexican counterpart agency to elaborate the Investment Framework in partnership with the World Bank Group.
- Deepening the process for determining Mexico priorities under the Investment Framework in terms of (i) evaluating work already performed under the National Climate Change Action Plan (presently under preparation), (ii) identifying additional analytical requirements, and (iii) identifying high potential investments and associated policy requirements for diffusion and replication of climate friendly technologies.
- Identifying institutions or individuals to explore selected analytical questions and prepare terms of reference for further analytical work.
- Evaluating financial mechanisms and amounts needed to stimulate low-carbon development initiatives.
- Promoting a shared vision and effective strategy on vulnerability and impacts assessment and their translation into effective adaptation measures.
- Hosting the next meeting of energy and environment ministers, currently proposed for September 2006 in Mexico City, as a follow-up to the November 2005 ministerial meeting.

4. Follow-up Action and Bank Assistance

67. The most important opportunities for near term action include:

- ***Adaptation.*** Improving Mexico's ability to deal with current climate variability is an important step to coping with potential future climate change impacts. An immediate focus on measurement, forecasting, and analysis of climatic trends, especially extreme events like droughts, floods, and storms, would be beneficial. Also, it would be useful to start the process of identification and formulation of specific adaptation measures that would address anticipated climate change impacts. In this context it would be important to: (i) improve understanding of the risks that Mexico faces in terms

of potential climate impacts, including the anticipated impacts from changes in rainfall patterns and increase evaporation rates on water basins, intensification of hurricanes and weather events on coastal areas, **and** expected flooding of coastal areas and inland watersheds resulting from sea level rise, among others (as well as the risks associated with current climate variability as enhanced through the El Niño Southern Oscillation and global climate change); (ii) analyze the most vulnerable sectors and localities; (iii) design a screening tool and analysis for proposed new infrastructure investments; and (iv) identify pilot measures that could illustrate the costs and benefits of adaptation.

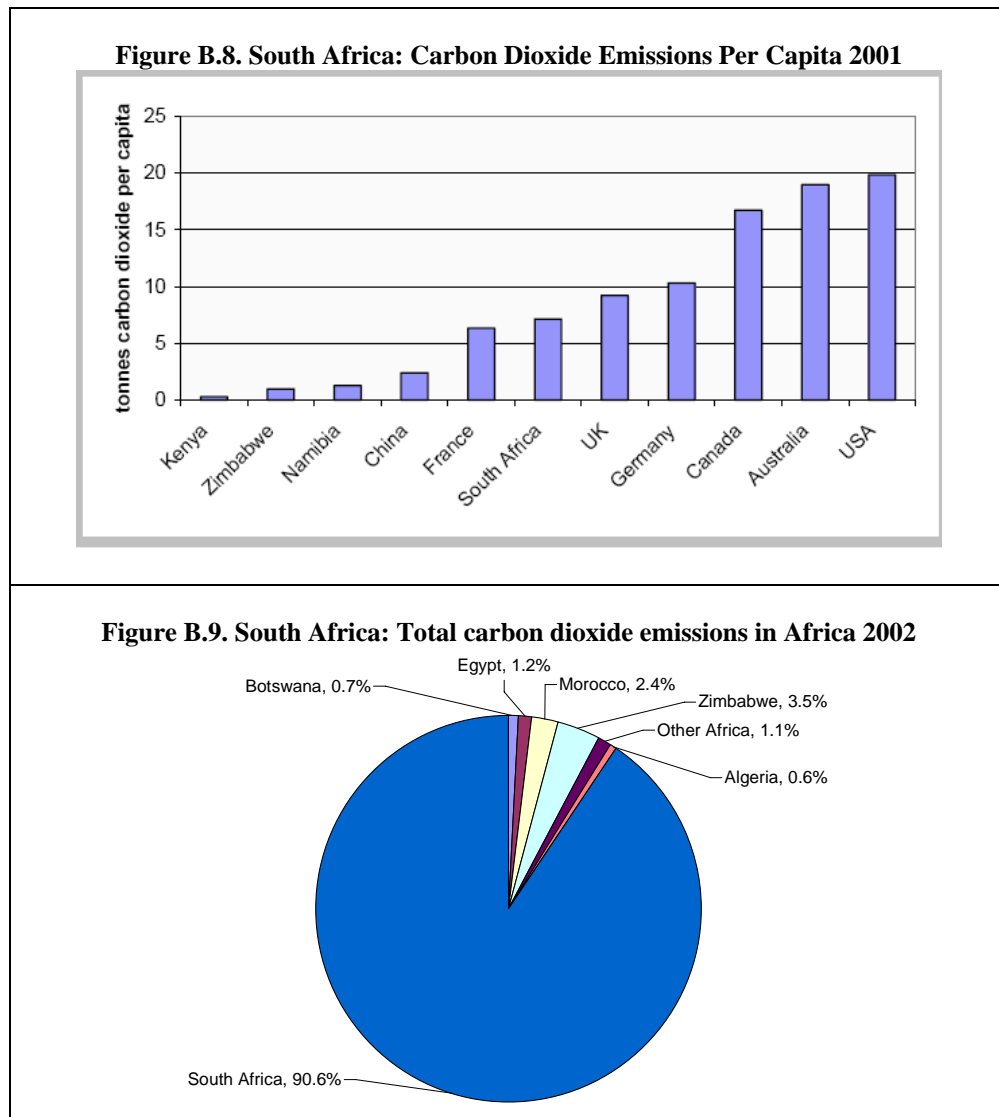
- ***Technology and Knowledge Transfer.*** The transfer of clean technologies and associated know-how from industrialized to developing countries is particularly important from Mexico's perspective. Some of the country's priorities are:
 - Deeper understanding of energy security and how source, fuel, and technology diversification can promote economic stability and growth.
 - Technical and economic integration of new types of energy sources (e.g., renewables) within existing energy/utility infrastructure.
 - Stimuli for private sector involvement in clean energy development and deployment, including design of subsidy schemes that are transparent and efficient.
 - Electricity interconnection contracts (Third party generation and cogeneration, self-supply, and wheeling).
 - High efficiency conversion of fossil fuels (e.g. gasification of refinery wastes).
 - Capacity building to exploit the carbon markets and carbon finance to promote learning- by-doing.
 - Integration of environmental and sustainability factors in investment planning.
 - A complementary package of investment loans and grants to aid technology transfer.
- ***Clean Development Mechanism (CDM) and the Future of Carbon Trading.*** Mexico is accelerating its participation in carbon market and includes CDM as an important tool to reach its development objectives. However, it is concerned with the uncertainty of the post-2012 period and the high transactions costs of the CDM, both of which are having a negative effect on the infant carbon market. Mexico can play a major role in helping to shape

opinion on the necessity and design of a future carbon trading regime in order to provide longer-term market signals.

- ***Clean Energy Development.*** Among the sectors where large reductions in greenhouse gas (GHG) emissions may be possible at moderate incremental costs are:
 - ***Energy efficiency.*** Industrial and refinery cogeneration, industrial and commercial energy efficiency, buildings, electric power, urban transport, and water and sanitation utilities.
 - ***Transport.*** Expand the experience and lessons from the work on transport and climate in Mexico City to other cities, including the work on harmonization of urban planning, air quality, and transport, and continuing the work already started on low carbon emission modes of transport (engines and fuels).
 - ***Waste management.*** Solid waste management, including landfill gas recovery, composting, biogas from animal husbandry.
 - ***Gas flaring and industrial gases*** reduce GHG by-products from production processes (i.e. hydrocarbons extraction, cement, and aluminum production).
- ***Renewable Energy.*** There are various promising renewable energy options for Mexico to develop:
 - ***Hydropower.*** Mexico depends on hydro for a relatively modest percentage of its electricity and will likely need to expand hydro to diversify its increasingly gas-based power system. Hydro, both large and small-to-medium scale, is renewable and may be preferable to many of the alternatives for electricity generation.
 - ***Wind and Geothermal.*** Mexico harbors some of the best wind resources in the world which to date are untapped. The country is now embarking on a commercialization strategy beginning with a combination of public and private sector projects. Geothermal resources are also substantial, but to date only about 1/3rd of the estimated economic potential has been exploited.
 - ***Bio-energy.*** There is strong government interest in developing bio-energy in rural areas, including biogas systems, and biomass cogeneration.

E. South Africa

68. South Africa currently relies almost completely on fossil fuels as a primary energy source (approximately 90 percent), with coal and oil providing about 70 percent of the primary energy supply. South Africa is in the top ten countries in the world in terms of carbon dioxide (CO₂) emissions per capita, with coal combustion being the main contributor to these emissions. Further, South Africa accounts for about 90 percent of CO₂ emissions in Africa (Figure B.8).



69. It follows that the major climate change issue facing South Africa is to reduce its greenhouse gas emissions, primarily by reducing its reliance on fossil fuels.

70. The likely impacts on South Africa of climate change have not yet been fully established, though it appears that climate variability has increased, which poses a potential threat for water supply and agricultural production. Thus, a second challenge facing South

Africa is to initiate the analytical work that would underlie the formulation, adoption, and implementation of adaptation policies.

71. Further, South Africa has not yet developed the institutional framework to formulate integrated national policies related to climate change. In particular, while the Department of Environment and Tourism (DEAT) has a coordination role, multiple climate change related agencies are undertaking their own work without adequate coordination, and it is not clear that all the requisite issues are being considered. Thus, a third challenge facing South Africa is to develop an institutional mechanism that will lead to the formulation, adoption, and implementation of integrated national climate change policies.

1. Country Context and Challenges

72. In 2002 total CO₂ emissions in South Africa amounted to 306 million tons. Energy use and corresponding CO₂ have been increasing only gradually in South Africa, reflecting the low overall economic growth rates.

73. **Sources of Energy.** As stated above, coal is the dominant primary source of energy in South Africa; the shares of the various sources are shown in Figure B.11.

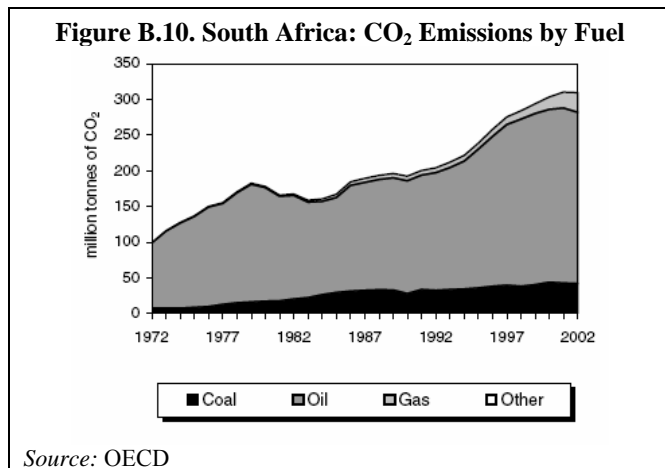
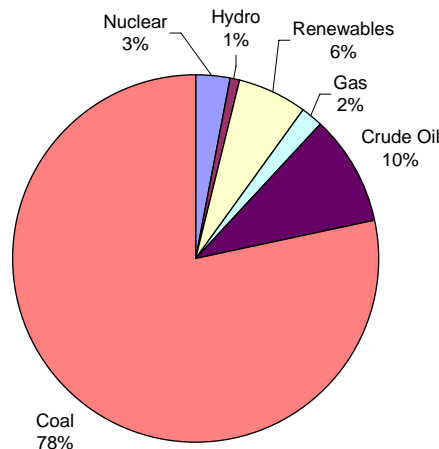
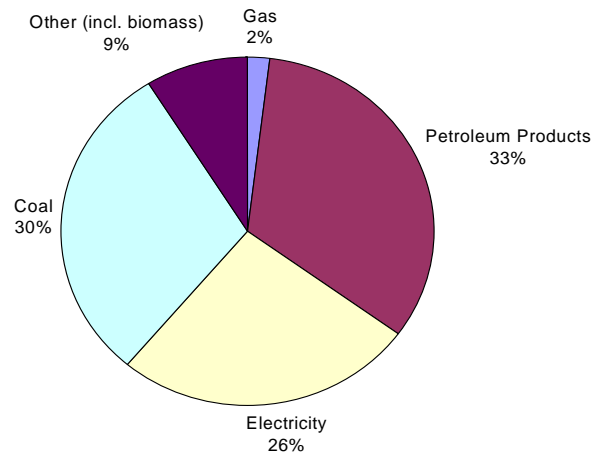


Figure B.11. South Africa: Primary Energy Supply 2000



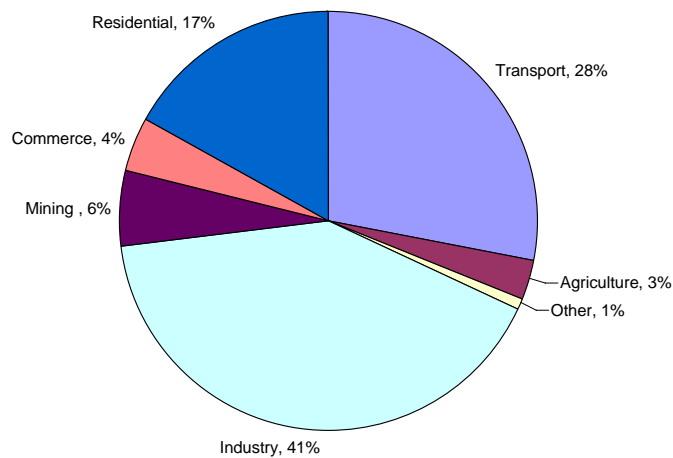
74. **Use of Energy.** Liquid fuels, coal and electricity are the main form of energy end use, as show in Figure B.12.

Figure B.12. South Africa : Main Forms of Final Energy Use, 2000



75. The main end-use sectors are industry, transport and residential, as shown in Figure B.13.

Figure B.13. South Africa: Final Energy Use by Sector, 2000



76. The energy supply and end-use patterns indicate that there are significant opportunities for climate change related activities in:

- Promoting local development of renewable energy, particularly to replace coal-based power generation
- Promoting energy efficiency in the industrial, transport, and residential sectors
- Importing ‘cleaner’ energy, such as hydro-based power from neighboring countries.

2. Government Strategy and Opportunities

77. South Africa has signed the Kyoto Protocol. Although this Protocol does not require South Africa to reduce emissions of greenhouse gases, the Government has begun to take actions to reduce its greenhouse gas emissions. In particular, the Government has adopted:

- A White Paper (2003) on Renewable Energy, which sets the following target for renewable energy:

“10,000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar, and small-scale hydro. This is approximately 4 percent (1,667 MW) of the estimated electricity demand by 2013 (41,539).”

- The White Paper lists these sources for meeting the target:

“The renewable energy is to be utilized for power generation and non-electric technologies such as solar water heating and bio-fuels.”

- An Energy Efficiency Strategy (2005), which sets the following target:

“A final energy demand reduction of 12 percent by 2015. The targets for the end-user sectors range from 9 percent (transport) to 15 percent (industry, commercial, and public building sector).”

3. Country Dialogue

78. South African government representatives are well aware of climate change issues, partly as a result of South Africa hosting the World Summit on Sustainable Development (Johannesburg 2002), and South Africa’s participation in various international conferences, such as the Gleneagles G-8 Summit (2005) and the UNFCCC Montreal Conference (2005). However, it is also clear that South Africa’s primary priority is to improve the well-being of its majority population, which suffered significantly under the apartheid regime. Given South Africa’s strong fiscal discipline, it is likely that requests for public resources to support climate change activities will face strong competition from domestic priorities.

79. At present, the Bank is engaged in the following climate change related activities:

- Renewable Energy Market Transformation (REMT) project, under which GEF will provide a \$ 6 million grant to help implement South Africa’s White Paper on Renewable Energy. Negotiations are expected in March 2006.
- A number of carbon finance projects, which are at various stages of processing.

80. In order to go beyond these activities, a World Bank mission visited South Africa over 2005. The mission's overall objectives were:

- for mitigation, this was a reconnaissance mission to explore the possible nature of Bank and GEF support for South Africa's energy efficiency strategy, which was adopted in March 2005;
- for adaptation, advance the recently initiated dialogue and work with Dept. of Environment and Tourism (DEAT) and other Departments as appropriate.

81. **Main Findings.** The mission's main finding was that there is considerable scope for additional climate change related activities in South Africa. However, at present, the Government of South Africa is not interested in borrowing funds from the Bank for these activities, so they will have to be co-financed by non-lending TA, GEF projects, Carbon Finance operations, and possibly IFC investments or *via* new instruments, such as Bank lending to parastatals, e.g., Eskom, without sovereign guarantees. Further, while there are some investment opportunities related to mitigation already available to be financed by GEF and Carbon Finance, significant non-lending TA, co-financed by local funds, is needed to assist South Africa in assessing its options for reducing its carbon intensity, and then setting in motion the practical steps to achieve this objective. The rationale for the TA is that the Government and the private sector are interested in participating in climate change activities, but they want the benefit of international experience and knowledge in making their decisions.

82. **Next Steps.** There will be a follow-up mission to South Africa in the Spring of 2006; in the interim, the project team has been following up with their South African counterparts in formulating proposals (to ESMAP, PHRD) for funds to finance some of the activities identified during the mission.

4. Follow Up Action and Bank Assistance

83. Based on the discussions with their South African counterparts, the Bank team is pursuing the following activities.

84. **New Analytical Work.** New analytical work is needed for mitigation and adaptation activities, as well as stock-taking to identify gaps in knowledge, capabilities and activities. In general, local funds of about 50 percent would be available to co-finance this work. A number of tasks have been identified by the mission in discussions with the Government, including:

- Development of a 'low carbon scenario' as part of the update of the 2003 Integrated Energy Plan.
- Development of a national biofuels strategy.
- Mainstreaming climate change adaptation activities into water sector strategy.

- Audit and Gap analysis—stock-taking of climate change activities and capacities to identify critical gaps.
- Integration of climate change into economy-wide modeling capacity at National Treasury and selected key economic research institutions.
- Assessment for the development of a national integrated capacity for long-term research and monitoring of climate change impacts on the rural economy.
- Monitoring impact of improved coal-based heating systems for poor households.
- Disseminate international best practices for carbon capture and storage with a planned national conference in the Summer of 2006.

85. ***New Investment Possibilities.*** The mission could identify investment opportunities related to both mitigation and adaptation in the form of GEF projects. Further, there are significant mitigation related investment activities that could be co-financed by Carbon Finance. These include:

- GEF:
 - Energy Efficiency Strategy implementation
 - Sustainable Land Management Strategy implementation with focus on the link between land management and adaptation to climate change.
- Carbon finance operations:
 - for large South African enterprises (SASOL, Anglo, Eskom) for a variety of climate change activities
 - large hydro and natural gas projects in neighboring countries, selling their output to South Africa

Table B.4. Outline of the World Bank Group Emerging Clean Energy and Adaptation Work Program in the G +5 Countries
(Brazil, China, India, Mexico, South Africa)

	Priorities for country dialogue	Diagnostic and Analytical work (on-going and proposed)	Projects and Programs (on-going and proposed)
Brazil	<ul style="list-style-type: none"> ➤ Improved capacity to manage climate risks, including extreme weather events ➤ Implementation of the forested areas strategy ➤ Hydropower development ➤ Capturing energy efficiency savings ➤ Industrial scale bagasse and ethanol production and research into biodiesel ➤ Development of Carbon Trading to promote clean energy and other development issues (e.g., waste management) ➤ Development of financial products to stimulate cleaner technologies and mitigate risks (debt finance, credit guarantees, disaster insurance) 	<ul style="list-style-type: none"> ➤ Improving country capacity to deal with current climate variability (focus on measurement, forecasting, and analysis of climatic trends and extreme events) ➤ Forestry management to balance economic development and environmental services provided by forests ➤ Evaluation of advanced biomass gasification technology in the sugar industry ➤ Energy policy and regulatory framework ➤ Renewable energy (development of low-cost/low-impact hydroelectricity and expanded production and use of bioenergy) ➤ Energy efficiency (energy production, industry, buildings, transportation, water and sanitation) ➤ Expanded use and efficiency of natural gas (production, transmission, and use) ➤ Reduction of gas flaring and industrial gases ➤ Renewable options for rural electrification ➤ Expanded regional energy trade 	<ul style="list-style-type: none"> ➤ Afforestation and reforestation ➤ Hydropower development ➤ Natural gas, including improved efficiency of production, transmission, and use ➤ Energy efficiency improvements in municipal water and sanitation facilities ➤ Urban transport energy efficiency ➤ Rural electrification in Amazonia and other areas with remote populations using RETs ➤ IFC investments in small hydro, wind, biomass cogeneration and gas utilities ➤ CF/CDM program and project development: <ul style="list-style-type: none"> o Sector support of bagasse cogeneration o Programmatic approach to landfill gas programs o Natural gas capture o Sequestration and biomass use
China	<ul style="list-style-type: none"> ➤ Energy security and diversification ➤ Reducing health and environmental damages due to high dependence on coal ➤ Climate vulnerability reduction and offsetting water availability and agricultural productivity decline ➤ Meeting energy demand for sustained economic growth ➤ Improving energy efficiency in the power sector, industry, buildings, and transport sectors ➤ Low carbon urban and transport sectors ➤ Market reforms of the energy sector ➤ Modernizing thermal power and industrial energy technologies ➤ Policy support for Renewable Energy technologies (target 10 percent of primary energy needs by 2020) 	<ul style="list-style-type: none"> ➤ National climate change response strategy (to be completed by June 2006) ➤ Energy sustainability strategy ➤ Cleaner and more efficient coal-fired power generation ➤ Power sector Demand Side Management (DSM) ➤ Coal bed methane development/ utilization strategy ➤ Natural gas development and utilization ➤ Metropolitan energy efficiency and sustainable urban transportation strategies ➤ Energy Efficiency awareness building and DSM (Shanghai) ➤ Voluntary green electricity schemes ➤ Scale-up renewable energy markets ➤ CF/CDM development and scale-up ➤ Assessment of climate change risks and adaptation strategies 	<ul style="list-style-type: none"> ➤ Energy efficiency program for large and medium-size investments ➤ Coal Power Energy Efficiency ➤ IGCC introduction (Yantai IGCC Project) ➤ T&D innovation and efficiency improvement ➤ Sustainable Transport Program ➤ Heat Reform and Building Efficiency Program ➤ Urban Development (Clean Coal - Hunan) ➤ Support for heating sector reform and heating and gas infrastructure (Second Medium-Cities Infrastructure Project) ➤ Renewable Energy Scale-up Program ➤ Renewable Energy Development Project ➤ Hydropower efficiency improvement ➤ Hydropower development in poor areas ➤ Methane management projects (coal mine and agriculture) ➤ IFC investments in small hydro, wind, biomass cogeneration, and gas utilities ➤ CF/CDM development and scale-up <ul style="list-style-type: none"> o Energy Efficiency o Industrial GHG reduction (HFC-23, methane) o Waste management gas recovery and utilization o Hydropower projects o Wind farm o Forestry

	Priorities for country dialogue	Diagnostic and Analytical work (on-going and proposed)	Projects and Programs (on-going and proposed)
India	<ul style="list-style-type: none"> ➤ Development and implementation of a climate risk management approach at policy and project levels ➤ Transmission and Distribution (T&D) loss reduction ➤ Renovation and modernization (R&M) of coal-fired power generation ➤ Large hydro power development ➤ Industry energy efficiency and fuel switching ➤ Renewable energy ➤ Sustainable transport ➤ Natural gas sector development ➤ Scaling up CF/CDM potential for offsetting India's total projected CO₂ emissions (2004-2012) 	<ul style="list-style-type: none"> ➤ Enhancing adaptation and reducing vulnerability through better integration of climate risk issues into relevant sector programs ➤ Energy efficiency financing mechanisms ➤ Power sector reform dialogue ➤ Low carbon long-term energy security (including gas and oil sector issues) ➤ Strategies for low carbon growth (multi-sectoral, including industrial EE, sequestration opportunities, etc.) 	<ul style="list-style-type: none"> ➤ Innovative climate risk adaptation pilot projects ➤ Coal power renovation and modernization support ➤ Renewable energy development ➤ T&D loss reduction ➤ Hydropower development ➤ Urban air quality management ➤ CPP for Low Carbon Development (multi-focal, including the Sustainable Transport Program) ➤ IFC investments in small hydro, wind, and biomass cogeneration ➤ CF/CDM development and scale-up <ul style="list-style-type: none"> ○ Coal power industry improvements ○ Energy efficiency in industry and water supply ○ Afforestation ○ Hydro offset investments ○ Vehicular pollution reduction
Mexico	<ul style="list-style-type: none"> ➤ Improved capacity to manage climate risks, including extreme weather events ➤ Energy diversification ➤ Energy efficiency improvements in buildings and industry (including electric power and petroleum sectors) ➤ Sustainable transport development, including promotion of cleaner and less energy-intensive modes ➤ Renewable energy development (including wind, geothermal, hydro, and biomass in rural areas) ➤ Low Carbon development <ul style="list-style-type: none"> ○ Energy Efficiency ○ Waste management ○ Gas flaring and industrial gases ➤ CF capacity building and CF/CDM scaling-up 	<ul style="list-style-type: none"> ➤ Risk assessment and adaptation needs for climate change ➤ Promoting a shared vision and effective strategy on vulnerability and impacts assessment ➤ Review of policies and strategies for energy efficiency ➤ Energy security analysis ➤ Energy efficiency studies for housing, industry, and institutional framework ➤ Renewable energy development and integration analysis ➤ Cogeneration and renewable self-supply ➤ Reduction of gas flaring and refinery waste gases ➤ Valuation and integration of environmental and social externalities into investment evaluation ➤ Rural electrification strategy ➤ Identifying high-potential investments and policy needs for diffusion/replication of climate-friendly technologies ➤ Evaluation of low-carbon financial mechanisms 	<ul style="list-style-type: none"> ➤ Coastal zone adaptation and water cycle management ➤ Transport efficiency ➤ Renewable energy development <ul style="list-style-type: none"> ○ Large-scale solar and wind generation ○ Rural energy delivery ○ Biomass gasification ➤ IFC investments in small hydro, wind, biomass cogeneration, and advanced gas-fired power generation ➤ CF/CDM development and scale-up <ul style="list-style-type: none"> ○ Industrial energy efficiency ○ Wind farm ○ Gas flaring reduction ○ Composting and methane capture ○ Solid waste management and carbon offset ○ Animal waste biomethanation ○ Agroforestry and reforestation
South Africa	<ul style="list-style-type: none"> ➤ Offsetting vulnerability to climate change with a focus on: <ul style="list-style-type: none"> ○ Extending health protection, monitoring, and forecasting systems, and disease prevention programs (e.g., vector- and water-borne diseases) ○ Natural Resource Management (water resource management and contingency planning, new forestry, agriculture and rangeland, biodiversity) ○ Offsetting potential negative economic impacts on the most vulnerable groups while sustaining economic growth ➤ Energy efficiency improvements <ul style="list-style-type: none"> ➤ Industrial commercial and residential sectors ➤ Coal power sector improvements ➤ Renewable energy development <ul style="list-style-type: none"> ○ Small-scale in South Africa: large hydro in neighbors 	<ul style="list-style-type: none"> ➤ "Audit and Gap" analysis for climate change activities and capacities ➤ Integration of climate change into economy-wide modeling capacity at National Treasury and selected key economic research institutions ➤ Development of national integrated capacity for long-term research and monitoring of climate change impacts on the rural economy ➤ Agriculture risk management initiatives (e.g. crop insurance, information dissemination), and scaling sustainable land management practices through the LandCare program ➤ Mainstreaming of adaptation into water sector strategy ➤ 'Low carbon scenario' update for the 2003 Integrated Energy Plan ➤ National biofuels strategy ➤ Reducing health impacts from coal heating systems (Soweto) ➤ Carbon capture and storage best practices 	<ul style="list-style-type: none"> ➤ CF/CDM: <ul style="list-style-type: none"> ○ GHG reduction in large enterprises (including SASOL, Anglo, Eskom) ○ Small-scale Renewable Energy power generation. ○ Large hydro and natural gas projects in neighboring countries, selling their output to South Africa ➤ Implementation of the 2005 Energy Efficiency Strategy ➤ Implementation of the 2005 Renewable Energy White Paper ➤ Sustainable land management and adaptation to climate change

ANNEX C. ANALYSIS OF CLEAN ENERGY TECHNOLOGY OPTIONS

1. An extensive array of technologies and practices currently exist in energy supply and end-use to enhance access to energy, improve energy security, and promote environmental protection at the local, regional, and global level. No single energy production or end-use technology promises to alter the energy development paths of any country. Indeed a broad portfolio of technologies, supported by appropriate policies, will be required to address the challenge of reducing emissions that impact local and regional air pollution.
2. These technologies are also required for the transition to a low carbon economy. Technologies employed to reduce greenhouse gas emissions normally reduce the emissions of local and regional pollutants as well. A clean energy and low carbon economy can be realized through a balanced portfolio of energy production and supply technologies. (Tables C.1-C.7).

Table C.1. Generation Plant Characteristic

PLANT CHARACTERISTICS		COAL						GAS		OIL			HYDRO			RENEWABLES			
		Sub-Critical Coal Plant (Asia)	Supercritical Coal Plant (Asia)	Ultrasupercritical Coal Plant (OECD)	IGCC (OECD)	Super critical Fluid-ized Bed (OECD)	Coal Rehab (OECD)	Gas Turbines (OECD)	CCGT (OECD)	Fuel Oil Steam (OECD)	Diesel (OECD)	Nuclear (OECD)	Large Hydro (OECD)	Small Hydro (OECD)	Hydro Rehab (OECD)	Wind (OECD)	Solar (OECD)	Biomass Steam (OECD)	Geo thermal (OECD)
Capacity (net)	MW	50	600	500	300	500	500	250	300	300	5	600	100	5		10	5	50	20
Efficiency (LHV, net)	%	25%	36%	42%	42%	40%	38%	36%	55%	38%	43%	38%	95%	94%	96%	30%	20%	80%	85%
Unit Investment Cost (in Year 0)	US\$/kWh	496.18	558.2	1100	1200	1100	300	500	600	820	560	2500	2100	2300	500	1400	6880	2150	3930
Fuel Cost	USc/kWh	3.62	2.49	2.16	2.16	2.26	2.38	4.60	3.01	5.83	2.17	0.5	0	0	0	0	0	0	0
Variable Operating Cost	USc/kWh	0	0	0.6	1	0.6	0.6	1	1	0.4	2.5	0.2	0.03	0.04	0.03	0.26	0.24	0.11	0
Fixed Operating Cost	US\$/ kWh-yr	14.89	16.75	20	30	20	20	6	10	15	30	24	10	12	10	17	17		14
Planned Maintenance	hrs/year	720	720	720	720	720	720	360	360	360	360	1440	360	360	360				
Forced Outages	hrs/year	349.2	349.2	480	720	480	480	180	180	180	180	720	90	90	90				
Economic Life	Years	35	35	35	30	35	35	35	35	35	20	40	70	70	40	25	25	25	30
CO ₂ Releases	g/kWh	1362	938	811	811	851	896	561	367	733	620	0	Small ¹	0	0	0	0	0	0

*coal plants assume FGD for SO₂ control and SCR for NO_x control to achieve low local emissions

¹ Shallow reservoirs can be a source of methane emissions if trees and shrubs are not removed before or during construction.

Table C.2. Summary of CO₂ Capture Costs for New Power Plants Based on Current Technology

Performance and cost measures	New NGCC plant			New PC plant			New IGCC plant		
	Range		Rep.	Range		Rep.	Range		Rep.
	Low	High	value	Low	High	value	Low	High	value
Emission rate without capture (kgCO ₂ /kWh)	0.344	- 0.379	0.367	0.736	- 0.811	0.762	0.682	- 0.846	0.773
Emission rate with capture (kgCO ₂ /kWh)	0.040	- 0.066	0.052	0.092	- 0.145	0.112	0.065	- 0.152	0.108
Percentage CO ₂ reduction per kWh (%)	83	- 88	86	81	- 88	85	81	- 91	86
Plant efficiency with capture, LHV basis (%)	47	- 50	48	30	- 35	33	31	- 40	35
Capture energy requirement (% increase input/kWh)	11	- 22	16	24	- 40	31	14	- 25	19
Total capital requirement without capture (US\$/kW)	515	- 724	568	1161	- 1486	1286	1169	- 1565	1326
Total capital requirement with capture (US\$/kW)	909	- 1261	998	1894	- 2578	2096	1414	- 2270	1825
Percent increase in capital cost with capture (%)	64	- 100	76	44	- 74	63	19	- 66	37
COE without capture (US\$/kWh)	0.031	- 0.050	0.037	0.043	- 0.052	0.046	0.041	- 0.061	0.047
COE with capture only (US\$/kWh)	0.043	- 0.072	0.054	0.062	- 0.086	0.073	0.054	- 0.079	0.062
Increase in COE with capture (US\$/kWh)	0.012	- 0.024	0.017	0.018	- 0.034	0.027	0.009	- 0.022	0.016
Percent increase in COE with capture (%)	37	- 69	46	42	- 66	57	20	- 55	33
Cost of net CO ₂ captured (US\$/tCO ₂)	37	- 74	53	29	- 51	41	13	- 37	23
Capture cost confidence level (see Table 3.6)	moderate			moderate			moderate		

Abbreviations: NGCC=Natural Gas Combined Cycle; PC=Pulverized Coal; IGCC=Integrated Gasification Combined Cycle; Representative value is based on the average of the values in the different studies. COE=cost of electricity production; LHV=lower heating value.

Notes: Because these costs include CO₂ compression but not additional CO₂ transport and storage costs, this table should not be used to assess or compare total plant costs for different systems with capture. All PC and IGCC data are for bituminous coals only at costs of 1.0-1.5 US\$ GJ⁻¹ (LHV); all PC plants are supercritical units. NGCC data based on natural gas prices of 2.8-4.4 US\$ GJ⁻¹ (LHV basis). Costs are stated in constant US\$2002. Power plant sizes range from approximately 400-800 MW without capture and 300-700 MW with capture. Capacity factors vary from 65-85% for coal plants and 50-95 percent for gas plants (average for each=80 percent). Fixed charge factors vary from 11-16 percent.

Source: adapted from *Carbon Dioxide Capture and Storage: Summary for Policymakers*, IPCC Working Group III Report, 2003

Table C.3. Coal Technologies

<i>Coal Technology</i>	<i>Rational</i>	<i>Cost Implications</i>	<i>Efficiency</i>	<i>Barriers</i>	<i>Issues for R&D</i>	<i>Research Priorities</i>
Supercritical Plants	Increase efficiency of about 5 percent relative to sub-critical boilers.	5 percent more than sub-critical, but expected to narrow quickly (roughly \$1,000/kWh).	5 percent compared to sub-critical boilers.	The primary constraint is capital cost as the technology is expected to be reasonably reliable.	Research on lowering capital costs and increasing efficiency.	Medium/low
Ultra-supercritical Plants	Further 5 percent efficiency gain relative to supercritical boilers.	5-10 percent more than supercritical boilers (roughly \$1,100/kWh).	5 percent better than supercritical boilers.	Two constraints: capital cost and lack of experience although technology risk is considered to be small.	Research on lowering capital costs and increasing efficiency.	Medium/low
Integrated Gasification Combined Cycle (IGCC)	Efficiency similar to ultrasupercritical boilers but more easily facilitates carbon sequestration.	20 - 40 percent more than supercritical boilers (from \$1,200-\$1,400/kWh).	5 percent better than supercritical boilers.	Two constraints: capital cost and reliability/technology risk.	Research needed on reducing capital costs, increasing efficiency, materials, optimization, waste material.	High
Supercritical Circulating Fluidized Bed	Good for low quality fuels.	Similar to conventional supercritical boilers (about \$1,200/kWh).	Similar to conventional supercritical boilers.	High operating costs, high capital costs, reliability/new technology issues.	Potential for India and other developing countries with low quality coal.	High

Table C.4. Energy Efficiency

<i>Energy Efficiency</i>	<i>Rational</i>	<i>Cost Implications</i>	<i>Carbon Reduction</i>	<i>Barriers to Implementation</i>	<i>Research Priority</i>
Industrial/ Commercial Energy Management Systems	Facilitate implementation of demand-side management strategies of power utilities.	10-20 percent more than conventional designs, mainly for upgraded control systems.	Energy Efficiency carbon savings depend on marginal fuel displaced.	Increased capital costs, improved management effectiveness, lack of utility incentives.	Medium/low
Thermal Energy Storage Systems	Facilitate implementation of demand-side management strategies of heat supply utilities.	10-50 percent more than for conventional designs, especially with underground TESS.	Energy Efficiency carbon savings depend on marginal fuel displaced.	The primary constraint is capital cost and appropriate geological structures (aquifers, boreholes) but the technology is reliable and commercially viable.	Low
High Efficiency Motor Driven Systems	Improve efficiency of electricity use by industrial processes and commercial/public buildings.	10-20 percent more than conventional motors, especially in combination with energy management systems.	Energy Efficiency carbon savings depend on marginal fuel displaced.	Increased capital costs, improved management effectiveness, lack of utility incentives.	Low
Fuel Efficient Vehicles	Improve efficiency of fuel use by transportation systems.	Efficiencies can be large depending on regulation and technology.	Energy Efficiency carbon savings depend on marginal fuel displaced.	Increased costs for the vehicle, uncertainty on the life and reliability of batteries for hybrids and electric vehicles.	High
Absorption Heat Pumps & Heat Transformers	Improve recycling of heat from effluents of industries and commercial/public buildings.	10-20 percent less electricity use than vapor compression heat pumps, especially when tapping into industrial/commercial/community waste heat.	Energy Efficiency carbon savings depend on marginal fuel displaced.	Increased capital costs, improved management effectiveness, lack of utility incentives.	Medium/low
Network Loss Reduction	Many developing countries have network losses >30 percent. Decreasing losses will decrease carbon emissions.	In many distribution networks in developing countries, loss reduction is the least-cost form of reducing supply costs.	Depending on generation mix, generation reduction could be anything from coal to hydro.	Increased capital costs, improved administrative effectiveness, socio-political problems of theft and nonpayments.	Low

Table C.5. Renewables

<i>Renewables</i>	<i>Rational</i>	<i>Cost Implications</i>	<i>Carbon Reduction</i>	<i>Barriers to Implementation</i>	<i>Research Priorities</i>
Biomass power	Commercial technology, widely used in conjunction with agricultural processing, such as in sugar industry or landfill gas capture. About 40 GW in operation.	Capital cost ~\$2000-2500/kWh. Electricity cost 6-7.5 USc/kWh.	No net carbon emissions. Land fill gas avoids release of more potent methane gas.	Fuel supply uncertainties. Biomass feedstock costs may be correlated with oil prices. Environment considerations in producing and harvesting biomass crops.	Low
Biomass heat	Widely used globally from household scale (cooking and heating) to agriculture and industrial process heat applications. Current use about 220 GWh thermal.	About 1-6 USc/kWh equivalent.	No net carbon emissions.	With agriculture residue, no major barriers. Fuelwood supply unless managed could lead to deforestation.	Low
Geothermal	Commercial technology with about 8 GW in operation worldwide.	Plant costs range from \$6000-7000/kWh for binary plant for using low temperature resources to about \$2000-2500/kWh for flash steam plants. Electricity cost is in 4-17 USc/kWh	Little or no carbon emissions.	Site specific but considerable potential. Resource investigation and development can be expensive and risky. Proper reinjection/disposal of water streams and effluents required.	High
Geothermal direct heat	Commercial technology widely used directly or in conjunction with heat pumps. Current usage about 28 GWh thermal.	0.5-5 USc/kWh equivalent.	Little or no carbon emissions.	Proper reinjection/disposal of water streams and effluents required.	Low
Wind	No carbon emissions, reasonable economics in good wind resource areas. Growing at 30 percent per annum over the past few years. Current global installed capacity 48 GW.	Under 100 kWh: \$3000-5000/kWh; 10-100 MW: \$1200-1400/kWh. Electricity cost is in 4-9 USc/kWh range.	No carbon releases from operations	High initial costs, need good wind regime, non-dispatchable technology due to uncertainty of wind.	Medium/ low
Solar photovoltaics	Economically attractive in remote sites or for low load densities. Fastest growth technology for past 4 years (from small base) but growth is where incentives exist. Global installed capacity around 4 GW.	20-200 W - \$7,220/kWh 5 MW - \$6,880/kWh. Electricity cost currently in 40-60 USc/kWh in off-grid and mini-grid configurations and 20-30 USc/kWh in grid connected applications.	No carbon releases from operations.	High initial costs, need good sunlight regime, non-dispatchable technology.	High
Solar hot water	Commercially available and economically attractive option for displacing electricity and fossil fuels. Providing energy to about 40 million consumers (77 GWh thermal)	Costs range widely from \$200 to \$1500 or more for household scale systems. Energy cost is 2-25 USc/kWh equivalent.	No carbon emissions.	Needs back up supply for low sunlight periods.	Low

<i>Renewables</i>	<i>Rational</i>	<i>Cost Implications</i>	<i>Carbon Reduction</i>	<i>Barriers to Implementation</i>	<i>Research Priorities</i>
	worldwide.				
Biofuel liquids	Enables substitution of imported petroleum fuels, support macro stability, balance of payments and local employment generation. Ethanol 31 billion liters/yr, biodiesel 2.2 billion liters per year in 2004.	Production costs are ~ twice the historical levels of diesel. Biofuels costs are changing rapidly and becoming a more attractive alternative as diesel and gasoline prices rise. 2004 costs: Ethanol 25-30 US cents/liter; biodiesel 40-80 US cents/liter.	Net GHG savings can be as high as 87-96% depending on fuel. Significant GHG reductions in transport.	Higher production costs. It is important to make a distinction between ethanol and bio-diesel.	Medium to high
Solar Thermal Electric	No carbon releases from operations. 400 MW in operation. Recently plans announced in USA and Spain for over 1000 MW. Also, high fuel prices have raised interest in several developing countries with high solar radiation (with GEF support).	30 MW (without thermal storage)=\$2,450 kWh. (with thermal storage)=\$4,780 kWh. Electricity cost 15-22 USc/kWh without storage to 10-15 USc/kWh with storage.	No carbon releases from operations	Relative high investment costs. Use best in areas with good year-round sunlight conditions. Used also combined with other technologies (e.g., combined cycle plants), to reduce costs and emissions.	Medium/High
Wind - Hydro/Diesel Coupling	No carbon releases from operations. Areas where good sunlight conditions in summer and good wind resources in winter (e.g., NW China, Mongolia, Central Asia) idea for this application.	300W=\$5,530 kWh - 100kWh=\$2,800 kWh PV-wind hybrid cost is in 15-20 USc/kWh for mini-grid applications.	No carbon releases from operations	Mainly used of isolated towns and villages Relative high investment costs. Technology more complex than stand-alone solar PV or wind.	Medium
Wave and Tidal Power and Ocean Thermal Energy	Technology at R&D and demonstration phase. Global technical potential estimated at about 2000-3000 TWh/year. About 300 MW (tidal) installed.	Projected electricity cost in 4-11 US cents/kWh range expected but no fully commercial plants yet in operation.	No carbon releases	Wave and tidal units applicable mainly at northern and southern latitudes with high wave. OTEC applicable mainly in coastal areas with deep water. Significant environmental impacts possible. Commercial market availability not anticipated under after 2010.	High
Sources: The World Bank, "Technical and Economic Assessment: Off Grid, Mini grid and Grid Electrification Technologies, November 2005." ² REN21, "Renewables 2005 Global Status Report" ³ Verdant technologies, "Next Generation/Unconventional Hydropower: Wave & Tidal Energy Devices ... and More!" Renewable Energy Modeling Workshop on Hydroelectric Power, May 10, 2005					

² See: <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTENERGY/0,,contentMDK:20796696~menuPK:1673175~pagePK:148956~piPK:216618~theSitePK:336806,00.html>

³ See: <http://www.ren21.net>

Table C.6. Hydropower

<i>Hydropower</i>	<i>Rational</i>	<i>Costs</i>	<i>Carbon Reduction</i>	<i>Barriers to Implementation</i>	<i>Issues on R&D</i>	<i>R&D Priority</i>
Large Hydro	No carbon releases from operations. Opportunities to combine with climate change adaptation benefits.	Site dependent - from \$1,000-\$4,000/kWh.	Low carbon impact from operations.	Environmental, resettlement, capital cost issues.	More research needed on methane emissions.	Low
Mini Hydro	No carbon releases from operations.	Site dependent - from \$1,500-\$4,000/kWh.	No carbon impact from operations. Construction related carbon emissions are small.	Environmental, resettlement, capital cost issues. Hydrologic risks.	More research and development of higher efficiencies.	High
Micro Hydro	No carbon releases from operations.	Site dependent - from \$2,000-\$4,000/kWh.	No carbon releases from operations.	Environmental, resettlement, capital cost issues.	More development on low cost, high reliability technologies.	High
Pumped Storage	Enable low carbon off-peak power to fuel peaking needs.	Site dependent - from \$1,000-\$4,000/kWh.	No carbon releases from operations.	May be a net carbon emitter as it is a net load.		Low

Table C.7. Nuclear Fission

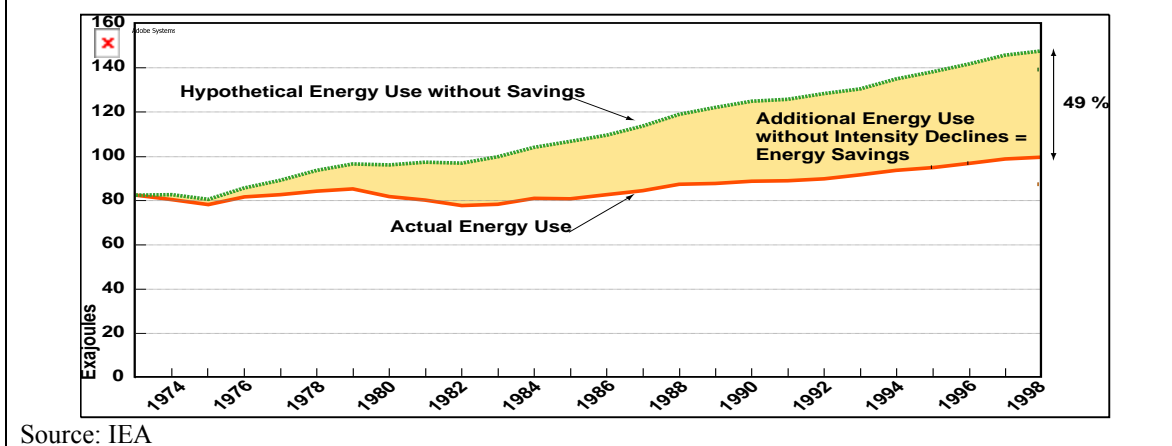
<i>Nuclear</i>	<i>Rational</i>	<i>Costs</i>	<i>Carbon Reduction</i>	<i>Barriers to Implementation</i>	<i>Issues on R&D</i>	<i>R&D Priority</i>
Nuclear Fission	No carbon releases from operations.	\$2,000-\$4,000/kWh	No carbon releases from operations.	MIT (2003) study lists 4 issues: high cost of nuclear; safety issues; proliferation of nuclear materials; and storage of waste.		Medium

ANNEX D. ENERGY EFFICIENCY AND RENEWABLE ENERGY

A. Energy Efficiency

1. **The Rationale for Energy Efficiency.** Improving energy efficiency can boost economic performance and industrial competitiveness, while reducing air pollution and greenhouse gases. Energy efficiency measures save both energy consumers and suppliers money while meeting the same needs for promoting economic growth. It is therefore critical that from economic, energy security, and environmental perspectives, energy efficiency should become one of the key cornerstones of the future energy path in middle-income and developing countries. The IEA has argued that energy efficiency needs to be viewed like other energy sources; it estimates that without the energy savings in the 25 year period (1973–1998), energy consumption in OECD countries would have been almost 50 percent higher, which makes energy efficiency contribution greater than that of oil and coal (see Figure D.1). IEA further estimates that over 65 percent of the reduction in GHG emissions in developing countries over the next 20 years could be driven by continued improvements in energy efficiency.

Figure D.1. Energy Gains from Energy Efficiency, OECD Countries, 1973-1998



2. Meeting growing energy demand is going to be challenging, with different energy sources each facing particular issues that need to be addressed on a country by country or on a global basis. A diverse set of alternatives, focusing both on how the world produces and uses energy, must be explored and implemented both for enhancing energy security and for promoting global environmental protection. The widespread commercialization of energy efficiency technologies and services—on both the supply and demand side -- is one of the most effective strategies to address the energy security concerns faced by developing countries. For instance, the recently implemented energy efficiency standards for appliances in China is expected to save 200 TWh of electricity by 2009, equivalent of China's total residential electricity consumption in 2002. As energy sector is the largest contributor of global GHG emissions, promoting energy efficiency becomes one of the strategic cornerstones to achieving the objectives of a low carbon economy and to mitigating the risks of global climate change.

3. A significant number of energy efficiency and demand side measures across various sectors are generally more cost-effective, low risk, and versatile, and reduce the need for expensive energy and associated infrastructure. The lowest levelized costs of electricity range between 25-45 \$/MWh. High efficiency industrial motors and irrigation pumps in most developing countries, for instance, can attain cost of saved energy as low as \$5-30/MWh. According to a recent study, investments in appliance energy efficiency standards in developing countries would cost about \$60 per kWh of energy saved compared to new installed generation capacities costing \$400-\$1500 per kWh.

Box D.1. Why Energy Efficiency?

- Enhanced energy security
- Macroeconomic and fiscal benefits and saved limited resources
- Economic benefits as cost of saved energy is less than cost of energy supply
- Lowered energy intensities across sectors
- Higher levels of reliability and flexibility
- Increased access to energy services
- Reduced urban local air pollution and health impacts
- Reduced risks of global climate change

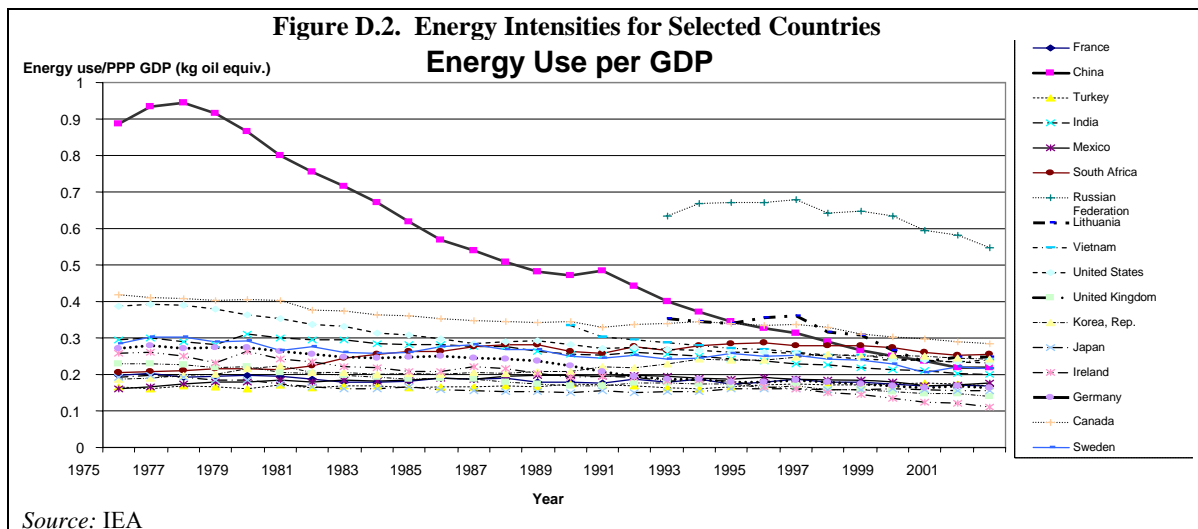
4. ***The Context for Energy Efficiency.*** In the absence of strong policy changes, the global energy use could grow by 60 percent over the next 30 years, with 85 percent of the increase likely to come from fossil fuels according to IEA. Electricity demand alone is set to nearly double by 2030. Much of the growth in energy demand among the emerging economies is expected to occur in emerging Asia, where the demand is projected to more than double by 2025. The robust economic growth in many economies is expected to boost the demand for energy to fuel a rapidly-increasing number of cars and to run newly-purchased home appliances for air-conditioning, space and water heating, and refrigeration across the developing world. With projected high economic growth rates in middle-income and developing economies, such as China (6.2 percent) and India (5.5 percent), their energy consumption will exceed that of the industrialized countries within the next 20 years, with a high risk of negative impacts on local and global environment.

5. Electric power sector is expected to grow at 4 percent per year in emerging economies compared to 2.6 percent per year worldwide. IEA estimates that over 2,400 GW of new capacity will have to be added by 2030, requiring an additional investment of \$5 trillion to meet the growing electricity demand. The projected electricity sector annual investment of \$60 billion for China represents a 2.5 percent share of its estimated GDP. In China, most of these investments will come from domestic capital resources or FDI flows and go toward building coal-based power plants, which will dominate its energy sector roadmap and continue to produce significant damage to the local and global environment. Even with this strong growth, per capita net electricity consumption will remain low in developing countries, especially in the residential sector. In other countries like India where over 100,000 MW new capacity needs to be added every decade to keep up with the projected demands, capital resource constraints would continue to pose the risk of continuing power and energy shortages. Poor reliability of supply could result in enormous productivity losses and outage costs across all sectors. For instance, 97 percent

firms in Nigeria identify poor electricity services to be a severe obstacle in business operation and growth. While on the other hand, annual power sector losses of over \$5 billion associated with thefts and inefficiencies in the Indian power sector are higher than what it would cost to support the country's primary health care system.

6. Similarly, oil is expected to remain another dominant energy source over the next 20 years, with its share of total energy consumption remaining in the range of 38 percent in 2025. On a worldwide basis, transportation sector accounts for about 60 percent of the total projected oil increase by 2025, with the industrial sector accounting for the rest of incremental demand. Transportation energy use in developing countries has been increasing at over 4 percent per year over the past 20 years, far exceeding the global 2.7 percent rate of increase. A fundamental shift toward efficient transportation systems and lowered industrial energy intensities will be necessary to address the issues of energy security associated with volatile oil prices and supply lines.

7. **The Role of Energy Efficiency.** An aggressive uptake of existing and new energy efficient technology choices is one of the key solutions for meeting the world's energy needs for supporting economic growth, meeting unserved energy needs, and ensuring security of energy supply while, at the same time, contributing to reducing the risks of global climate change. Although energy intensities are declining (see Figure D.2) due to structural changes, technological effects, and globalization, much remains to be done in transforming the energy efficiency markets to their fullest potential. For instance, energy consumption in major industries and buildings in China is 40 and 200 percent respectively higher than in developed countries.



8. A systematic approach along the energy value chain will be composed of a series of complementary measures. On the supply-side, the key strategy to focus in middle-income and developing countries will be to transition to more efficient, cleaner capital stock and utilize the existing supply side resources more efficiently. On the demand-side of the equation, significant untapped energy efficiency improvement potential across various sectors—industry, transportation, buildings, residential and agricultural - needs to

be converted into investments to contribute to the low carbon energy path towards sustained economic growth.

9. **Energy Efficiency Technologies.** Two broad groups of technologies could provide ways to meet the energy challenges in developing countries while retaining their energy security path, supporting economic growth, and lowering local pollutant and greenhouse gas emissions. These include efficient technologies for producing and supplying energy (Box D.2), and technologies that help moderate the use of energy on the demand side (Box D.3). For example, on the supply-side, the average Chinese thermal power generation efficiency is about 33.8 percent which is 6-7 percentage points lower than more advanced countries. Advanced transmission and distribution systems in could reduce electricity network losses that are significantly higher in developing countries compared to the industrialized world.

Box D.2. Technical Measures for Transforming Energy Production and Supply in the Electricity Sector

New thermal power plants: Combined cycle, supercritical boilers, IGCC, etc which have efficiencies that are significantly higher than the average fossil-fuel power plant efficiencies in the range of 30 percent in developing countries.

Existing generation facilities: Refurbishment and re-powering (including hydro), improved operation and maintenance practices, and better resource utilization (higher plant load factors and availability).

Reduced transmission and distribution losses: Both technical and commercial losses (primarily, theft) which together could be as high as 15-45 percent in many developing countries could be reduced to the OECD average of 6-7 percent through introduction of high voltage transmission systems, better insulated conductors, capacitors, efficient and low-loss transformers, and improved metering systems and instrumentation.

Box D.3. Technologies for Transforming Energy Use

Transportation: Efficient gasoline/diesel engines, Urban mass transport systems, Modal shifts to inter- and intra-city rail and water transport, improved fleet usage.

Buildings: Energy use in residential, commercial, school, hospital, and municipality and government buildings can be substantially reduced with integrated building design and measures such as better insulation, advanced windows, new lighting technology, efficient space cooling and heating, water heating, refrigeration, etc.

Industry: Cogeneration, waste heat recovery, pre-heating, new efficient process technologies, and efficient drives (motor, pump, compressors systems).

Municipalities/Urban Local Bodies: District heating systems, combined heat and power, efficient street lighting, and efficient water supply pumping and sewage removal systems.

Agricultural: Efficient irrigation pumping systems.

10. Energy demand must also be moderated through greater efficiency in the use of energy. An increased emphasis must be placed on technical end-use efficiency improvements across various sectors, i.e., industry, agriculture, buildings, residential, and transportation (see Box. D.3).

11. Evidence shows a decline in global energy intensity of more than 28 percent during the past decade, with efficiency improving in major industrialized and developing countries. However, considerable untapped potential for energy efficiency improvements exists along the delivery and end-use chains across various sectors of developing countries. By one estimate, five major GHG emitting developing countries—Brazil, China, India, Mexico and South Africa - can save 33-49 percent of the total primary

energy used to produce steel if best-practiced benchmarks are adopted in all plants (See Table D.1 for energy intensity indicators for major industry sectors in China). Globally, the industry sector accounts for 35 percent of energy consumption and has 25 percent potential for energy efficiency improvements, with 30 percent of that improvement due to more efficient motor systems.

Table D.1. Primary Energy Intensities for Selected Energy-Intensive Industries

<i>Sector</i>	<i>Indicator</i>	<i>China</i>	<i>OECD</i>	<i>Best Practice</i>
Iron and Steel	GJ/tonne	36	18-26	16
Cement	GJ/tonne	5.6	3.7-4.4	3.4
Refining	GJ/tonne	3.5-5.0	2.9-5.0	1.3-3.8
Ammonia	GJ/tonne	39-65	33-44	19.1
Aluminum	MWh/tonne	16.3	14.1-19.3	

Source: Lynn Price et. al (2000) [Lawrence Berkeley National Laboratory].

12. **Barriers to Scaling Up Energy Efficiency (see Box D.4).** While interventions on the supply side are driven largely by the availability of technologies and capital, on the demand side of the energy efficiency paradigm, significant technical, institutional, policy, economic and financing barriers exist. Financing barriers are amongst the most significant; the perceived risks are high and many efficiency measures tend to be small investments resulting in high transaction costs. The major barriers need to be removed for accelerating the shift toward higher energy efficiency levels. Significant public investment is required to catalyze the process as markets alone will not accomplish the transition.

Box D.4. What Hinders Energy Efficiency Market Development?

- Energy prices do not reflect full costs of supply.
- Consumers use high discount factors to make decisions based on first costs, not lifecycle costs.
- Financiers perceive risk and high transaction costs as energy efficiency projects are smaller in size, are savings-based (and not asset-based) and are dispersed/ decentralized.
- Energy Service Companies (ESCOs) in developing countries are unable to take financial risks.
- Robust monitoring and savings verification system/protocol is key to projects and is missing.
- Energy efficient technologies are not always available in the market.
- Lack of technical information about energy efficiency potential and benefits.
- Lack of skilled, certified energy managers/energy auditors.
- Absence of regulatory mandates and legislations.

13. **Energy Efficiency Strategies.** Adequate pricing is a necessary condition for promoting energy efficiency. However, in most developing economies, subsidies for fossil fuels and cross-subsidies across end-use sectors continue to distort energy prices which, on the overall, do not reflect the true cost of energy supply and gives incorrect signals to consumers. In this kind of environment, the transition to lower energy intensities will be facilitated through various enabling policy/regulatory interventions or market-based instruments (see Box B.5) which would be implemented to help convert the untapped technical energy efficiency potential into project or program investments

Box D.5. Strategies for Energy Efficiency Market Transformation

- Establishing a policy framework for removal/targeting of subsidies for fossil fuels; Institutionalizing targeted tax and other fiscal incentives for promoting energy efficiency;
- Implementing regulatory interventions and legislative measures for utility demand side management, building codes, industrial energy efficiency norms/benchmarks, energy audits and certification programs, and appliance and equipment minimum energy performance standards and labeling systems;
- Stimulating market-based interventions, such as through performance contracting delivered by ESCOs, and innovative financing schemes involving credit guarantees and incentives available through the GEF and CDM;
- Bundling of energy efficiency measures, particularly in agricultural, residential and small-scale industry sectors, through ESCOs or financial intermediaries;
- Promoting efficient transport corridor and spatial urban planning practices that encourages efficient transportation and urban management systems; and
- Sharing information with, and capacity building, training and skill building of, a range of organizations including self-standing energy efficiency agencies/ public institutions, professional industry associations, chambers of commerce, and financial institutions; and a range of support to institutions and programs tailored to other energy efficiency market stakeholders.

B. Renewable Energy

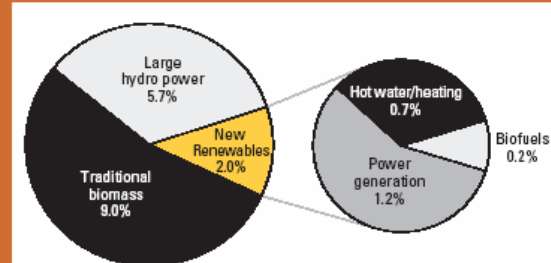
14. Renewable energy offers an option that emits little or no greenhouse gases. *Renewable energy share of total primary energy today is approximately 17 percent of the approximately 10 billion tons of oil equivalent (Btoe) consumed globally with the majority of energy being obtained from traditional uses of biomass for heating and cooking and large scale hydropower* (Figure D.3). Renewable energy contributes 160 GW of power from solar, wind, small hydro, biomass and geothermal sources today. In addition, larger scale hydro provides another 720 GW. By far the most pervasive form of renewable energy used in the developing world is fuelwood and agriculture residue used for heating and cooking. It accounts for about 10 percent of total primary energy used, or 77 percent of total renewable energy used globally. About 87 percent of it is used in non-OECD countries, primarily in Africa and South Asia. About \$50-55 billion was invested in renewable energy worldwide in 2004, including large hydropower, compared to conventional power sector investments of about \$110-150 billion. Biomass for industrial and agricultural process heat is used extensively in developing countries and at current oil prices, its use is expanding. Biomass can have a great potential for power generation especially in some of the developing countries where other energy sources are not abundant. The challenge is to generate efficiencies for energy production with often-times seasonal input fuels of variable quality. Table D.2 presents a summary of renewable energy use in 2004.

15. Solar and wind are the fastest growing renewable energy with growth rates of 60 and 28 percent per annum respectively, albeit starting from a small installed base. Growth rates of biodiesel production was 25 percent, solar hot water/heating 17 percent, off-grid solar PV 17 percent, geothermal heat capacity 13 percent, and ethanol 11 percent. The more conventional renewables such as geothermal power, biomass power and hydropower grew at about 2–4 percent per year. See Figure D.4.

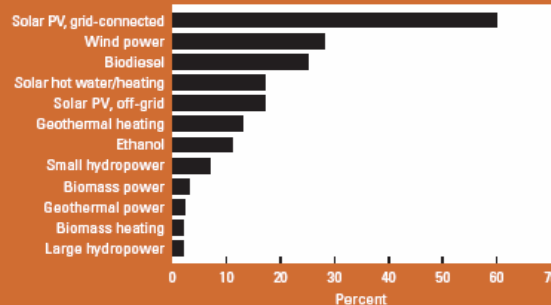
Table D.2. Summary of Renewable Energy Use in 2004**Table 1. Renewable Energy Indicators**

Indicator	Existing Capacity End of 2004	Comparison Indicators
Power generation (GW)		
Large hydropower	720	World electric power capacity=3,800
Small hydropower	61	
Wind turbines	48	
Biomass power	39	
Geothermal power	8.9	
Solar PV, off-grid	2.2	
Solar PV, grid-connected	1.8	
Solar thermal power	0.4	
Ocean (tidal) power	0.3	
Total renewable power capacity (excluding large hydropower)	160	
Hot water/space heating (GWth)		
Biomass heating	220	
Solar collectors for hot water/heating (glazed)	77	
Geothermal direct heating	13	
Geothermal heat pumps	15	
Households with solar hot water	40 million	Total households world-wide=1,600 million
Buildings with geothermal heat pumps	2 million	
Transport fuels (liters/yr)		
Ethanol production	31 billion	Total gasoline production=1,200 billion
Biodiesel production	2.2 billion	
Rural (off-grid) energy		
Household-scale biogas digesters	16 million	Total households off-grid=360 million
Small-scale biomass gasifiers	n/a	
Household-scale solar PV systems	2 million	
Solar cookers	1 million	

Source: REN21 Renewable Energy Policy Network, "Renewables 2005 Global Status Report." Worldwatch Institute, 2005.

Figure D.3. Renewable Energy Contribution to Global Primary**Figure 1. Renewable Energy Contribution to Global Primary Energy, 2004**

Source: REN21 Renewable Energy Policy Network

Figure D.4. Average Annual Growth Rates of Renewable Energy Capacity, 2000-2004**Figure 2. Average Annual Growth Rates of Renewable Energy Capacity, 2000-2004**

Source: REN21, Global Status Report

16. **RE Use in G+5 Countries and Scale-up Plans.** The G+5 countries use of renewable energy varies significantly:

- Brazil.** Approximately 44 percent of Brazil's primary energy supply comes from renewable sources such as hydropower and biomass (about 36 Mtoe). Hydroelectricity represents 85 percent of Brazil's power generation; however, Brazil has developed only 41 percent of its hydropower potential with an estimated 260,000 MW of potential capacity available. Brazil is the undisputed leader in producing bioethanol and obtained more than 40 percent its liquid fuels for transportation from biofuels, primarily ethanol. In 2004, Brazil made commitments to increase its ethanol and biodiesel production, add 3,300 MW of small hydro, wind and biomass generation capacity, add nearly 3,000 MW of large scale hydropower, and use renewables to achieve 100 percent electrification rate, all before 2010.

- **China** obtains about 240 Mtoe of primary energy from renewable energy sources (about 21 percent of total primary energy) of which about 90 percent is from fuelwood and agricultural residues for heating and cooking. Their small hydro capacity alone is more than 30,000 MW. China's Renewable Energy Law came into force on January 1, 2006 which is expected to increase China's share of total power generation from renewables from 7 percent today to 15 percent by 2020. The World Bank-GEF China Renewable Energy Scale-up Project supports the achievement of this target.
- **India** obtains more than 210 Mtoe of primary energy (about 40 percent of total primary energy) from renewables of which about 96 percent is from fuelwood and agricultural residues for heating and cooking. Close to one-fifth of India's total electricity generation now comes from hydro sources, and this share is planned to increase. India is the fourth largest user of wind power and the fifth largest producer of energy from commercial biomass and small hydropower. India is in the process of drafting a Renewable Energy Law.
- **Mexico.** Approximately 10 percent of Mexico's primary energy is from renewable energy (about 16 Mtoe), including fuelwood and agriculture residues that account for 53 percent of its renewable energy share. Mexico depends on hydro for a relatively modest percentage of its electricity, and will likely need to expand hydro to diversify its increasingly gas-based power system. Mexico has some of the best wind resources in the world which to date are untapped, but is now embarking on a commercialization strategy beginning with a combination of public and private sector projects. Geothermal resources are also substantial, but to date only about 1/3rd of the estimated economic potential has been exploited. The proposed World Bank-GEF large Scale Renewable Energy Development Project will support the development of wind sector.
- **South Africa** currently relies almost completely on fossil fuels as a primary energy source (approximately 90 percent), with coal and oil providing about 70 percent of the primary energy supply. About 10 percent of its primary energy (about 12 Mtoe) is obtained from renewables and almost all of it from wood and agriculture residues. Nevertheless, the Government has made a commitment to raise the profile of renewable energy. In the White Paper on Renewable Energy issued in 2003, the Government has committed adding 10,000 GWh of renewable energy to final energy consumption by 2013, mainly from biomass, wind, solar and small-scale hydro. This is approximately 4 percent of the estimated electricity demand by 2013. The Government has also noted the potential for non-electric renewables, such as solar water heating and bio-fuels.

17. **Economics of Renewable Energy.** Some forms and uses of renewable energy are economic and are financially viable. These include hydropower, biomass, geothermal, and solar hot water heating, solar electricity (photovoltaics) for off-grid electrification in dispersed areas far from the grid. Others such as wind and solar PV for grid connected

applications depend on policy incentives to make their use financially viable. For more details see Annex C, Table C.3. **Renewable energy is more economical than conventional generation for some off-grid (less than 5 kWh) applications.** Renewable energy technologies - wind, mini-hydro, and biomass-electric - are the least-cost option (on a levelized cost basis) for off-grid electrification applications, assuming availability of the renewable resource. Pico-hydro, small wind, and PV-wind hybrid technologies in particular are competitive with gasoline and diesel engine generators. The solar PV is competitive for small power applications (50-300 W). **Several renewable energy technologies are potentially the least-cost option for mini-grid applications.** Mini-grid applications are village- and district-level networks with loads between 5 kWh and 500 kWh not connected to a national grid. Several RE technologies (biomass, biogas, geothermal, wind, and micro-hydro) are least-cost. Two biomass technologies—biogas digesters and biomass gasifiers—seem particularly promising. Geothermal is economical in areas with easy-to-tap hydrothermal resources and no large field development costs. **Conventional power generation technologies remain more economical for grid connected applications.** In grid-connected configurations, large conventional power generation (open cycle and combined cycle gas turbines, coal- and oil-fired steam turbines) remain the least-cost option. Four major renewable power generation technologies - geothermal, bioenergy, hydro, and wind power—are potentially as economical as conventional power plants of similar size (e.g., less than 50 MW). However, these renewable energy technologies cannot compete with larger (50-300 MW) conventional generating units.

18. *Renewable Energy for Heating Applications is in Commercial use Worldwide.* Biomass, solar and geothermal heat for applications are cost effective compared to their fossil fuel alternatives in many cases.

19. *Liquid Biofuels Made from Biomass are Attracting Increasing Interest Worldwide,* with the industrial countries seeing a means to reduce GHG emissions and the developing countries seeing a means to diversify their energy supplies and thus dampen the impacts of crude oil price increases and price volatility as well as stimulate rural development and create jobs (see Box B.6.). Historically, the main constraint to the expansion of biofuels has been economic, though Brazil has shown that it can now produce ethanol competitively with gasoline through the development of an integrated sugarcane-ethanol industry. Other countries interested in Brazil's ethanol program should assess to what extent they can replicate the conditions for Brazil's success.¹

Box D.6. Brazil's Ethanol Program

Brazil's ethanol program is a classic example of what can be achieved over a 30 year period. Through substantial state intervention and subsidy of targeted research and price support, Brazil now finds itself displacing more than 40 percent of gasoline use with ethanol, generating significant numbers of rural jobs, and saving 26 million tons per year in GHG emissions (WRI research). The removal of trade restrictions to ethanol worldwide would benefit low-cost suppliers such as Brazil. Current costs of production of ethanol in the state of Sao Paulo are 25-29 US cents per liter, or equivalent to US\$35-50/bbl. Brazil's ethanol industry has been aided considerably by the introduction of flexible-fuel vehicles which can use any combination of gasoline and ethanol.

¹ Masami Kojima and Todd Johnson, Potential for Biofuels for Transport in Developing Countries, ESMAF Report No. 312/05, The World Bank Group, Washington DC, October 2005.

20. The production of liquid biofuels, ethanol and biodiesel, has been increasing rapidly in the last few years in response to high oil prices and climate change concerns. Biofuel production costs are expected to decline over the medium term and new feedstock supply options expanded. While biodiesel production processes are mature, cost reduction potential lies in improvements in production, harvesting and transport of feedstock. Over the long term, the greatest promise for ethanol lies in the conversion of cellulose to ethanol using wood wastes, crop residues and energy crops such as switch grass. Their widespread availability, low cost and significant lifecycle GHG emissions reductions make them particularly attractive.

21. In the case of hydropower (Annex C, Table C.4), emerging issues will need to be resolved with respect to emissions from methane coming from the flooding of the reservoir, especially in the of coal and other fuel sources, though with significantly less recurring costs. In addition, opposition from environmental groups of large hydro detracts from governments and investors engaging in this renewable source of energy. However, run of river hydro does not face that uncertainty either in actual emission reductions or on acceptability. But to make run of river more viable increased efficiency in turbines is needed. Although this is far from basic research, it is important area for many developing countries.

22. ***Actions to Scale Up RE Use.*** Among the work needed to be done to overcome the principal constraints are the following:

- Policies to encourage, or at a minimum, not to discourage renewable energy use are needed. Renewable energy supportive policies are in place in about 48 countries including 15 developing countries. These include feed-in policies and renewable portfolio standards. Policy targets for renewable energy have been passed by 45 countries including 10 developing countries and all EU countries. A majority of targets is for renewables for electricity production and they range from 5-30 percent of total power generation capacity, in approximately a 10 year time frame.
- Subsidies for fossil fuels remain a serious constraint to improving the financial viability of renewables. However, recent price rises for oil and gas and the inability of many developing country governments to fully absorb these rises from budgetary resources have made some renewables financially more cost-effective.
- Regulatory barriers need to be overcome to ensure that market entry of renewables for power generation and heat applications and for expanding the use of biofuels is facilitated. In particular, regulations that reduce transactions cost and reduce risks to investors in renewable energy are needed.
- Given the capital intensities of renewable energy, greater access to long term financing is needed. While foreign direct investment and ODA helps, these have to be used more effectively to leverage significantly greater amounts of domestic capital in developing countries.

- Research and development needs to be conducted to increase performance and reliability, and to reduce capital and operating costs. Greater effort is needed to more rapidly move technological advances gained through R&D into the marketplace. Manufacturing operations have to increase to take advantage of scale economies and to lead to lower costs. More credible and long term renewable energy resource information is needed.
- Improved methods for renewable energy planning and integration into energy supply systems, in particular electric power systems, is required. These methods must be able to value renewables ability to hedge against fuel price volatility, account for risk and be able to manage the intermittency of some renewable energy sources.
- For large scale hydropower and for biofuels production, environmentally and socially sustainable development must be supported. Emerging issues such as emissions from methane coming from the flooding of the hydro reservoir needs resolution.

ANNEX E. CONSULTATIONS WITH INTERNATIONAL FINANCING INSTITUTIONS

I. SYNOPSIS

1. Following on the Gleneagles Plan of Action, the World Bank Group (WBG) initiated consultations with other International Financing Institutions (IFIs: AfDB, ADB, EBRD, EIB, IADB, and IDB), the IEA, and the GEF Secretariat, about opportunities to collaborate in identifying financing mechanisms to support less-carbon-intensive development and adaptation strategies. The consultation process aimed to define the Investment Framework and explore opportunities for collaboration in order to increase lending effectiveness, share information on current and planned investment programs, define financing gaps, assess existing product lines, and identify needs and modalities for the development of new financial products, including in partnerships with the private sector.

2. To date, this process has included three major consultative meetings (hosted by the WBG, EBRD, and IADB, respectively), an EBRD-hosted workshop and analysis, and a number of less structured discussions. A knowledge-sharing conference on Adaptation is scheduled for later in 2006. The IFIs have coordinated their work on establishing a common baseline of their lending activity in low carbon energy systems and adaptation, while charting and advancing the Investment Framework preparation process, and finalizing the Investment Framework conceptual outline. The consensus view among the IFIs is that the consultations are already proving valuable in mobilizing, producing, and sharing a body of work that in itself substantially advances their own engagement in the clean energy and adaptation areas.

A. Focus and Process

3. The IFIs see the Investment Framework as a catalyst for improving the use of resources (financial instruments and concessional tools) in dealing with climate change and adaptation. Where gaps are identified it will make the case for these to be filled, while describing the necessary instruments and the role of the involved parties on the basis of appropriate analysis of capacity and budget needs, etc. The Investment Framework should further maximize the use of private sector resources, highlighting mechanisms to better leverage private finance and complement specific instruments such as insurance and carbon trading.

4. In this context, the IFI consultations have focused on identifying options for both catalyzing private sector investments and expand the IFI's own lending support for the development of clean energy systems, energy affordability and security, and adaptation. All IFIs also recognize the significant implications that the Investment Framework can have on their ability to meet their respective poverty reduction targets, including the development of robust procedures for addressing poverty and adaptation issues.

5. Process-wise, all IFIs agree that it is essential to fully participate and work in a harmonized manner. In this respect, the consultation process has provided a platform for the IFIs to brainstorm, coordinate, and cooperate in sharing information, experience, and analytical work. Consultations to date have been structured along a three-step work plan comprising (i) assessment of existing lending and non-lending activities in the area of clean energy and adaptation, including risk adjustment instruments; (ii) identification of opportunities and modalities for improving effectiveness through capturing synergies and increased collaboration;

and (iii) finalization of a draft Investment Framework concept and implementation action plan in time for the WBG Spring Meetings. Based on the guidance of the Gleneagles Action Plan, it is still expected that each IFI will present its own specific recommendations to its Board and Annual Meetings.

B. Current IFI Context and Emerging Issues

6. Early in the consultation process, all IFIs initiated baseline assessments of their existing portfolios and institutional capacity in clean and low carbon energy systems and adaptation, looking at good practices, constraints (i.e. expertise, adequacy of TA and grant resources, risk management, debt or equity provision, speed, instrument integration, etc.), and outreach issues, among others. Table E.1 presents a snapshot of all IFIs' low carbon portfolios and pipelines, while Table E.2 offers the rationale and criteria used to define these investments as illustrated by the World Bank low carbon investment baselines as of September 2005. It is important to note that the submitted data presents only a rough approximation since none of the IFI management information systems is designed to capture such data. The problem is particularly acute for adaptation, where the IFIs had difficulties distilling a meaningful baseline. Thus, providing for such capacity has been highlighted as a major requirement to ensure that in the long term resources mobilized under the Investment Framework are managed effectively and with due accountability.

7. In the context of adaptation all IFIs face steep learning curves in analyzing climate risk, integrating climate change across their specific sectoral activities, and identifying broader opportunities to increase the climate resilience of growth. Agreed early steps include sharing of knowledge and learning on climate risks, systematic climate risk assessments, and on opportunities to increase the climate resilience of development as well as cooperation in broadening the use among the IFIs of climate risk screening tools, such as the World Bank's Climate Risk Screening Tool¹.

8. The consultation process has produced a consensus on the key challenges in the mitigation arena, including on the imperative of stemming the build-up of lower efficiency coal generation throughout the world and in China and India in particular. While renewable energy will continue to be an important component to pursue, energy efficiency stands out as the single most important driver for carbon reduction in the shorter to medium term (10 to 20 years, with significant technology lock-in implications for the rest of the century). Key sectors such as transport and related infrastructure are also emerging as principal emissions drivers, posing equally significant threat of high carbon intensity lock-in if conventional individual motor car modalities and associated urban form continue to dominate.

9. In this context, the IFIs noted the heavy emphasis on renewable energy financing across their portfolios in contrast to smaller, piloting energy efficiency programs largely focused on demand side management. There is a clear recognition that the IFI policy and technical support and lending for higher efficiency coal power generation and rehabilitation of the existing aged coal power and hydropower plant fleet could be an important factor for lowering the carbon intensity of energy sector growth in larger industrializing developing countries. Rapidly

¹ The WBG assessment of the climate risk exposure of its lending estimates that \$4.5 billion of its lending activities were prone to serious climate risk but that only \$250 million of lending recognized this risk and attempted to address it in the project design.

increasing domestic energy demand in growing economies like China and India poses particular challenges in defining low carbon power sector investments. Yet, most IFIs have limited experience and technical capacity in this area, with the exception of EIB, and, to some extent, EBRD, which have been engaged in the rehabilitation of Eastern Europe's coal and hydropower plants.

10. Addressing these challenges, the IFIs are focusing systematically on clean energy and low carbon systems, initiating new efforts and stepping up existing initiatives to bridge the gaps, strengthen their technical capacity, and better align their energy sector and lending work. The consultation processes is giving further impetus to increased sharing of country analysis of low carbon development pathways and energy sector needs and opportunities, including required policies, incentive systems, and financing gaps, with a view to building a common country dialogue platform and avoiding duplication among the IFIs. Reflecting on existing comparative advantages, the IFIs are initiating shared sector analysis across the following areas:

- ADB is focusing on the development of a transport strategy for reduced carbon emissions, with particular focus on the needs of the growing transport sectors in China and India;
- EBRD is taking a lead in the area of industrial sector energy efficiency, including the mainstreaming of its energy audit program;
- EIB is considering options for lowering the water supply and sanitation carbon intensity; and
- IEA is taking a lead in developing a common understanding among the IFIs of the various technology scenarios, including the low carbon scenario for global energy sector development, and deepening the understanding of each scenario's financing needs at both global and regional/large- country levels. IEA is also taking a lead on developing and mainstreaming benchmarks for energy efficiency not only in the industrial sector but also for building shells and appliances.

11. The primary focus of these efforts is to assist client countries in better understanding the available opportunities that are already in their domestic economic interest as well as helping them identify additional technologies and measures that will become economically feasible if additional resources are made available to manage incremental cost and risks.

C. Financing Tools and Needs

12. Most IFIs are closing their reviews of existing instruments while the IFC has completed an overall assessment of both the WBG and across the IFIs. The objective has been to determine the adequacy of existing instruments to meet the Investment Framework objectives and, drawing on lessons from more innovative products such as the EBRD energy audits, to the identify scope for increasing their compatibility and expediting their offer to the market.

13. Across the board, there is an emerging consensus that existing financial tools can support the Investment Framework objectives but they cannot substitute for covering incremental costs associated with the adoption of new low carbon technologies. There is a clear need to develop a

financing window with the single objective to provide the resources required for financing mitigation and adaptation. The IFIs need, however, to streamline the offering of their instruments to the market, including through blending and aggregation services within and across IFIs. The area of risk-management poses a particular challenge, whereby the existing product base has to be adapted and expanded to address broader climate risk in collaboration with the re-insurance industry and to provide for more effective incremental risk management of high efficiency lower carbon energy and infrastructure development. In this respect, it will be critical to expand and maintain effective coordination and cooperation both among IFIs and with the private sector.

14. In parallel, the IFIs are assessing incremental capital needs, including adjusting the application of existing sources of concessional finance and creating synergy with carbon finance. The consultation process has further identified (i) addressing the high transaction costs of pure demand side energy efficiency, (ii) replenishing the GEF and adapting it to support low-carbon development under its new resource allocation framework, and (iii) addressing the long lead times, scalability, and post-2012 continuity in demand, as some of the key areas which IFIs need to focus on addressing in cooperation with the broader international community.

D. Continuity

15. The Investment Framework consultation process has provided a catalyst for better cooperation and coordination among IFIs and within regions and the IFIs are recognizing its immediate value in learning about the activities of others. A number of opportunities have been already identified for exchange of good practices and further learning to support scaling up in energy efficiency (EBRD), renewable energy (several IFIs) and cross-IFI collaboration (e.g. ADB-IDB joint operations). Respectively, there is consensus that the consultation process must be maintained and strengthened beyond the Spring Meetings, as the Investment Framework work evolves.

Table E.1. Baseline of IFI Low Carbon Investment (US \$ millions):
The table presents the IFI project pipelines and portfolios as of September 2005.

		Category	WB FY01-05	WB FY06-07	EBRD* FY01-05	EBRD* FY06-07	ADB pub FY01-05	ADB private FY01-05	ADB pub FY06-07	ADB private FY06-07	IADB current	IADB pipeline	AfDB# FY01-05 estimates	AfDB# FY06-07 estimates	EIB* ^ FY01-05	EIB* ^ FY06-07	Cat Totals	
Projects having lowering carbon emissions as their main rationale	Category-specific commitments	Energy Efficiency	870	209	704	320		280			438	343	49	8	2,901	1,429	7,552	
		Renewable Energy	608	680	3	43	161		35		52	105	380	22	2,590	1,275	5,954	
		Hydropower	721	308	21	30	355	3,133	223		166	1,228		108	573	282	7,148	
Projects that directly or indirectly contribute to lower carbon emissions or have the intrinsic capacity to do so	Category/ Sector/ Project commitments	Gas Development	250	707	38	80	230	10,843	100	345	479		18	56	6,328	3,115	22,589	
		Coal Efficiency	102	18	236	80									439	216	1,091	
		Oil Efficiency				115										507	250	872
		Gas Flaring, Venting, and Landfill Gas		40	11		221				57	16			142	70	557	
		Improved dispatch	1,024	285	72	50	4								238	116	1,789	
		Power Loss Reduction	797	710	165	50	2,127	249	1,190						1,206	593	7,087	
		Improving Transport Efficiency	215		84	96	73					285	962	79		18,956	9,330	30,080
		Nuclear			652	600												1,252
		TOTAL FY 01-05	4,587		1,986		3,171	14,505			1,477		526		33,880		60,132	
		TOTAL FY 06-07		2,957		1,464			1,548	345		2,654		194		16,676	25,838	
							17,676	1,893										
		G-TOTAL	WB: 7,544		EBRD: 3,450		ADB: 19,569			AIDB: 4,131		AfDB: 720		EIB: 50,556		85,970		

Notes: FYs not consistent across all institutions

* Euro-\$ conversion as of end Sept 20: \$1.22525/1EURO

UA conversion: \$1.58673/1UA

^ **EIB: (i) higher range of estimates; (ii) investments are overwhelmingly in EU, EFTA and Accession Countries, with the exception of "power loss reduction" and "gas development," where 61 percent and 38 percent respectively have been invested in other countries.**

Table E.2. Baseline of the World Bank Low Carbon Investment:
The table presents the World Bank project pipelines and portfolios as of September 2005.

Categories	Rationale	Description & Examples	2001-2005 allocations (\$M)	2006-2007 allocations (\$M)
(a) Projects having <i>lowering carbon emissions as their main rationale</i>			Category-specific commitments	
Energy Efficiency	These projects are all highly likely candidates for carbon reduction. The category includes a mix of traditional energy efficiency projects and district heating projects	<p>Include operations to improve the efficiency, by which energy is produced, transformed and used. Specifically:</p> <ul style="list-style-type: none"> ➤ specialized entities/technologies providing energy efficiency services ➤ any other interventions which support the reduction of energy use through efficiency gains ➤ production, transportation, and distribution of steam/hot water (heat) through an interconnected network [production may be conventional, thermal (including combined heat and power plants whose majority production is heat), nuclear or geothermal in origin <p>[DH projects are considered, by the EU and the WB, to be energy efficiency projects since by including space heating they increase the usable heat from a thermal plant from mid-30 percent (power only) to roughly 80 percent]</p>	870.2	208.5
Renewable Energy	The carbon use of these projects is negligible thus decreasing carbon impact.	<p>Include all new and renewable energy except for hydropower. Specifically:</p> <ul style="list-style-type: none"> ➤ geothermal for electricity generation ➤ hydrogen and non-carbon fuel cells ➤ off-grid (distributed) electricity ➤ wind and other renewable energy, including ocean energy ➤ photovoltaic (solar cell) ➤ solar thermal energy, including solar thermal electricity ➤ sustainable biomass fuel wood use and fuels produced from urban wastes ➤ bioenergy fuels, including transportation fuels converted from biomass 	608.3	679.5
Hydropower	This category is meant to cover all hydropower projects (both greater and smaller than 10 MW).	Cross check with the adaptation matrix to ensure compatibility and double counting issues	721.4	308.0
(b) Projects that <i>directly or indirectly contribute to lower carbon emissions or have the intrinsic capacity to do so</i>			Category/Sector/Project commitments	
Gas Development	Carbon benefits can be achieved by burning gas in place of fuels with higher carbon levels. In addition, this could enable higher efficiencies on the basis of technologies that would not be used otherwise (gas-fired CCGT).	<p>Include operations supporting the exploration, production, refining, storage, transportation, and distribution of gas. Specifically:</p> <ul style="list-style-type: none"> ➤ gas transportation distribution, gas pipelines, liquefied natural gas (LNG) plants ➤ coal-bed methane ➤ natural gas and its fuel products ➤ processes and technologies reducing transportation losses and improving gas efficiency ➤ gas-fired power 	250.2 (sector-specific)	707.3 (sector-specific)

Categories	Rationale	Description & Examples	2001-2005 allocations (\$M)	2006-2007 allocations (\$M)
Coal Efficiency	Considerable carbon savings could be achieved by replacing 30 percent efficient plants with ones that are 36-40 percent efficient.	Include operations supporting improvement of coal quality, introduction of technologies that improve coal plant efficiency, or support otherwise the reduction of inefficient coal production and/or use.	101.6 (category-specific)	18.0 (category-specific)
Oil Efficiency	Carbon savings could be also achieved by improving the efficiency of oil-fired power plants.	Include operations supporting introduction of more energy efficient technologies for oil-fired power plants.		
Gas Flaring, Venting, and Landfill Gas	Benefits can come from methane leakage reduction as well as from substituting higher carbon fuels with gas and enabling greater efficiency.	Include operations supporting gas-flaring and gas venting abatement as well as operations supporting landfill installations for methane processing and distribution.		39.8 (category-specific)
Improved dispatch	Changing dispatch roles that favor cleaner technologies could reduce carbon releases. In selected cases, establishing regional energy trade enables greater energy efficiency through improved dispatch and by facilitating technologies that may not be justified in smaller markets.	Include operations supporting regional energy trade which have resulted or are expected to result in improved energy efficiency as a result of either improved dispatch or introduction of energy-efficient technologies (e.g. large hydro, gas-fired combined cycle, etc.)	1024.3 (sector-specific)	284.5 (sector-specific)
Power Loss Reduction	Transmission and distribution projects can be used to reduce network losses.	Include operations supporting transmission and distribution loss reduction. These estimates present the upper bounds on loss reduction	796.8 (sector-specific)	710.0 (sector-specific)
Improving Transport Efficiency	By improving transport efficiency, fossil fuel use can be reduced. Fuel switching to more benign fuels is also possible.	Include operations supporting cleaner transportation technologies, including mass transit.	214.9 (sector-specific)	
Nuclear	While nuclear energy production has its own environmental externalities, it offers a viable low carbon energy production alternative	Include investment in nuclear power production and nuclear waste treatment.	-	-

II. INVESTMENT FRAMEWORK PROFILES OF PARTNER IFIS

A. Asian Development Bank

16. **Strategic Direction.** ADB is involved in three areas related to climate change: (i) effective development and promotion of clean energy technologies; (ii) establishment of an effective carbon market over the long term; and (iii) integrating climate change adaptation in development and natural resource management decision-making. The following initiatives and activities have been undertaken to complement and/or contribute to the Investment Framework by providing new avenues for developing and investing in low carbon energy systems, lowering the carbon emissions intensity of the energy sector, and catalysing private sector investment:

17. **Energy Efficiency Initiative (EEI).** Started in September 2005, the EEI explores how ADB could contribute to: (i) lowering effective consumption of energy, measured as energy input per unit of delivered service or output, and (ii) reducing emissions of greenhouse gases. The EEI will: (i) compile and analyze existing knowledge and experience on energy efficiency policies, potential investments and strategies, from in-house, DMC and international expert sources; (ii) identify strategies for expanding ADB clean energy investments and activities; and, (iii) define a near- and medium-term operational plan, and (iv) define a cohesive way forward for supporting investments and activities in clean energy by developing a *portfolio* of tools and investment modalities adapted to the specific requirements of each distinct market targeting both public and private sector investments.

18. **Carbon Market Special Initiative.** Established in August 2003, the ADB Clean Development Mechanism (CDM) Facility aims to help developing member countries access financing opportunities available through CDM. Experience to date has demonstrated that lack of adequate and timely *upfront financing* poses a major obstacle to project development. To further catalyze the carbon market and serve better client countries' need for sustainable energy, ADB has recently started to develop a new *Carbon Market Special Initiative (CMSI)* that is looking into the merits of establishing a dedicated carbon co-financing facility. The objective of the initiative is to define practical interventions by ADB to work in the carbon market by exploring three interrelated activities: (i) establishment of a special co-financing facility, focusing on the implementation phase of projects; (ii) provision of marketing/brokerage support to sponsors with projects with carbon credit content; and (iii) technical services ADB's support ADB's operating departments—covering work at the country strategy and program, project processing and implementation levels. This facility, unlike other emission credit procurement vehicles currently available, would provide up-front funds to project sponsors so that projects could incorporate more efficient and cleaner technologies.

19. **Transport and Energy Efficiency.** ADB is undertaking a series of studies aimed at developing a policy and investment framework for energy efficiency and climate change in the transport sector, focusing specifically on the road sector. While this work will cover the entire region, emphasis is being placed on India and People's Republic of China, as the growth in the transport sector in these countries are expected to significantly impact and influence the overall global outcome. The studies will examine options for reducing emissions and avoiding lock-in problems associated with high carbon intensity in this sector; keeping in view the rapid expansion of urban populations, high rates of economic growth, increasing real incomes and the

corresponding steep increases in vehicle fleets and vehicle use. The work will also examine the co-benefits from the perspective of both global climate change as well as local pollution. This will have benefits during the implementation phase since local issues will be easier to adopt compared to global issues and the co-linkage of mitigating issues could provide solutions to local as well as global concerns.

20. The studies are examining the wide range of issues including cleaner fuels and vehicles, fuel economy standards, alternative fuels, and the use of market-based mechanisms to affect behavioral change. The work will also focus on traffic demand management issues to reduce total vehicle travel, promote use of public transport, and better integrate transport and land use planning. A further component of the work will examine the potential for introducing new technologies both for carbon fuel substitution as well as fuel saving technologies. These strands of work will be welded into an action plan which will provide a policy and investment framework that assesses policy options and their impact on climate change issues.

21. *Investment Framework Needs Assessment.* The resource requirements for moving forward will only be realistically known when these initiatives and studies are completed in April/May 2006.

B. African Development Bank

22. *Status and scope of Investment Framework-related work.* With assistance from DFID the AfDB has started assessing its existing investment portfolio and instruments, as well as to identify its key priorities, constraints and resource needs. The joint lessons learnt will provide a useful contribution to the ongoing review of the Bank's energy sector policy and development of a Renewable Energy and Energy Efficiency Strategy and Guidelines.

23. *Key (client) issues and positions.* Africa has a unique energy situation characterized by wide regional disparities, heavy reliance on traditional energy sources, and limited access to other modern energy services. Key energy sector issues include: lack of access to modern energy services in rural areas; inadequate policy, regulatory and institutional frameworks; lack of public and private investment capital to harness available resources; limited human and institutional capacity in the energy sector; small and stand alone national grids and energy systems that are costly to operate; high dependence on oil imports and associated exposure to price volatility; inefficient utilisation of available resources; and attendant health, social and environmental impacts from the extraction, transportation, transformation, and utilization of energy resources.

24. *Past and Future Consultations.* The Bank has been represented at a number of international consultative conferences and worked in collaboration with UNECA in consulting its stakeholders on African (energy) input to CSD14. A number of consultations have been initiated and there plans to consult with wider stakeholder community on its draft energy policy and RE&EE Strategy. Further Investment Framework-specific consultations with Bank staff, Senior Management, the Bank's board and wider stakeholders are planned. The consultations will make use of Bank's and FINESSE websites and newsletters, among other means.

25. The Bank will, in collaboration with the World Meteorological Organization, UNDP, GEF, and UNECA, be developing Africa's climate change adaptation Implementation Strategy under the auspices of the Global Climate Observation System (GCOS).

26. ***Investment focus and strategic directions.*** The Bank's current investment focus in the energy sector is to reduce poverty mainly by increasing access to sustainable energy. Operations have to date encompassed: multinational projects i.e. cross-border transmission lines, power pools and hydropower generation; rural electrification and the deployment of renewable energy technologies; institutional and human capacity building; power sector reforms (including preparation of national energy strategies); and construction of new and rehabilitation of existing power infrastructure.

27. ***Strategic Directions.*** The Bank identified the need to refocus its instruments and policy to deliver sustainable, reliable and environmentally friendly energy through replicable and scalable mechanisms on: exploitation of available energy resources (renewable and non-renewable); widening energy accessibility for poverty reduction; mobilizing additional financial resource; regional cooperation and trade; capacity building; strengthening strategic partnerships and synergies; and increased focus on climate change adaptation.

28. In the context of its Energy Policy review, the AfDB will engage in an in-depth analysis of the role of energy in the focal areas of the Bank, will seek to analyze the barriers and constraints to increasing access to sustainable energy, and to find the right investment approach. Priorities are expected to include:

- Broader shift towards low-carbon economies by promoting energy efficiency;
- Supporting the dissemination of renewable energy technologies, namely improved and modern biomass technologies; small hydropower; and solar and wind; and
- Widening access to cleaner fossil fuels and ensuring the use of efficient technologies to avoid high carbon technology lock-in.

29. ***Investment Framework needs assessment.*** Additional resources and processes required to advance Investment Framework work over the next 2 years are mainly internal capacity building and investment operations (project identification and development for example through a dedicated multi-donor Energy Facility within the AfDB). It is estimated that a total of 200 million € is required.

30. The AfDB will be further working to define the processes and resources needed to clearly identify and address the key external and internal constraints for effectively addressing energy poverty and adaptation needs in Africa. Possible focal areas could include:

- *Adaptation: develop and mainstream risk assessment tools at macro and micro levels to influence policy and project design to help RMCs to build resilience to natural disasters.*
- *Communication/ Country dialogue.* Dialogue within the Bank, with RMCs and among RMCs to build firm commitment at Bank management, operational and shareholder level. Possible country-level energy strategy development work based on ongoing Bank funded studies on rural electrification/renewable energy in the Gambia, Uganda and Tanzania.

- *Capacity enhancement* mobilize further support for RMC capacity building as well as for reorientation of Bank processes, policies, and instruments to better promote clean energy (e.g. providing energy audits to clients).
- *Assessment of financing instruments.* Analysis of the current financial products available and identification of potential new products, and ways of improving the effectiveness of these products.

C. European Bank of Reconstruction and Development

31. ***Scope and status of Investment Framework-related work.*** EBRD is preparing a new Energy Policy which is now available on the Bank's web site for public consultation. The Policy proposes a fundamental shift in emphasis towards energy efficiency and climate change mitigation throughout all Bank operations. To facilitate this, organizational changes are being implemented in the Bank with a renewed 'Energy Efficiency and Climate Change Team' being placed alongside the corporate planning function to drive and support all sector and country banking teams to develop energy efficiency and climate change-related activities.

32. ***Key (client) issues and positions.*** High energy intensity and energy security are the two major issues across the EBRD's region of operation. Most of the EBRD's client countries are industrialized economies, including a number of Annex 1 countries. The Bank operates in a climatically cold environment and the region has both abundant fossil resources and a lot of carbon credit surplus under the Kyoto protocol. Low energy prices reduce the impact on economic performance but this is now changing quickly because of increases in gas prices. General awareness about energy efficiency is low and climate change is not a high priority for governments or the general population. Adaptation to climate risks is more complex to assess than in some developing countries and is barely recognized as an issue.

33. ***Past and future consultations.*** EBRD is preparing a comprehensive energy efficiency and climate change initiative to be introduced at its Annual Meeting in May 2006. This will also form the basis of the EBRD's contribution to the development of the IF.

34. ***Investment focus and strategic directions:***

- Mainstream energy efficiency and climate change activity throughout sectors and countries including build up of industrial energy efficiency activities (including benchmarking).
- Enhance energy efficiency scope of financial intermediation instruments.
- Increase volume of renewable energy finance.
- Further develop carbon credit activities through establishment of Multilateral Carbon Credit Fund (MCCF).
- Set target for combined volume of energy efficiency and renewable energy investment.

35. Investment Framework needs assessment:

- Resources and processes mobilized internally:
 - Internal reorganization placing energy efficiency and climate change activity alongside corporate planning function to drive and support activity across the Bank.
 - TC resources being mobilized on case by case basis for energy audits and energy management training and for the preparation of energy efficiency benchmarking methodology.
 - Additional staff assigned for energy efficiency and renewable energy activities.
- Additional resources and processes required to advance Investment Framework work over the next 2 years:
 - TC resources for energy audits and training
 - TC and grant co-financing for FI and direct lending products;
 - TC and grant co-financing for new capacity building and policy assistance programs.
 - Total funding needs are being defined in context of initiative being under preparation with funds required over next 5 years estimated at up to €150 million.

D. European Investment Bank

36. *Scope and Status of Investment Framework-Related Work.* EIB activities in the area of climate change mitigation range from long-standing support for investments in renewable energy, energy efficiency, co-generation, district heating, natural gas use and supply, public transport, and research and development to technical cooperation with the European Commission and other European institutions, to supporting the development of carbon credits in projects financed by the Bank. EIB activities are generally conceived as a pro-active response to EU policy.

37. *Investment Focus and Strategic Directions.* The Bank aims at allocating at least 50 percent of its total lending for new power generation capacity in the EU-15 countries to renewable energy schemes during the period up until 2010, in line with the objective of providing 22 percent of overall EU electricity consumption from renewable sources by 2010. A similar approach will be followed for lending in the new member states and outside the EU.

38. The Bank is **mainstreaming** climate change mitigation and adaptation by incorporating climate change considerations into its internal appraisal procedures, in three respects:

- All projects are now routinely screened for potential to mitigate climate change and generate carbon credits, which could be used for Kyoto compliance purposes and/or in the EU Emissions Trading Scheme.
- The economic value of greenhouse gas (GHG) emission reductions, where significant, are internalized in the profitability analysis of the project and incorporated in the financial risk analysis.
- Projects teams have also started to address the adaptability of projects to climate change in cases where adverse effects could have a significant impact on project performance.

39. In order to support the EIB shareholders and EU companies seeking to purchase project-based carbon credits, the Bank is working on co-sponsorship and/or participation in carbon funds. Discussions are ongoing with the EBRD about the detailed structure of the Multilateral Carbon Credit Fund (MCCF). Discussion and negotiations are ongoing with the World Bank on establishment of the Carbon Fund for Europe (CFE). The launch of both funds is planned for 2006. Opportunities for sponsoring and/or participating in other targeted clean energy or carbon funds are being investigated.

40. ***Investment Framework Needs Assessment:***

- EIB is exploring the development of new financial instruments, but its assessment to date points to little scope/need for new products. Increased access to grant financing and technical assistance funds, however, would be valuable.
- *Resources and processes mobilized internally.* The Bank currently has two financial instruments dedicated to addressing climate change mitigation:
 - The ***Climate Change Financing Facility*** (CCFF) is a EUR 500 m financing window for GHG emission reduction projects undertaken to meet obligations under the EU Emissions Trading Scheme (about EUR 200 m committed) and projects eligible for the Clean Development Mechanism (CDM) and Joint Implementation (JI) instruments of the Kyoto Protocol. Expansion of this facility is under review to include a wider range of climate change mitigation and adaptation projects.
 - ***The Climate Change Technical Assistance Facility*** (CCTAF) of EUR 5 million provides advance funding of activities associated with the development of carbon credits under the CDM and JI instruments of the Kyoto Protocol (two projects underway).

E. Inter -American Development Bank

41. ***Scope and status of Investment Framework work.*** The IDB has approved a new Action Plan for Renewable Energy, Energy Efficiency, Greenhouse Gas Mitigation, and Carbon Finance (September 2005) through which it is carrying out or setting up several lines of activity relevant

to the Investment Framework. The Bank is also mobilizing increased technical support for barrier reduction and project inception in order to expand its renewable energy and energy efficiency investments throughout LAC. These actions support regional energy security as well as long-term sustainable development goals related to energy. The Bank is conducting a review of opportunities for action by the it and its borrower countries in order to support a clean energy investment framework in LAC. Finally, the IDB continues to develop its processes and capacities for incorporating carbon finance in its energy portfolio.

42. ***Key (client) issues and positions.*** Priorities include reduction of petroleum import costs through energy supply diversification and energy efficiency; expansion of modern energy services to under-served rural and other populations; regional energy and broader economic integration for improved competitiveness and more rapid economic progress; and improvement of urban transport systems in order to reduce local pollution, upgrade service quality, and improve energy efficiency. Clean energy investments need to be economically and financially sustainable as well as environmentally and socially beneficial. Borrower countries in LAC are also expressing increased concern about vulnerability to climate change.

43. ***Past and future consultations.*** The IDB hosted a major regional workshop on carbon finance in LAC and the role of the IDB in July 2005; it is scheduled to host a major regional workshop on a clean energy investment framework in LAC in mid-March 2006. Country level consultations are ongoing with a number of borrowing members on increasing energy efficiency and expanding access to carbon finance.

44. ***Investment focus and strategic directions:***

- Near-term investment and technical assistance efforts to advance energy efficiency (end-use and otherwise) in order to reap multiple economic and environmental benefits.
- Medium-term investments to expand cost-effective smaller-scale renewable energy, in particular in the context of rural development and micro-enterprise initiatives.
- Strategic assessment of opportunities for increased replacement of fossil motor fuels by biofuels in LAC.
- Increased regional integration of energy systems to increase efficiency and access to cleaner energy resources.
- Routine incorporation of carbon finance as appropriate in energy investments as a means to expand clean energy use.
- Increased capacity to measure the net impacts of Bank investments on borrower country GHG emissions.
- Increased awareness and response to potential vulnerability to climate change in the design and implementation of Bank investments, especially in sectors of greater

potential vulnerability (agriculture, tourism, infrastructure, water resources, coastal areas, public health).

45. Investment Framework needs assessment:

- ***Resources and processes mobilized internally.*** Non-reimbursable resources have been deployed for expanding RE and EE investment and for framing the key issues and actions needed for a clean energy investment framework in LAC; some limited TC resources also have been mobilized for promoting inclusion of carbon finance in IDB projects.
- ***Additional resources and processes required to advance Investment Framework work over the next 2 years:***
 - support for the kind of energy efficiency mainstreaming capacity in the IDB portfolio already being undertaken by the EBRD;
 - expanded start-up (PIN) funding for adding carbon finance to IDB investment projects;
 - increased use of innovative mechanisms for financial engineering, financial risk management and financial support services to project developers in clean energy and carbon finance investments;
 - improved capacity to track the GHG implications of the IDB's overall investment portfolio; and
 - increased technical support funding for strengthening and broadening the consideration of climate change vulnerability in IDB operations.

The first three items in the list above could lead to a “one stop help desk” within the IDB to support other specialists in promoting clean energy and carbon finance, if additional funding and human resources were available.

ANNEX F. WORLD BANK GROUP CLEAN ENERGY, ADAPTATION, CARBON FINANCE, AND RISK MITIGATION WORK

A. Clean Energy Portfolio

1. The overarching goal of the World Bank Group's (WBG) energy business is to improve access to modern and affordable energy services for the world's poor and to achieve sustainability in the environmental, financial, and fiscal aspects of the energy sector. The WBG's commitment to clean energy is in line with the current energy strategy which rests on four pillars:

- ***Improve Access of the Poor to Modern Energy Services*** by reducing the cost and improving the quality of energy supplied to low-income households and social services and ensuring that energy subsidies are targeted at and reach the poor;
- ***Improve Macroeconomic and Fiscal Balances*** by rationalizing energy taxes and enhancing effective payment by all energy users to eliminate operating subsidies to state-owned enterprises, thus leveling the playing field for clean energy;
- ***Promote Good Governance and Private Sector Development*** by divesting assets to strategic investors in a socially responsible and corruption-free way, catalyzing private investments by liberalizing entry to energy markets and strengthening the voice of consumers and communities, thus improving the investment climate for clean energy;
- ***Protect the Environment*** by removing market and regulatory barriers to renewable energy and energy efficiency investments and reducing gas flaring, reducing or eliminating local pollution, and facilitating carbon trading and joint investments to reduce GHG emissions.

2. With the aim of ensuring an institutional focus on cleaner energy sources, the WBG committed to scale up assistance for RE and EE at the June 2004 International Renewable Energies Conference in Bonn, Germany. More specifically, it committed, among others, to ensure that RE and EE are seen as economically viable and essential ingredients in the energy choices of our member nations and committed to a target of 20 percent average growth annually in both EE and new RE¹ commitments over the five years—FY05-09. It also committed to foster greater collaboration across national and institutional lines. These commitments were later incorporated into the WBG Management Response to the Extractive Industries Review.

3. The WBG support for clean energy encompasses investment and technical assistance for renewable energy and energy efficiency as well as support for gas development and use to displace dirtier fuels, and improving the conditions of coal mines, including mine rehabilitation. The total WBG commitments in the energy sector were \$56 billion from 1990-2005 (please see Table F.1 for detailed breakdown). WBG has committed over US\$9 billion toward RE and EE during this period, equal to 16 percent of total energy sector commitments. Of this amount, about

¹ New RE includes solar, wind, geothermal, biomass and hydropower with capacities no more than 10 MW per facility.

US\$6.8 billion were for RE (comprising \$4.3 billion for hydropower with capacities more than 10 MW per facility and \$2.5 billion for new RE) and US\$2.2 billion for EE. The WBG new renewables commitments have increased steadily with commitments in the 2000-2004 period 47 percent higher than in the 1990-94 period. Likewise, energy efficiency also showed a significant increase, doubling in the last five years compared to 1990-94.

4. In FY05, the WBG's financial support for RE and EE totaled US\$748 million, including US\$661 million for RE and US\$87 million for EE.² In FY05, the WBG share of RE and EE financing was 26 percent of total energy sector commitments of US\$2.8 billion. As a share of power sector commitments of US\$1.18 billion, RE and EE financing was 64 percent. In FY05, the WBG support for new RE and EE was \$299 million and exceeded the 20 percent per annum scale-up commitment of \$251 million. Importantly, every dollar of WBG FY05 RE and EE commitments will leverage an additional five dollars from other financing sources.

Table F.1. World Bank Group Energy Sector Commitments 1990-2005

	<i>IBRD/ID A*</i>	<i>IFC*</i>	<i>MIGA</i>	<i>Total</i>	<i>Percent</i>
Energy efficiency**	2,075	148	5	2,228	3.9%
Coal ***	3,323	15	35	3,373	5.9%
Oil & Gas	6,895	3,756	707	11,358	20.0%
Power	24,415	4,439	2,345	31,199	55.0%
Renewable energy	5,346	938	514	6,798	12.0%
General energy sector****	1,753	0	0	1,753	3.1%
Total	43,807	9,297	3,606	56,709	100%
percent of RE/EE in Total Energy	17%	12%	14%	16%	

* Includes GEF and Carbon Finance.

** Includes efficiency improvements in energy supply and demand and improvements in district heating.

*** Includes support for mine rehabilitation and mine closing.

**** Classification used if no other energy sector category is appropriate or for activities that span more than five sectors.

5. *Analytical and Advisory Activities (AAA)*. An integral part of the WBG's scale-up program for clean energy is the upstream AAA. These activities include economic and sector work (ESW) and non-lending technical assistance (TA). The World Bank support for clean energy AAA activities has grown significantly; this bodes well for the enhanced institutional focus on clean energy and scale-up of RE and EE lending in the coming years. Importantly, there was a significant increase in specific references and requests from WBG partner countries for RE and EE support in FY-04-05 CAS and PRSP.³ Some of the key knowledge products issued in FY05-06 were the Renewable Energy Toolkit, the Technology Performance and Characterization report, the RE for Development web site, and the Renewable Energy Financing and Policy Network study.⁴

² From a regional perspective, countries in the East Asia and Pacific (EAP) region received the highest level of commitments in FY05, with a total of US\$314 million. Europe and Central Asia (ECA) ranked second, with US\$227 million in commitments, followed by Sub-Saharan Africa (AFR), with US\$101 million. Both the AFR and EAP regions saw significant increases, with AFR commitments more than doubling from US\$46 million to US\$101 million, and EAP commitments increasing more than six-fold, from US\$47 million to US\$314 million.

³ Specific references for RE & EE support were found in 60 and 74 percent of the PRSP and CAS issued in FY04-05 compared to hardly any mention in prior years.

⁴ For more information, please see <http://www.worldbank.org/re> and <http://www.worldbank.org/retoolkit>.

6. *Partnerships.* The WBG has special partnerships with donors that help to move the clean energy agenda forward. Some of these partnerships are: Energy Sector Management Assistance Programme (ESMAP), Global Gas Flaring Reduction Initiative (GGFR), Asia Alternative Energy Program (ASTAE), IFC Carbon Finance, IBRD Carbon Finance and Global Village Energy Partnership (GVEP).⁵

Table F.2. World Bank Group Energy Sector Commitments
(All amounts in millions of U.S. dollars)

IBRD/IDA*	FY90	FY91	FY92	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	Total
Power	2,699	1,126	3,306	1,694	1,440	2,243	2,528	2,438	1,427	826	557	1,068	1,272	518	394	879	24,415
Renewable Energy	53	127	145	1,139	300	339	765	171	212	184	513	20	349	282	259	488	5,346
Energy Efficiency		265	54	10	59	148	373	53	350	10	289	193	36	88	67	80	2,075
Coal	31	428	27	30	28	22	557	220	902	254	51	111	194	75	160	234	3,323
Oil & Gas	430	1,549	635	867	1,250	696	12	160	241	266	116	218	227	74	41	113	6,895
General energy sector	24	165	36	215	38	98	19	3	74	251	176	175	55	170	128	125	1,753
Total	3,237	3,660	4,203	3,956	3,115	3,547	4,254	3,046	3,207	1,790	1,702	1,784	2,132	1,206	1,050	1,919	43,807

MIGA	FY90	FY91	FY92	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	Total
Power						107	109	79	67	135	386	394	456	474	73	66	2,345
Renewable Energy						30	35	15	65	26	252					91	514
Energy Efficiency														5			5
Coal								35									35
Oil and Gas						65	0	10	64	46	15	196	0	122	113	75	707
Total	-	-	-	-	-	202	144	139	196	207	653	590	456	601	186	232	3,606

IFC*	FY90	FY91	FY92	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	Total
Power		231	0	302	257	371	630	251	246	96	397	432	216	327	452	231	4,439
Renewable Energy	0	25	72	26	186	7	66	165	200	29	0	6	1	60	14	83	938
Energy Efficiency	0	0	0	0	0	0	7	3	6	16	6	0	31	75	0	7	149
Coal				10									5				15
Oil and Gas		250	238	220	179	149	415	237	296	188	76	230	65	344	495	374	3,756
Total	-	506	310	558	621	527	1,118	655	747	329	479	673	312	806	961	695	9,297

	FY90	FY91	FY92	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	Total	%
Power	2,699	1,357	3,306	1,996	1,697	2,721	3,267	2,768	1,740	1,057	1,340	1,894	1,944	1,319	918	1,175	31,199	55%
Renewable Energy	53	152	217	1,165	486	376	866	351	477	239	765	26	350	342	273	662	6,798	12%
Energy Efficiency	0	265	54	10	59	148	380	56	356	26	295	193	67	168	67	87	2,228	4%
Coal	31	428	27	40	28	22	557	255	902	254	51	116	194	75	160	234	3,373	6%
Oil & Gas	430	1,799	873	1,087	1,429	910	427	407	601	500	207	644	292	540	650	562	11,358	20%
General energy sector	24	165	36	215	38	98	19	3	74	251	176	175	55	170	128	125	1,753	3%
World Bank Group	3,237	4,166	4,513	4,514	3,736	4,276	5,515	3,840	4,150	2,326	2,834	3,047	2,900	2,614	2,197	2,845	56,709	100%

* Includes GEF and Carbon Finance.

7. *Partnerships.* The WBG has special partnerships with donors that help to move the clean energy agenda forward. Some of these partnerships are: Energy Sector Management Assistance Programme (ESMAP), Global Gas Flaring Reduction Initiative (GGFR), Asia Alternative Energy Program (ASTAE), IFC Carbon Finance, IBRD Carbon Finance and Global Village Energy Partnership (GVEP).⁶

⁵ For more information visit <http://www.esmap.org>, <http://www.worldbank.org/ggfr>, <http://www.worldbank.org/astae>, <http://www.ifc.org/carbonfinance>, <http://www.carbonfinance.org>, <http://www.gvep.org>

⁶ For more information visit <http://www.esmap.org>, <http://www.worldbank.org/ggfr>, <http://www.worldbank.org/astae>, <http://www.ifc.org/carbonfinance>, <http://www.carbonfinance.org>, <http://www.gvep.org>

B. Global Environment Facility

8. **Program scope.** The Global Environment Facility (GEF), established in 1991, helps developing countries fund projects and programs that protect the global environment. GEF grants support projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants. GEF has three Implementing Agencies – UNDP, and UNEP and the Bank.

9. GEF projects in climate change help developing countries and economies in transition to contribute to the overall objective of the United Nations Framework Convention on Climate Change (UNFCCC). The projects support measures that minimize climate change damage by reducing the risk, or the adverse effects, of climate change.

- **Climate change mitigation.** The GEF supports projects that reduce or avoid greenhouse gas emissions in the areas of renewable energy, energy efficiency, and sustainable transport.
- **Climate change adaptation.** The GEF supports interventions that increase resilience to the adverse impacts of climate change of vulnerable countries, sectors, and communities.

10. **Current/planned support for climate change agenda.** As the financial mechanism of the Climate Convention, GEF allocates and disburses about \$250 million dollars per year in projects in energy efficiency, renewable energies, and sustainable transportation. The GEF also manages two special funds under the UNFCCC—the Least Developed Countries Fund and the Special Climate Change Fund—as well the Adaptation Fund under the Kyoto Protocol.

11. The participants in the fourth GEF replenishment are currently considering a range of funding scenarios that could allocate between \$906 million and \$1,065 million to climate change activities in FY07-10. The main areas of focus under mitigation include energy efficiency, renewables and sustainable transportation. The desired outcome from GEF interventions is to create favorable conditions for market development in terms of policy, finance, business models, information and technology. Main themes under the GEF operational program on energy efficiency, which will be allocated about \$350-380 million, include promoting industrial energy efficiency, energy-efficient buildings and appliances, and retrofitting of power plants. Under the GEF operational program related to renewable energy that will also receive about \$350-400 million under GEF 4, the focus will be on both grid-connected as well as off-grid renewables. Under the operational program related to sustainable transportation, the focus will be on facilitating sustainable mobility in urban areas and this program will receive an allocation of US\$ 95-150 million. In addition to these key allocations, an operational program focused on cost-reduction of low GHG emitting technologies would receive about \$35-50 million. On the adaptation agenda of the GEF, \$30 million could be allocated under GEF 4 to pilot a strategic approach to adaptation.

1. Portfolio Status

12. There are 17 renewable energy, 9 energy efficiency, 1 transport, 4 short-term response measures, and 1 cost-reduction project in the active portfolio.

2. Energy Efficiency (OP 5)

13. The role of GEF in developing financial mechanisms for EE is particularly noteworthy. The growing role of GEF as a risk mitigating instrument for promoting EE received validation through the strong performance of the China Energy Conservation II project, which utilizes GEF proceeds in a guarantee instrument. The China National Investment and Guarantee Company was launched in late 2003 and has approved over US\$13 million in loan guarantees. The EMC Association is fully operational, has 89 members, and is promoting energy performance contracting and helping new EMCs get established. Total energy performance investment in 2004 was over US\$70 million - US\$23 million by the three Energy Conservation I pilot EMCs and at least US\$47 million by new EMCs - three times the project target. Together with the IFC Hungary Energy Efficiency project, which first championed the innovative use of GEF funds to mitigate EE project risks, key lessons are now available for the design of EE financing projects. It is now evident that a combination of a technical assistance program for “technical packaging” and an appropriate financial risk mitigation instrument for “financial packaging” are necessary features of design. “Technical packaging” can involve a range of activities including energy audits, feasibility studies, training etc. while “Financial packaging” could involve choice of an appropriate debt or guarantee instrument suitable to the market conditions provided through a local financial intermediary as support for innovative structuring of individual sub-projects. There are now a number of projects in WB-GEF Op 5 pipeline featuring these characteristics.

3. Renewable Energy (OP 6)

14. The Op 6 portfolio under implementation suggests that the GEF is playing a key role in the design of comprehensive rural electrification programs that involve both traditional grid-extension approaches as well as innovative off-grid approaches. The GEF supported off-grid programs have been particularly successful in Asia, where programs in Bangladesh, Sri Lanka and China continue to show strong progress in renewable energy market development. A key lesson from these experiences is that a demand driven, private sector/NGO anchored program design is suitable in these market conditions. In the case of PV market development, availability of reliable servicing arrangements and rural credit facilities are particularly useful. In the case of grid-connected renewables, the presence of enabling policy conditions such as standardized power purchase contracts is critical for successful market development. Implementation of renewable energy projects continues to be challenging in Africa. Given the market conditions in Africa which is characterized by low private sector involvement, the approaches have involved close collaboration with government Ministries in an effort to mainstream renewables in their programs. Given the weak capacity in the public sector, projects have encountered implementation delays.

4. Renewable Energy- Long-term Technology Cost Reduction (OP 7)

15. In response to council concerns over the slow progress of the Solar thermal projects, the World Bank completed a review of its Solar thermal portfolio which includes four projects in Egypt, Morocco, Mexico and India, with a grant volume of US\$ 194.2 million in total, managed by the World Bank. Each project has encountered significant delays. Apart from an unsuccessful attempt for the Indian project in 2003, no Requests for Proposals have yet been issued from any of the four client countries. The India project has now been dropped from the pipeline.

16. This report determines that solar thermal electricity technology is worthy of continued GEF support. The benefits of a successful industry, particularly for developing countries, are significant. The technology is not new, but stalled in its development path. All required technology elements are essentially already in place. The major outstanding issue is the need for cost reduction, and this study concludes that there is no fundamental reason why the technology could not follow a similar cost reduction curve to wind energy and eventually be cost competitive. However robust, long term support mechanisms will be required.

5. Sustainable Transport (Op 11)

17. There is currently only one project in the portfolio, but this operational program is showing rapid growth as there are several projects being developed in Latin America and Caribbean as well as the East Asia regions of the bank.

C. Carbon Finance Portfolio

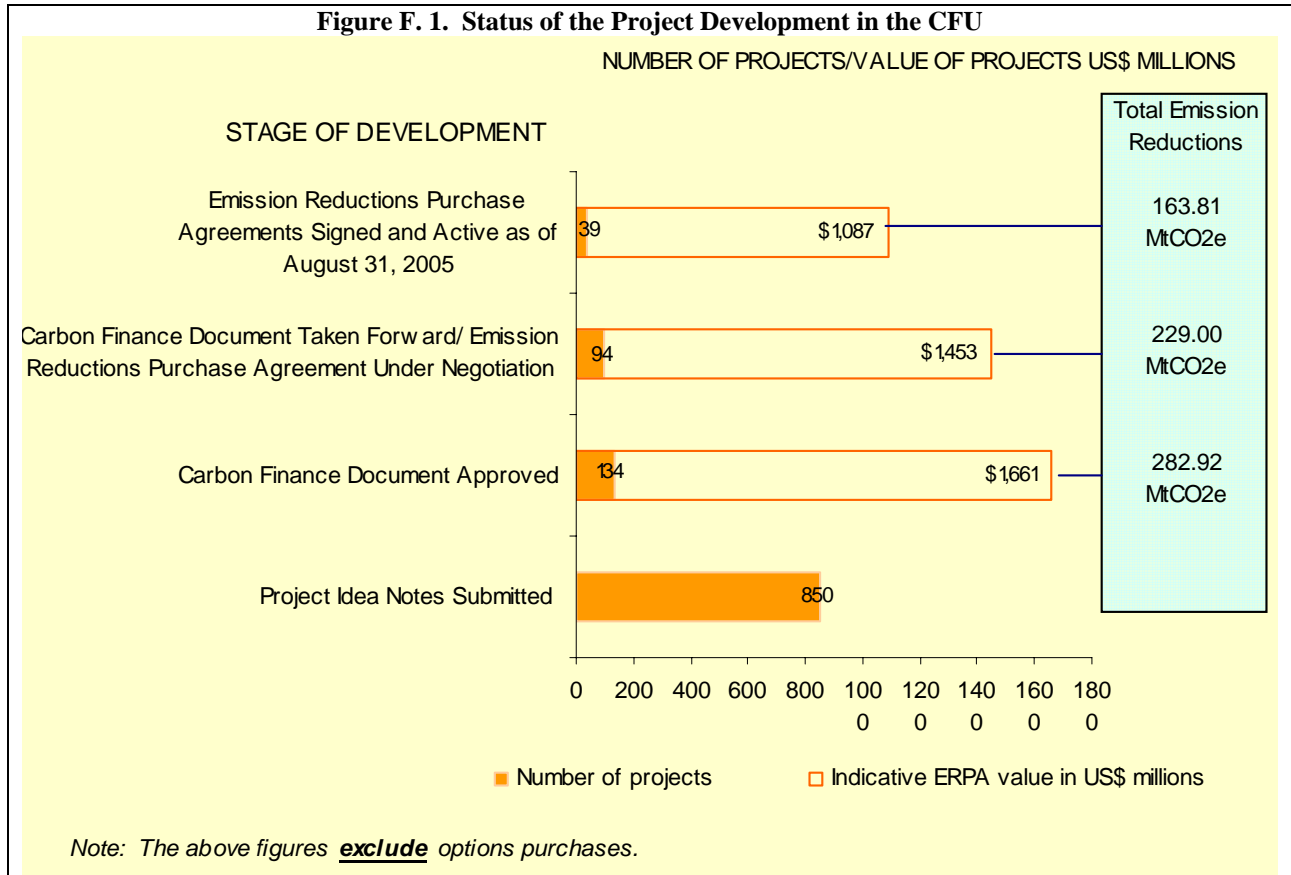
18. The Bank's engagement in carbon finance started with the establishment of the \$180 million Prototype Carbon Fund in 1999. Since then the Bank has also agreed to administer country carbon funds for the Dutch, Italian, Spanish and the Danish Governments (see Table F.3). In addition to the country carbon funds, the Bank established the Community Development Carbon Fund on March 25, 2003 and the BioCarbon Fund on September 11, 2003. The growth of the carbon funds in the last year has been rapid. Bank administered carbon funds grew from \$413.6 million on July 1, 2004 to about \$ 914.7 million on July 1, 2005 (Table F.3). Following the approval of the approach paper for carbon finance (*The Role of the World Bank in Carbon Finance: an Approach for Further Engagement* on December 9, 2005 by the Executive Directors, Bank administered carbon funds are expected to be about \$1,751.1 million by July 1, 2006.

<i>Name of the fund</i>	<i>July 2004 Available Funds</i>	<i>July 2005 Available Funds</i>	<i>July 2006 Expected Available Funds</i>
Prototype Carbon Fund	180.0	180.0	180.0
Netherlands Clean Development Mechanism Facility	171.6	171.6	222.0
Community Development Carbon Fund	39.5	128.6	128.6
Bio Carbon Fund	7.5	53.5	63.5
Italian Carbon Fund	15.0	45.0	100.0
Netherlands European Carbon Facility	NA	40.0	40.0
Spanish Carbon Fund	NA	221.0	286.0
Danish Carbon Fund	NA	75.0	75.0
Proposed Umbrella Carbon Facility ⁷	NA	NA	657.0
Total	413.6	914.7	1752.1

* The totals indicated in the table indicate funds available for emission reduction purchases and all project preparation costs, project monitoring and supervision costs. Administrative costs and fees are included in some of the funds.

⁷ To avoid double counting the Umbrella Carbon Facility shows only external financing, not volume purchased by existing World Bank carbon funds.

19. The Bank has signed emission reductions contracts for over \$ 1 billion as of February 2006 and has built a portfolio of greenhouse gas emission reduction projects offered for carbon financing both by the Bank’s administered funds and by other purchasers. Approximately 850 project proposals have been reviewed by the Carbon Finance Unit to date (Figure F.1). Of these, 134 have proceeded to the Carbon Finance Document (CFD) stage and been approved by the relevant Participant Committees. Of these 134 projects, 94 remain active and have progressed to the Emission Reduction Purchase Agreement (ERPA) negotiation phase. Thirty-nine projects have active signed ERPAs totaling \$1,087 million, of which 10 have been signed to date in FY06 with a total value of \$969.24 million.



20. Technological diversity is a preference of several of the funds of the Carbon Finance Unit and is exhibited below. Waste management and renewable energy each account for 9 percent of the portfolio based on contract value. Energy efficiency projects, including cement and other construction material efficiency improvements, district heating, steel gas recovery and others, represent a further five percent of the portfolio. Forestry projects, mainly through the BioCarbon Fund, account for four percent of the portfolio.

Figure F.2. Technology Distribution Based on Indicative Value of Project Portfolio
(Total \$1453 million)

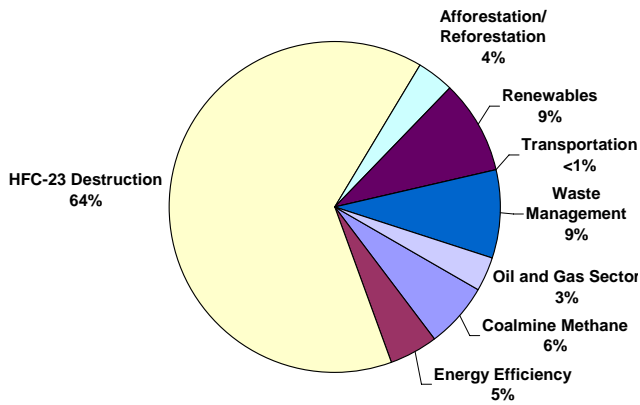
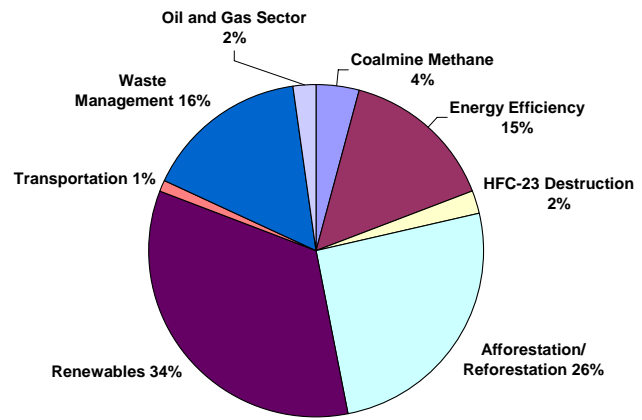


Figure F.3. Technology Distribution Based on Number of Projects in the Portfolio
(Total 94 Projects)



21. Geographic diversity is presented below. The East Asia and Pacific region accounts for 76 percent based on indicative contract value. The Latin America and Caribbean region, while maintaining the lead in number of projects with 33 active CDM projects, accounts for only 8% in terms of portfolio value.

Figure F.4. Regional Distribution Based on Indicative Value of Project Portfolio
(Total 1453 million)

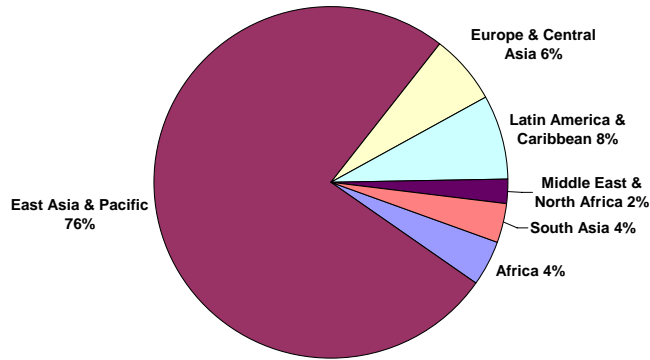
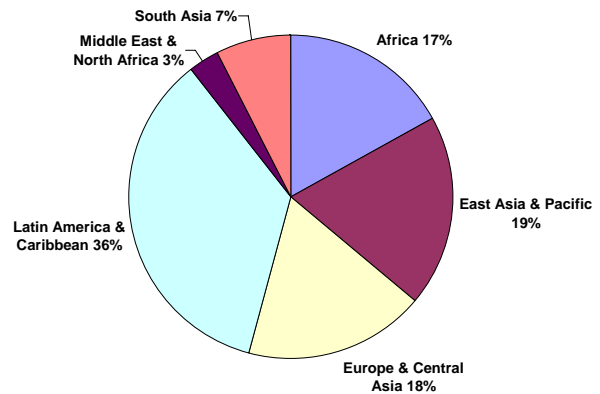


Figure F.5. Regional Distribution Based on Number of Projects in the Portfolio
(Total 94 Projects)



D. Assessment of Vulnerability of World Bank Projects to Climate Change

1. Projects Relevant to Adaptation

22. The World Bank does not have a readily identifiable portfolio of projects for adaptation to climate change. There is a small portfolio amounting to about \$30M of GEF and Trust Fund support for projects specifically focusing on adaptation. However, many Bank projects will prove beneficial to coping with climate variability and climate change even though this is not seen as the primary purpose. An electronic search of project documents on keywords and a

visual check of the document identified such projects for the period FY01 to FY05⁸. The projects were classified into the categories shown in Table F.4.

23. About 2 percent of Bank projects accounting for an average of about \$250M per year mentioned climate risk in their design documents. These projects fall mainly in infrastructure (especially urban flood control) and land management categories.

Table F.4. Distribution of Projects Mentioning Climate Risk at Design Stage

<i>Sector / Theme</i>	<i>Description & Examples</i>	<i>2001-2005 allocations (\$M) (no. of projects)</i>
Land Management		
Land Degradation (prevention and/or rehabilitation)	Include all activities in which a significant goal is the prevention or rehabilitation of degraded lands. These projects will likely also have agricultural, rangelands or forestry components, but include them here if land degradation is the rationale for selecting the main activities, the locations, the communities etc	111.6 (4)
Watershed / catchment management	Include projects that seek to implement integrated management of a range of different ecosystems within a watershed or watersheds. Include projects here if watershed management is the defining focus.	142.9 (5)
Agriculture	Improved agricultural management including institutional reform; risk spreading through insurance; marketing facilities. Do not include projects that are specifically related to irrigation here, but include them instead under Water Management below.	103.0 (2)
Rangelands / grazing lands	E.g. Capacity building for drought management; disease control; capital investments livestock management. Exclude investment in marketing, slaughtering etc.	30.0 (1)
Forestry	Include reforestation & afforestation projects, avoided deforestation, improved forest and logging (extraction) management. Do not include new plantations based on either exotic species or monocultures, unless they can be included under Land Degradation.	-
Protected Areas	Include both the expansion of protected areas as well as better management of existing protected areas.	3.7 (1)
	Land Management TOTAL	391.2 (13)
Water Management		
Large Scale Hydro	<i>Covered in Low Carbon Template</i>	
Water storage, delivery and irrigation projects	Include small scale water storage primarily for irrigation purposes; transport from water storage or supply sites (e.g. ground wells) to farms or households; all aspects of water delivery and distribution within a farm unit. Include management of water demand.	73.6 (2)
Wetland management	Include protection & restoration projects	2.9 (1)
	Water Management TOTAL	76.5 (3)

⁸ These projects were identified from several keyword searches in Imagebank of all Project Appraisal Documents (PADs) for the period 2001-2005. The following keywords were used: "climate change," "climatic," "vulnerability to climate," and "global warming". Additionally, all projects listed under the category "natural disaster management" on the Operations Portal were also included in the list. Projects that addressed non-climate disasters or recovery from one-off climatic events, such as a specific hurricane, were excluded. The PADs were then scanned by electronic searches and by eye for discussions of the impacts of climate variability or change and for support for activities that might be adaptive to climate change. Projects containing components that would facilitate adaptation to climate change were identified, including those that did not specify adaptation to climate change as a specific objective.

<i>Sector / Theme</i>	<i>Description & Examples</i>	<i>2001-2005 allocations \$M (no. of projects)</i>
Climate sensitive Infra-Structure		
Coastal	All forms including urban and non-urban	15.4 (2)
Urban	Include storm & flood planning & management, improved infrastructure (roads & buildings) to reduce damage etc	429.0 (6)
Rural	Focus on climate sensitive activities such as roads and flood management structures	103.8 (3)
	Infrastructure TOTAL	548.2 (11)
Technology		
R & D & forecasting capabilities	E.g. Research or technology transfer for improved crop varieties for salinity, drought etc; irrigation technology; meteorological data collection, institutional reform of meteorological services	112.3 (4)
Capacity Building for Adaptation		
Capacity building for coping with climate variability or change	Projects that may contribute to this but are part of specific sectors described above (e.g. capacity building for drought management) should be included above.	164.1 (8)
	TOTAL	1292 (39)

2. Projects at Risk from Climate Change

24. The above analysis represents only a partial picture of the component of the Bank's portfolio relevant to adaptation to climate change. An equally important group of projects are those subject to climate risk, but which do not mention these risks in their design documents. These were identified by taking a random sample of 50 projects approved by the Board in each of FY03 to FY05 and examining their design documents for climate risk. Projects were assessed into one of four categories of climate sensitivity⁹ and an estimate of the portion of the investment subject to climate risk was made.

⁹ The risk categories were:

- None – E.g. promote telecommunications through financial and institutional support
- Level 1—Includes activities in sectors, location etc known to be climate sensitive (e.g. rural development project focusing mostly on institution building and capacity building)
- Level 2—Includes activities that might be subject to climate risk (e.g. support for coastal management including design of port facilities etc)
- Level 3—Includes activities that are likely to be subject to significant risks from climate change (e.g. support for new irrigation schemes)

Table F.5. Bank Portfolio Subject to Climate Risk

<i>Year</i>	<i>2003</i>	<i>2004</i>	<i>2005</i>	<i>Average per year</i>	<i>Percent of projects</i>
Total projects	400	425	494	440	
Sampled	50	50	50		
Sensitivity Level (>=1)	22	32	28	27.3	55%
>=2	16	25	19	20.0	40%
=3	10	15	12	12.3	25%
Expenditure at risk (\$M) Levels 2 & 3 only	\$ 3,954	\$ 4,601	\$ 7,641	\$ 5,264	
Percentage of annual investment	21%	23%	34%	26%	

25. This analysis (Table F.5) showed that about half (55 percent) of all WB projects over FY03 to FY05 were exposed to some degree of climate risk. Importantly, this exposure is to *climate risk (current and future climates)* and not only a risk from climate change. A quarter of projects were assessed to be exposed to a ‘high’ climate risk where expert advice would suggest that due diligence should include a detailed assessments of the threats from climate change. Only a few of those sampled mentioned climate risk in their project design documents confirming the estimate of 2 percent of projects identified in the previous analysis.

26. The projects that were assessed to involve activities subject to levels 2 & 3 climate risk (40 percent of the sample) represented 33 percent of the Bank’s portfolio and, when corrected for the proportion of the investment in each project that is at risk, accounted to about a quarter of the Bank’s portfolio (26 percent or \$5 billion per year). Similar analyses by the OECD and other IFIs have found 10 percent to 40 percent of portfolios subject to climate risk.

27. In summary, about a quarter of the Bank’s portfolio is subject to a significant degree of risk from current and future climates. Currently only about 2 percent of projects discuss these risks in the project design documents. It is possible that consideration of climate risk is taken up during implementation of the project and appropriate actions taken, however, there is clearly a need to provide stronger incentives and tools for a better due diligence on climate risks in project design.

E. Risk Mitigation

28. As part of the process undertaken in response to the G8 Communiqué, the World Bank Group undertook an inventory to compare the risk adjustment instruments that are available across IBRD/IDA, IFC, and MIGA for addressing technology and climate related risks. The objective of this work was to assess complementarities and redundancies and suggest redesign or additional design features as needed.

29. The assessment concluded that the WBG has a wide range of existing financial products that can be used to facilitate mitigation and adaptation related investments. However, the impact of these products could be increased—potentially substantially—by packaging, integrating, and otherwise deploying them more effectively. An overview of existing WBG financial instruments with their coverage and key features is included in Table F.6.

30. While the range of the identified *existing WBG financial products* is perceived to be responsive to many of the needs associated with low carbon development and adaptation, several challenges will need to be addressed:

31. ***Scaling up.*** The first and most fundamental is an issue of scale; the resources and skill set necessary to do a few infrastructure projects is not the same needed to work on a large scale to support a national program; these would require new financial modalities and substantial additional concessional resources:

32. ***Better integrating existing instruments.*** A key challenge to increasing the impact of WBG financing of climate change measures will be to *work together as a Group* and potentially with other IFIs, utilizing the combined knowledge, diverse product offerings, and resources available. While there are several notable examples of WBG collaboration in the context of infrastructure projects¹⁰, these collaborations have not been systematic and have arisen largely in frontier countries when individual IFC and World Bank staff has proactively sought to leverage different instruments available within the World Bank Group.

33. ***Providing dedicated financing to promote EE technologies and related services.*** Lessons can be drawn from the WBG energy efficiency portfolio, much of it prepared and implemented with GEF support. Existing evaluations of WBG experience on energy financing emphasize the importance of dedicated financing to promote EE technologies and related services.

34. ***A one-stop WBG system for product and expert identification and contact.*** At present there is no single catalog or source of information on the range of WBG financial products, resulting in the need for an ad hoc process of expert identification and contacts. A more formal and thorough screening and analysis process may be useful.

35. In addition, there are several areas where an effort to develop *new financial products* and related support for market development appear justified, including (i) extending the carbon market past 2012 (the end date in the Kyoto Protocol), (ii) insurance and/or guarantee products to address project delivery risks for purchasers of carbon credits; and (iii) weather risk management instruments. Carbon finance in particular could be a highly promising source of revenue for investments in low carbon systems but faces numerous challenges and uncertainties:

- The G+5 countries are likely to be among the most appealing locations for carbon investments due to their larger potential volumes and the confluence with other conditions favorable for investment.
- The market for project-based emission reductions is growing steadily following the coming into force of the Kyoto Protocol and the implementation of the European Emissions Trading System, which has brought about a substantial increase in buyers for emission reductions.

¹⁰ For example, in Ghana IFC financing for power generation was combined with World Bank advice on sector reform coupled with IDA lending for power distribution. In Tajikistan, the Pamir Electricity Concession included IDA financing and technical assistance support, IFC debt and equity financing, and IFC trust funds assistance. In Senegal, the Kounoune IPP supported development of a 67.5 MW power plant supported by a WB partial risk guarantee to provide political risk mitigation and IFC commercial financing.

- The current value of carbon credits, even if available for a decade, does not appear to be sufficient to cover more than very small incremental costs relative to conventional energy projects.
- Under current arrangements buyers assume political and project risks associated with any infrastructure projects, a substantial disincentive. The Kyoto Protocol commitment period also ends in 2012, which brings into question the likely value of emission reductions after that date. The regulatory environment for carbon credits also faces substantial uncertainty under the administration of the CDM Executive Board, a political agency under the auspices of the UN Framework Convention on Climate Change.

Table F.6. World Bank Group Risk Mitigation Instruments

	IFC	MIGA	IBRD/IDA
Products	Foreign Currency and Local currency Loans, Equity and Quasi-Equity, Partial Credit Guarantees, Hedges for clients(interest, rate, currency and commodity swaps)	Non-commercial risk insurance	PRG, PCG, PBG
Loans	Yes	Yes	Yes
Equity (Quasi-Equity)	Yes	Yes	No
Coverage (Risk)	IFC takes full credit risk (commercial and political) on all instruments it provides.	<ul style="list-style-type: none"> • Currency convertibility and transferability • Expropriation • War and Civil Disturbance (incl. terrorism and sabotage) • Breach of Contract 	Government Contractual Obligations <i>including</i> : <ul style="list-style-type: none"> • Currency convertibility and transferability • Expropriation • Political Violence • Breach of Contract • Regulatory • Subsidy payment (e.g. OBA)
Guaranteed percentage	The % of debt guaranteed under IFC's Partial Credit Guarantees is determined on a case by case basis	Debt: up to 95% Equity: up to 90%	Up to 100% of a tranche
Eligibility	Must be a member country	Must be a member country	Must be a member country
Tenors	Market based but IFC's involvement can lengthen tenors	Up to 15 years (20 years in some cases)	Market based
Limits	Based on client's needs	Project: up to \$110mm (net) Country: up to \$420mm (net)	Based on project and country needs
Government Counter Guarantee	No	No	Yes

ANNEX G. CONSULTATIONS WITH PRIVATE SECTOR FINANCIERS, COAL TECHNOLOGY SUPPLIERS, AND THE REINSURANCE INDUSTRY

1. In the immediate post-Gleneagles period the World Bank Group (WBG) engaged in discussions with equipment suppliers, commercial lenders, the re-insurance industry, and entities engaged in commercializing promising technologies for sustainable development. This process formed an integral part of the Bank's work on defining the Investment Framework and proved effective in identifying recommendations and practical opportunities for partnerships with the private sector.

2. The consultations also highlighted industry expectations for substantial coal-driven power sector infrastructure growth over the next two decades and pointed to specific barriers that impede the level of private investments in promoting clean and efficient energy development. Risk, including financial risk, country and political risk, and regulatory risk, emerged as the principal issues for private sector involvement. Discussions further focused on defining opportunities for collaboration with the reinsurance industry on enhancing the capacity of agro-ecosystems and the more climate-vulnerable populations in developing countries to cope with increased climate risk.

A. Financing and Commercialization of Energy-Efficient Technologies

3. Noting the projected demand for investments in energy infrastructure through 2030 (\$17 trillion, two-thirds of which is in the developing countries), industry representatives pointed out that power sector growth will be dominated by coal-fired power plants, with close to 800 new plants projected to enter operation in less than a decade. At present industry sees no incentives to build in scale any but conventional PF/FB plants, which are 20-60 percent less efficient than existing super or ultra-super critical plants. The demand for energy in China and India and the old age of the existing global fleet of coal-fired plants offer an opportunity for accelerated development and investment in high efficiency coal generation, but also pose significant challenges for finance mobilization in the face of an array of regulatory, technical, and financing risks.

4. Clarifying that under existing market conditions clean coal technologies already inside the technological frontier might not be commercially deployed in scale until after the global coal power fleet is largely locked-in for the remainder of the century, the industry stressed the urgent need for greater public sector funding in the OECD for clean coal R&D and commercial scale demonstrations, followed by technology transfers to developing countries. From the industry perspective, the cleaner coal technology burden should not be borne by developing countries, despite an indicated willingness to deploy new technologies when they become economically feasible, since this would further exacerbate investment risks in an already difficult financing environment.

5. Participants also confirmed the dramatic decline in commercial financing of power sector development since 1997, and emphasized that renewed larger scale participation is unlikely due to the insufficient returns on investment under the existing regulatory and market conditions. The same holds true for the substantial local financial resources presently available in some of the Plus 5 countries. The risk-reward ratio for investment in high efficiency clean coal technology is unfavorable as higher capital and operating costs, especially the additional costs and risks of new

technology deployment, are not compensated by any premium for additional environmental benefits, local or global. As a result, as seen in the case of China and India, domestic financing realities drive investment toward lower capital cost, high operating cost plants. Thus, efforts to mitigate risks and increase financial returns on investing in more energy-efficient technologies will be key to improving the investment climate. Innovative financing and risk management instruments are needed to support even already proven energy-efficient technologies inside the technology frontier (e.g. super critical PFC plants).

6. The reinsurance industry confirmed that at present it has sufficient capacity to cover political risk but also highlighted the importance of security for foreign participation in ownership, the ability to repatriate profits, and adequate pricing and creditworthiness of power off-takers, among others, as preconditions for sustained private sector investment. Meeting these preconditions in the electric power sector continues to pose particular challenges and the industry faces declining incentives for extending coverage to that sector. As a consequence, coverage is now being provided only in relatively few countries judged to have good governance and a record of respecting contracts. In this context, industry also emphasized WBG/IFI involvement as an important factor in making the financing of individual projects more attractive.

7. The GEF, carbon finance, and other sources of incremental funding are critical for GHG-reducing programs and projects, and expanding both their availability and effectiveness is essential. Industry representatives emphasized the potential for carbon finance to fill many of the financing gaps in the absence of other markets for the environmental benefits of cleaner coal and other low carbon technologies. As a stream of foreign currency revenues, carbon trade and carbon finance could provide a substantial portion of the incremental cost and incremental risk financing in hard currency to both offset higher capital costs and offer important payment and conversion risk hedge for specific projects. At the same time, industry stressed that the lack of clear signals on the value of carbon assets beyond 2012 presents a serious limiting factor that is already effectively denying large-scale power sector investment access to carbon revenues under the Kyoto compliance market.

8. The lack of a significant pipeline of bankable projects for investing in emerging market power assets surfaced as a major bottleneck for industry engagement even in areas where there is industry willingness for participation. Power system planning tools have not evolved significantly since the 1970s and need to be reviewed in the context of addressing both environmental externalities and the uncertainties stemming from increased fuel price volatility. The WBG and other IFIs have an important role in strengthening national power sector planning as well as in underwriting some of the front-end costs of project preparation in order to reduce upstream barriers to entry in otherwise promising markets.

9. Industry found the range of WBG financial and risk-management products broadly responsive to the project cycle for infrastructure investments, but less well defined and responsive to opportunities for energy efficiency improvements, and even less responsive with respect to adaptation. Discussions confirmed that the complete range of available WBG products is not well known to industry. Risk burdens could be shared more cost effectively if the WBG/IFIs would better integrate their products and offer project-specific menus of products (guarantees, loans, equity, and technical assistance). While stressing the need for the WBG/IFIs to expedite decision-making and streamline documentation, industry representatives also noted that the products already offered by the WBG are attractive and bring value in enabling deals to

happen. In this context, some of the opportunities for the WBG and other public sector financiers to support reducing barriers to lower carbon technology deployment in the developing countries include:

- To assist developing countries in establishing and maintaining clear and comprehensive power sector legislative and regulatory systems to enable private participation.
- To focus on commercializing the technologies that are already proven, but are yet-to-be deployed.
- To mobilize grant or concessional financing to buy-down the higher costs of commercializing new energy technology (for the first 4-5 commercial scale projects).
- To blend finance among IFIs and with export credit agencies to extend loan tenors out to 15 years and beyond, lowering debt service and increasing the financial viability of large clean coal plants;
- To extend carbon finance or domestic environmental payments in support of new high efficiency coal plants and for re-powering of the existing fleet.
- To help client countries develop business plans and financing instruments to lower political risk and the economic and financial cost of outages to levels that make re-powering feasible.
- To consider a “one-stop” approach to the provision of risk mitigation packages and routinely integrates systematic political risk assessment within the upstream financial feasibility assessment.
- To work with client countries to ensure that investment in intellectual property embodied in lower carbon coal plants could be recovered at levels that would motivate ongoing investment in technology development and transfer.
- To consider a public-private partnership for project development, including bundling smaller projects to make them financially attractive.
- To consider possible private sector participation at the earliest stages of project design and financing in order to minimize transaction costs and increase the likelihood of private investment.

B. Risk Mitigation for the Poorest Most Climate-Vulnerable Populations in Developing Countries

10. The consultations offered the WBG an opportunity to share with the Reinsurance Industry its pilot work on using index-based weather insurance¹ as a mechanism for reducing the systemic vulnerability of poor populations caused by weather hazards and to support the larger goals of climate risk management adaptation. However, climate risk coverage needs to move to the national level while complementing micro-level activity in order to justify private industry review, analysis, product development and participation. The industry shared common recognition of the importance of WBG involvement in climate risk insurance. The following facets of the WBG contribution were identified as particularly valuable:

- *Data and knowledge production* resulting in higher reliability of indexes.
- *Knowledge dissemination targeting both private sector and governments*, whereby the WBG can systematically share product development progress and good practices. The Bank is also uniquely placed to promote the development of national enabling regulatory frameworks for the weather-based insurance market and integrated policies on climate resilience.
- *Moral Hazard issues*, where the WBG has an essential role in ensuring that extending climate risk coverage is predicated on firm government commitment to long-term climate risk management in economic development planning.
- *Scaling up climate risk coverage*, with the WBG/IFIs playing an important role in building institutional and data capacity and in the intermediation with government counterparts.
- *Support to the development of market liquidity* through the development of a Global Index Insurance Facility (GIIF) as a signal of the international community's commitment to the climate risk management agenda.

C. Next Steps

10. Recognizing the value of these exchanges, meeting participants underscored the need of an ongoing dialogue with the WBG on barrier removal for investment and technology transfer. Regular meetings were further proposed between the reinsurance industry and the WBG to exchange information about specific financing risks and changing country and global economic circumstances and explore products and partnerships for risk sharing to expand investment in these sectors and activities.

¹ Index-based weather insurance products are contingent claims contracts for which payouts are determined by an objective weather parameter (e.g. rainfall, temperature, soil moisture etc.) that is highly correlated with farm-level yields or revenue outcomes. Reinsurers find index-based instruments innovative and value the fact that they can be independently verifiable and are transparent and stable over time. The World Bank is presently piloting this approach in Ethiopia, Malawi, and Dominica.

ANNEX H. POTENTIAL FLOWS FROM DEVELOPED TO DEVELOPING COUNTRIES BEYOND 2012**A. Methodology**

1. 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.

These four factors are very uncertain.

2. The analysis below is based on a set of assumptions about the objective of the climate policy, about regional baselines and about regional abatement costs. Each set of assumption is then analyzed to examine where the money should be spent between developed and developing countries (hereafter “North” and “South”) to minimize total abatement costs. This forms the basis of the discussion on how these expenditures might be shared between North and South, and what the implied transfers are.

3. **Parameter (i): Objective of climate policy.** The long-term objectives of climate policies are often expressed in terms of maximum atmospheric GHG concentrations¹ not to be exceeded in the very long run. But there are several emissions paths that meet these long-term objectives, with very different implications for the period 2000-2030 (or even, for that matter, for the period 2000-2050). In this note we use the stabilization paths developed by the IPCC Working Group 1 (WG1) for 450 and 550 ppm targets. The WG1-450 path authorizes 170 GtC of emissions between 2000 and 2030, and 272 GtC between 2000 and 2050. The WG1-550 path allows for 193 GtC between 2000 and 2030, and 333 GtC between 2000 and 2050.²

4. **Parameter (ii): Baseline emissions.** The baseline emissions are defined on the basis of the six scenarios developed by the IPCC Special Report on Emissions Scenario. Total cumulative emissions range between 214 and 265 GtC from 2000 to 2030, and between 392 and 574 GtC from 2000 to 2050.³

5. **Parameter (iii): Abatement Costs.** Abatement costs, both between 2008 and 2012 and beyond are very uncertain. Of particular importance to this study is the fact that bottom-up studies (e.g., the World Bank National Strategic Studies) suggest that the gap in abatement costs between North and South might be less important than most top-down models anticipate. This

¹ Or in terms of long-term maximum increase in average annual temperatures.

² We do not attempt to optimize the abatement path to reduce total discounted costs.

³ Nakićenović, N. and R. Swart, 2000: Special Report on Emissions Scenarios. IPCC, Cambridge University Press: Cambridge, calibrated to fit IEA 2000 emissions data. We consider CO₂ emissions only.

analysis uses two sets of regional marginal abatement cost curves. One derived from the MIT EPPA model, and another with higher abatement costs in the South based on bottom-up studies.⁴

6. Abatement costs⁵ are assumed to decrease by 1 percent per annum between 2000 and 2050. However, a detailed technico-economic model would be necessary to correctly project abatement costs beyond 2012. Because of this limitation and other methodological problems associated with compact marginal abatement cost curve functions, the figures presented below should be read as no more than educated guesswork.

B. Total Costs of Abatement Between 2013 and 2050 for 450 or 550 ppm Targets

7. Total discounted costs of following the WG1-450 ppm path from 2000 to 2050 range between \$1.2 and 14.9 trillion USD (1995).⁶ The annualized equivalent is \$ 72 to 775 billion USD per year.

8. Total discounted costs of following the WG1-450 ppm path from 2000 to 2030 are significantly (nearly two-third) lower—\$ 0.6 to 5.7 trillion USD—despite discounting and technological change. The reason is that, in four out of the six SRES scenarios, emissions are projected to grow very rapidly between 2030 and 2050 (they usually peak around 2050).

9. The result above is obviously dependent on the profile of the WG1-450 stabilization path. The ratio between total discounted costs up to 2030 and total discounted costs up to 2050 could be increased by choosing a stabilization profile that requires more abatement in the early years, and comparatively less between 2030 and 2050. But such a path seems politically unrealistic. In fact, the most prominent alternative to WG1-450, the so-called WRE-450 stabilization path,⁷ requires *less* effort in the early years and *more* between 2030 and 2050. **This suggests that 2050 is a more relevant horizon than 2030 for analyzing long-term climate policies.** This also suggests that the tensions over emissions might be maximal between 2030 and 2050—at least under some baseline scenarios—and that some planning ahead is necessary.

10. When shifting to a 550 ppm target, total discounted costs from 2000 to 2050 decrease to \$ 0.2—8.2 trillion USD (1995). The annual equivalent amount is \$ 12—427 billion USD. The low end of this range translates the fact that the lowest emissions baseline (B1) is very close to the WG1-550 ppm stabilization path. For any given baseline scenario, shifting from a 450 to a 550 ppm target reduces total discounted costs by a factor of 2 to 3.

11. Between baseline scenario B1 and baseline scenario A1f, total discounted costs of abatement increases about six-fold in the 450 ppm case. The increase is even higher in the 550

⁴ Ellerman D. and A. Decaux, 1998: *Analysis of Post-Kyoto CO2 Emissions Trading Using Marginal Abatement Curves*, MIT Joint Report on Climate Change 40, Cambridge, USA; and World Bank, 2004: *The CDM in China*, World Bank: Beijing, <http://www.worldbank.org.cn/English/content/295q62710336.shtml>.

⁵ Expressed as functions of the percentage of abatement relative to the baseline.

⁶ A discount rate of 4% is used throughout this analysis.

⁷ Wigley T.M.L., Richels R. and J. Edmonds, 1996: Economic and environmental choices in the stabilization of atmospheric CO2 concentrations, *Nature* **379**, 240-243.

ppm case. Thus, policies that would increase the chance for adopting less carbon intensive development paths could be extremely cost-effective from a climate mitigation point of view.⁸

12. In addition, some of the policies that could arguably help shift the baseline towards a less carbon-intensive path are also desirable for reasons other than climate change, and are already promoted by, for example, the World Bank. Energy sector reforms or trade openness in carbon intensive sectors are obvious examples. Thus, to the extent that the benefits of these policies in terms of baseline emissions are unambiguous, there seems to be a rationale for using carbon finance to fund them. However, this requires a detailed understanding of the synergies and trade-offs between different (non-climate) development policies and emission pathways. To our knowledge, this link has received little attention so far.

C. Optimal Distribution of Abatement Expenditures Between North and South

13. The optimal *distribution* of abatement expenditures between developed and developing countries is remarkably constant in all scenarios.⁹ With the EPPA marginal abatement cost curves, total discounted abatement costs in developing countries between 2000 and 2050 represent between 67 percent and 72 percent of total world discounted costs, regardless of the stabilization objective and of the baseline scenario. Even when assuming higher abatement costs in the South, total discounted costs in the South still represent a clear majority—between 58 percent and 65 percent—of total discounted costs of abatement from 2000 to 2050.

14. In other words, efficiency dictates that half to two-thirds of the World total abatement expenditures from 2000 to 2050 be spent in the developing world. For example, for the WG1-450 ppm stabilization path, an annualized amount of \$ 52 to 501 billion USD (1995) should optimally be invested to finance abatement activities in the South.¹⁰

15. The result above can be explained by the combination of two factors:

- First, abatement costs in the South are expected to be lower than in the North because of, *inter alia*, higher inefficiencies or lower costs of capital and labor. As noted above, experts disagree about the magnitude of this wedge, but not about its existence.
- Secondly, emissions in the South are expected to become higher than emissions in the North by 2025 in all but one of the six scenarios used here. Since most of the abatement occurs beyond 2025, sheer volume tilts the balance of total abatement costs towards the South.

⁸ Such policies exist. Indeed, the drivers of baseline scenarios are in part beyond anyone's control (e.g., amount of fossil-fuel reserves, breakthrough, or not, in clean energy generation), but also, in part, driven by policy decisions (e.g., R&D, transportation and energy policies, environmental policies in that they impact on greenhouse gases emissions, etc.).

⁹ In what follows "North" or "developed countries" refer to the current Annex B of the Kyoto Protocol, that is the U.S., Canada, Western Europe, Eastern Europe including Russia, Japan, Australia and New Zealand. "South" or "developing countries" include all the other countries.

¹⁰ Other considerations not included in the model, such as differentiated returns on R&D expenditures or induced technical change might modify the relative efficiency of abatement spending on the North and in the South. But we can conjecture that, even in such a model, abatement opportunities would—for any given price—remain at least as large in the South as in the North.

16. It is important to note that the two assumptions above are common to all the scenarios on abatement costs and baseline that we are aware of.

D. Potential Flows of Carbon Finance from North and South from 2013 to 2050

17. The fact that most abatement expenditures should be spent in the South says nothing about *who should pay for the abatement costs*. In theory, any burden sharing is possible, from North pays all to South pays all. In practice, however, ability to pay for climate mitigation is likely to remain higher in the North for most of the 2013-2050 period. This suggests that important North-South transfers might occur.

18. To give an example, let us assume here that abatement costs are distributed pro-rata income (proxied here by GDP). Under this burden-sharing principle were adopted, North would have to make some payments to the South because its share in the World GDP is higher than its optimal share of abatement expenditures. More specifically:

- *With a 450 ppm target, annualized North to South payments for carbon from 2013 to 2050 would be between \$ 20 and 130 billion USD (1995). This would still leave, however, between \$ 32 and 370 billion USD (annualized) to be paid by the South.¹¹*
- *With a 550 ppm target, annualized North to South payments for carbon from 2013 to 2050 would be between \$ 3 and 68 billion USD (1995).*

19. Again, total North-South flows generated by carbon finance are higher because of the leverage effect of carbon finance is taken into account. Assuming the same ratio as estimated today (the real figure will depend on the mechanism through which these transfers are implemented), total flows generated by international climate policies might be four times as large as the figures above,

20. As noted above, these figures should not be taken at face value. Yet this numerical exercise yields important messages:

- First, because of the differences in marginal abatement costs, the costs of *not* allocating abatement expenditures optimally between North and South can be very high.¹²
- Second, it suggests that North-South transfers between 2013 and 2050 could increase by one or two orders of magnitude relative to their first commitment period levels. Whether the CDM alone can carry such a massive scaling-up is questionable. In that, there are reasons to believe that project-by-project approaches might not be adapted to this task. **Instruments to support sectoral mitigation programs in developing countries are likely to become necessary.**

¹¹ Taking damages of climate change into account would modify this result. If damages are higher in the South than in the North, then it can be argued that some additional compensation should be paid to the South.

¹² For example, it costs a discounted total of 8 trillion US\$ to the North to reduce its emissions by 60%, or by 150 GtC relative to the baseline in the A1b scenario. This would leave the World's emissions in that scenario at about 400 GtC between 2000 and 2050, far higher than even the 550 ppm objective. By comparison, Table 2 shows that it costs only 6.5 trillion dollars to reach 550 ppm in the A1b scenario (even assuming high abatement costs in the South) if abatement costs are distributed optimally. And Table 1 shows that if abatement costs are not too high in the South, 450 ppm might even be reached with 6.6 trillion dollars. The gains of efficiency are thus very large.

ANNEX I. CLEAN ENERGY FINANCING VEHICLE (CEFV) CONCEPT

1. A progressive move towards cleaner energy would require action on multiple fronts:

- On the supply side, there is a need to ensure that the new capital stock, such as the power generation equipment, is created using the latest low carbon technology, as any capacity especially power generation would have an impact on the carbon emission/ climate change for the asset life of 40-60 years.
- In parallel, there is a need to upgrade inefficient existing facilities such as power plants to their optimal level with consequential reduction in carbon emissions.
- Measures on the supply side would need to complement measures on the demand side; including steps to encourage use of more efficient equipment, preparation and enforcement of standards in urban and transportation sectors to ensure more efficient use of energy.
- Last but not least, in a number of countries, there is a need to ensure that energy is properly priced (to reduce waste and ensure financial viability of the sectors) and sector reform is expedited to make the sector more efficient. This would enable a much greater participation of private capital in managing and financing of the energy sector- generally a resource constrained sector.

2. Under the current energy environment in the developing countries and for a variety of operational reasons, there is very little incentive for the developing countries to invest in new low carbon but more expensive technologies. Similarly, in developing countries which are facing chronic energy shortages and the cost of “unserved energy” is extremely high, there is no incentive to upgrade/ rehabilitate the existing inefficient capacity. The following paragraphs discuss setting up a Clean Energy Financing Vehicle (CEFV) to address these constraints, specially the former. Measures (iii) and (iv) of the clean energy strategy require policy reform and strategic changes in the sector which require long term engagement. It is expected that these would be addressed as part of the ongoing engagement by the Multilateral Development Banks (MDBs), and financing from the CEFV would complement this role. Under the right policy environment, it is expected that the private sector can also play a role in financing the investments for the last two measures.

A. Need for CEFV

3. As mentioned earlier in the paper, it is estimated that about \$40 billion will be required annually for mitigation in the next two decades. The existing multilateral institutions, under their current framework, are unable to provide the scale of resources, or take the risks required for financing significant mitigation measures. There is a large potential for private capital to advance the mitigation agenda by supporting improved end user energy efficiency and use low emission technologies for industries such as manufacturing, transportation, etc. However, the availability of resources for high impact, high cost mitigation in key sectors like power, oil and gas and district heating is limited. Similar financing constraints are also face by the renewable technologies. While investment needs for economically and financially viable projects will be

largely fulfilled by borrowings at commercial rates, loans at commercial terms cannot be used to finance high carbon emission reduction technologies required for some sectors, e.g. power utilities, because there is very limited incentive for the implementing entities to invest more in low emission technologies, and at the same time taking on, potentially high technological risk.

4. The current funding for cleaner technologies through grants and concessional financing is woefully inadequate and can be directed to most of the high impact initiatives. Under the most optimistic scenario for private and commercial financing, there would still be a gap of nearly \$10 to 15 billion per year for high impact, high cost interventions such as supercritical boilers. To bridge this large gap in funding for mitigation in the next two decades, to provide the right incentives to implementing agencies, e.g. power utilities, etc, and deal with the complexity of actual implementation, there is a need to establish a vehicle or financial window with the objective of mitigating climate change through: (i) buying down cost of new technology and infrastructure; (ii) mitigating technology risk; (iii) funding efficiency improvement of existing assets and (iii) strategically advancing research in new clean technologies with the objective of advancing their commercial application.

B. Structure and Role of CEFV

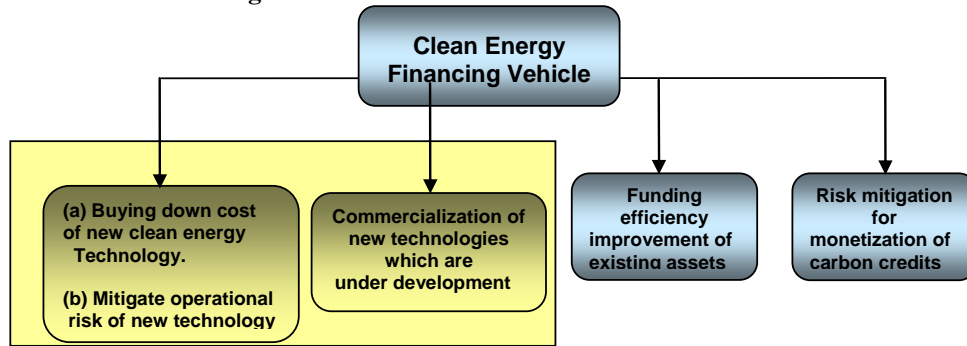
5. A (CEFV) which would provide resources to implement new low carbon technologies and other mitigation measures, and would not be commercially viable without grant or soft financing, would have the following key characteristics: (i) a mandate focused exclusively on climate change with initial focus on high impact, high return investments: e.g. introduction of supercritical boiler technology for coal based power generation; (ii) ability to take on large financial exposures in a few critical sectors in a few countries; (iii) ability to finance investments on soft terms which would provide adequate incentive for the implementing entities in the beneficiary countries to use low carbon technologies and/or undertake other mitigation measures; (iv) no direct recourse to the country governments; (v) ability to directly interact with the implementing entities, where it provides financing; and (vi) ability to finance and support the commercialization of new low carbon technologies, as well set up arrangements to mitigate the risk of new technologies for the implementing entities. The initial focus of CEFV would be in the four or five high impact countries and with the subsequent coverage to other countries.

6. As the CEFV develops, it could potentially consider a greater role in the area of carbon trading, especially regulatory risk mitigation. However, any enlargement of the mandate could potentially dilute its focus on high impact, difficult mitigation investments.

7. There are three broad options for financing support from the CEFV. It could provide grants (with a front end fee to cover its operating costs) to the implementing entities or loans on very soft terms akin to IDA or a mix of both. This financing would be for the marginal cost of mitigation beyond what is being undertaken currently. The latter option, though less attractive for the implementing entities, that would be looking at the additional cost and risk of mitigation, would enable recycling of some resources. Softer IDA type term compared to an outright grant could potentially be an important incentive for governments providing the resources to CEFV specially as the major beneficiaries of CEFV will be the countries creating the largest new capital stock (coal fired generation capacity) i.e. relatively well of G+5 countries. Potentially, an arrangement can also be worked out where the carbon credits generated by technology upgrades

are recycled into the CEFV, thus providing it a useful but relatively limited revenue stream. There, however, needs to be some more assessment to clearly identify the type of financial and risk mitigation support that would be optimal, to entice implementing entities to use low carbon technologies. The Figure I.1 below shows the basic structure and role of the CEFV.

Figure I.1. Basic Structure and Role of CEFVR

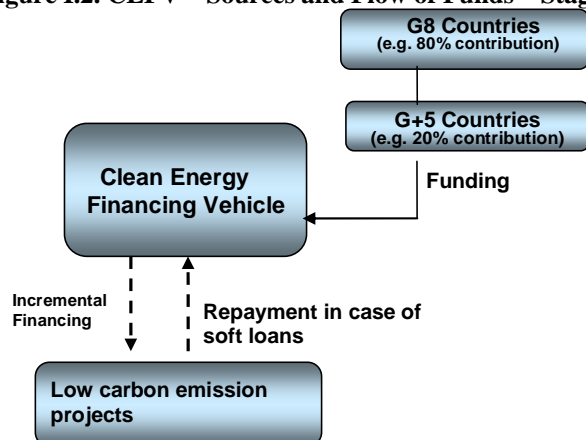


8. In order to buy down the cost of technology, the CEFV would need to identify the projects (see subsequent paragraphs) and establish benchmark costs for various technologies in each of the countries. The mitigation of technology risk would require intermediating arrangements for extended warranties by manufacturers as well as technology transfer to some of the key countries. Commercialization of new technologies would give the CEFV the role of a venture capital fund. Funding of efficiency improvement is an area where the CEFV could create an important role. For example, most of the developing countries have a large number of power plants which operate very inefficiently. Given the huge opportunity cost of limiting electricity generating capacity as a result of major rehabilitation, there is no incentive to improve their efficiency. The CEFV could either directly or through contracts with the private sector create pools of capacity (this would have to be such that it can be removed after a short period—skid mounted or container modules) which could be leased by the utilities for the period when they undertake rehabilitation of their power plants. The paper also discusses the potential of such an activity being handled through an independent entity, if justified.

C. Sources and Flow of Funds—Stage I

9. In any of the above scenarios, the CEFV would need to be funded through donor financing, with most of the funding coming from the G8 countries and potentially some from the G+5 countries (see Figure I.2). While the focus of the CEFV initially would be high impact countries, it is expected to have a mandate for global engagement and other countries could contribute to its capital as well. The need for mitigation, in fact, goes beyond the developing world and an issue worth considering is whether CEFV should play

Figure I.2. CEFV—Sources and Flow of Funds—Stage 1

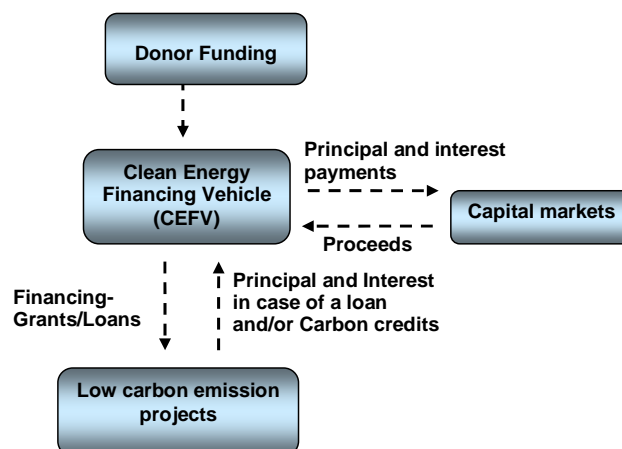


any role in financing mitigation measures in developed countries. This would dramatically increase the financing requirements and make the structure far more complex.

D. Structure and Flow of Funds—Stage II

10. As the CEFV evolves over its first decade of its operations, it could potentially have more flexibility in mobilizing resources, as depicted in Figure I.3. In the case of stable revenue stream and depending upon its capital structure¹, it could potentially raise some financing linked with future repayments from the revenue stream generated by the sale of carbon credits by the project and transferred to CEFV². The latter would require a stable international regulatory framework for carbon trading and an agreement on country specific benchmarks.

Figure I.3. CEFV—Structure and Flow of Funds—Stage II



E. Role of Private Sector

11. As discussed in the first paragraph, the CEFV would complement the resources that would be provided by the private sector, which is expected to focus on financially viable investments in sectors such as manufacturing, energy efficiency improvement and possibly some viable utility operations using proven technologies. Experience over the last fifteen years has shown that private capital is expected to play a limited role (telecommunication being an exception) in utility and infrastructure investments in the developing world where the regulatory environment and financial viability of the implementing entities over the long term is uncertain. There would, however, be a major role for the private sector in the manufacturing and supply of equipment required for high end low carbon technologies, e.g. super critical boilers. Depending on the final structure and terms of financing to the implementing entities, there could be a potential for the CEFV to intermediate private financing, although for the first decade this possibility appears to be remote.

F. Role of MDBs, other IFIs, and the GEF

12. CEFV would effectively complement the multi-faceted role of the MDBs, which would focus on their economy wide mandate and overall development agenda. The ongoing work on improving the operational environment and the sector specific ESW work of the MDB would be an input into CEFV's work. It can also draw upon the massive pool of country knowledge available in these countries. A more aggressive approach to risk mitigation and capital market

¹ If in addition to donor financing it has callable capital some what similar to IBRD—a structure which could be a blend of IDA and IBRD.

² The feasibility study should look at the a possibility of CEFV's ability in the long terms to intermediate private capital although with the scant repayment stream prima facie, it looks very difficult during the first decade of CEFV

development supported by the MDBs would also enable the countries to progressively tap into greater local and offshore liquidity for financially viable operations. In the long run, this would reduce the financing required from CEFV.

G. Operational Framework

13. The CEFV would face two major challenges—financial resources and operational flexibility. A structure similar to the International Development Association could be envisaged with the initial funding / commitments from the G8 and G+5. While, it would be an independent entity, it could be managed by one of the existing multilaterals with the benefit of a quick start up, extensive existing network, as well as, reduced operational costs. The key challenge would be to ensure that it can operate independently to fulfill its limited mandate, and that its operations are not impacted by the operational and policy constraints of existing multilateral institutions—a challenge if the same staff and management are responsible for the operation of the CEFV.

14. To access the resources (e.g. incremental cost of technology upgrade) of CEFV the countries would need to agree on a medium and long term energy strategy including the steps which would be taken to ensure that the country would move towards clean energy supply and more efficient energy use. The project supported by CEFV would be a part of the least cost investment plan³. Governments and implementing entities (e.g. power utilities) would agree to transfer the carbon credits associated with the technology upgrade to CEFV.

H. Next Steps

15. The following steps are envisaged in fleshing out the CEFV concept:

- Validation of base data regarding investment needs with and without carbon constraint - especially for countries with major investment needs.
- Discussions with countries likely to be the major beneficiaries of CEFV regarding feasibility of the financing approach outlined.
- Discussions with manufacturers and Governments' to flesh out core issues such as need, feasibility and mechanisms required in the following three areas:
 - Mitigating operational risks and commercialization of new technologies;
 - Funding needs for efficiency improvement of existing assets; and
 - Need for risk mitigation instruments in the carbon market.
- Identification of potential sources and preliminary modalities of operation.
- Feasibility study.
- Preparation of the implementation plan.

³ The least-cost planning currently undertaken by the countries does not take into account externalities such as benefits of low carbon technologies (e. g., super critical boilers).

ANNEX J. COSTS AND FINANCING OF SHIFTS IN THERMAL POWER GENERATION TECHNOLOGIES

A. Renovation and Modernization (R&M)

1. The renovation and modernization (R&M) investments can be justified on the basis of fuel savings and additional revenues from the sale of power alone. The increase in power revenues from R&M leads to a less than 3 year payback for the investment.
2. Carbon revenues add to the attractiveness of R&M measures. The present value of a 21-year carbon revenue from the renovation and modernization is in the range of 10-25 percent of the R&M investment

B. Super-critical

3. Shift from sub-critical to super-critical can be justified based on fuel saving alone (Table J.1): for an incremental investment cost (based on cost data for the OECD countries) of \$50 to \$250/kWh, the present value of lifetime savings are in the range of \$74-\$255/kWh depending on the efficiency of the sub-critical power plant.
4. For OECD cost of super-critical technology, shift from sub-critical to super-critical cannot be justified purely from carbon finance: present value of carbon finance can contribute between 40 percent to 90 percent of the incremental capital cost.
5. For super-critical technology costs achieved by the Chinese (Table J.2), shifts from sub-critical to super-critical can be justified on the basis of cost savings *and* carbon revenues: for incremental investment cost of the shift in the range of \$33-\$62/kWh, the *annual* saving is in the range of \$22 to \$85/kWh and the annual carbon revenues are in the range of \$11 to \$56/kWh.

C. Ultra-supercritical

6. Shift from sub-critical to ultra-supercritical can be justified on the basis of cost savings for sub-critical power plants (Table J.1) with the shifts being particularly attractive if the overall efficiency of sub-critical power plant is lower than 30 percent.
7. Carbon revenue (present value) can be 24 percent-84 percent of the incremental investment of the shift from sub-critical coal thermal power to Ultra-supercritical coal thermal power generation depending on the price of carbon (range \$8-\$15/tCO₂e) and the efficiency of the sub-critical power plant.
8. If a 60 percent cost reduction is achieved by manufacturing the ultra-supercritical technology (though with performance trade-offs—see Table J.4) in China, shifts from low efficiency sub-critical to ultra-supercritical becomes particularly attractive.

D. Integrated Gasification Combined Cycle (IGCC)

9. OECD manufacturing cost for IGCC (Table J.1 and Table J.2) cannot justify shifts from sub-critical to IGCC based on savings; even with carbon revenues the shift cannot be justified (Table J.1).

10. If investment cost reductions of 60 percent can be achieved, shift from low-efficiency sub-critical to IGCC results in savings which are nearly the same as the incremental investment cost (Table J.3). The shift becomes particularly attractive if carbon finance revenues are included in the assessment. At prices exceeding \$10/tCO_{2e}, the shift can be justified on the basis of carbon finance alone.

11. Costs of carbon capture and storage (CC&S) do not allow IGCC with CC&S to be a viable option for the upper range of the price of carbon (\$15/tCO_{2e}) used in the analysis. The IPCC report⁷⁹ indicates that cost of capture and storage from coal- or gas- fired power plant in the range of \$15 to \$75/tCO₂.

12. Shifts from super-critical technology to IGCC (with or without CC&S) are not justified even with carbon finance.

Box J. 1: Estimate of Benefits from Renovation and Modernization (R&M) of a Coal Fired Power Plant

Existing capacity (MW)	100
Estimated R&M investment (@ \$350/kWh)	35
Increase in capacity	5%
Increase in efficiency	10%
Emission factor before R&M (grams/kWh)	1078
Emission factor after R&M (grams/kWh)	980
Baseline emission factor (grams/kWh)	1000
Increase in capacity factor (absolute increase)	20%
Capacity factor before renovation	65%
Capacity factor after renovation	85%
Generation before renovation (million kWh)	569
Generation after renovation (million kWh)	782
Assumed tariff for power (US\$/kWh)	0.05
Increase in power revenues due to R&M (mill US\$/yr)	10.6
Emission reduction	
Emission reduction not accounting for increase in CF (tCO ₂ /yr)	55,801
Emission reductions from increased generation (tCO _{2e} /yr)	4,249
Total emission reductions (tCO _{2e} /yr)	60,050
Estimated carbon revenues (US\$/year)	1
- assuming a price of \$8/tCO _{2e}	480,398
- assuming a price of \$10/tCO _{2e}	600,498
- assuming a price of \$15/tCO _{2e}	900,747
Present value of the carbon investment (21 year crediting) with the discount rate	10%
- assuming a price of \$8/tCO _{2e}	\$4,154,819
- assuming a price of \$10/tCO _{2e}	\$5,193,524
- assuming a price of \$15/tCO _{2e}	\$7,790,285
Present value of the carbon investment as a proportion of investment	
- assuming a price of \$8/tCO _{2e}	12%
- assuming a price of \$10/tCO _{2e}	15%
- assuming a price of \$15/tCO _{2e}	22%

⁷⁹ Intergovernmental Panel on Climate Change, 2005, Carbon dioxide capture and storage: Summary for Policymakers and Technical Summary, p. 10

Table J.1. Benefits from Technology Shifts (OECD cost data)

		Low efficiency Sub-Critical to super-critical	Higher efficiency Sub-Critical to super-critical	Low efficiency Sub-Critical to Ultra supercritical	Higher efficiency Sub-Critical to Ultra supercritical	Low efficiency Sub-Critical to IGCC	Higher efficiency Sub-Critical to IGCC	Low efficiency Sub-Critical to IGCC+ CC&S	Higher efficiency Sub-Critical to IGCC+ CC&S	Super critical to IGCC	Supercritical to IGCC+ CC&S
Incremental efficiency		10%	2%	12%	4%	16%	8%	8%	0%	6%	-2%
Incremental investment cost	US\$/kWh	250	50	300	100	650	450	1300	1100	400	1050
Fuel cost saving	US\$/kWh	1.01	0.10	1.09	0.18	0.80	-0.11	0.42	(0.49)	(0.21)	(0.59)
Variable operating cost saving	US\$/kWh	-0.60	0	-0.60	0	-1.00	-0.40	-1.0	-0.4	-0.4	-0.4
Incremental fixed operating cost	US\$/kWh-yr	5.00	0.00	5.00	0	15.00	10.00	15.00	10.00	10.00	10.00
Incremental fixed operating cost	US\$/kWh	0.07	0.00	0.07	0.00	0.20	0.13	0.20	0.13	0.13	0.13
Net cost saving	US\$/kWh	0.34	0.10	0.42	0.18	-0.40	-0.64	-0.78	-1.02	-0.74	-1.12
Annual cost saving	\$/kWh	26	8	32	14	-30	-49	-60	-79	-57	-86
Carbon savings	g/kWh	199	45	239	85	290	136	916	762	91	717
Carbon revenues											
at \$8/tCO ₂ e	US\$/kWh	0.16	0.04	0.19	0.07	0.23	0.11	0.73	0.61	0.07	0.57
at \$10/tCO ₂ e	US\$/kWh	0.20	0.05	0.24	0.09	0.29	0.14	0.92	0.76	0.09	0.72
at \$15/tCO ₂ e	US\$/kWh	0.30	0.07	0.36	0.13	0.44	0.20	1.37	1.14	0.14	1.07
Annual carbon revenues											
at \$8/tCO ₂ e	US\$/kWh	12	3	14	5	18	8	56	47	6	44
at \$10/tCO ₂ e	US\$/kWh	15	3	18	6	22	10	70	59	7	55
at \$15/tCO ₂ e	US\$/kWh	23	5	27	10	33	16	106	88	10	83
Total annual savings and carbon revenues											
at \$8/tCO ₂ e	US\$/kWh	39	10	47	19	-13	-41	-4	-32	-51	-42
at \$10/tCO ₂ e	US\$/kWh	42	11	50	20	-8	-39	11	-20	-50	-31
at \$15/tCO ₂ e	US\$/kWh	49	13	59	23	3	-34	46	9	-46	-4
Present value of the savings & carbon revenue	10%	Discount rate									
Savings	\$/kWh	\$255	\$74	\$309	\$131	(\$286)	(\$464)	(\$564)	(\$742)	(\$537)	(\$814)
Carbon revenues											
at \$8/tCO ₂ e	\$/kWh	\$106	\$24	\$125	\$45	\$154	\$72	\$487	\$405	\$48	\$387
at \$10/tCO ₂ e	\$/kWh	\$132	\$30	\$156	\$156	\$193	\$90	\$609	\$507	\$61	\$483
at \$15/tCO ₂ e	\$/kWh	\$198	\$45	\$235	\$84	\$289	\$136	\$913	\$760	\$91	\$725
Carbon revenues (present value) as a proportion of incremental investment											
at \$8/tCO ₂ e		42%	48%	42%	45%	24%	16%	37%	37%	12%	37%
at \$10/tCO ₂ e		53%	60%	52%	56%	30%	20%	47%	46%	15%	46%
at \$15/tCO ₂ e		79%	90%	78%	84%	45%	30%	70%	69%	23%	69%

Table J.2. Technology Assumptions (OECD cost and performance data)

Plant Characteristics		Sub-Critical Coal Plant (low efficiency)	Sub-Critical Coal Plant (higher efficiency)	Supercritical Coal Plant	Ultra-supercritical Coal Plant	IGCC	IGCC + CC&S
Capacity (net)	MW	200	500	500	500	600	600
Efficiency (LHV, net)	%	30%	38%	40%	42%	46%	38%
Unit Investment Cost (in Year 0)	US\$/kWh	800	1000	1050	1100	1450	2100
Fuel Cost	USc/kWh	2.80	1.89	1.79	1.71	2.00	2.38
Variable Operating Cost	USc/kWh	0	0.6	0.6	0.6	1.0	1.0
Fixed Operating Cost	US\$/kWh-yr	15.00	20	20.00	20	30	30
Planned Maintenance	hrs/year	720	720	720	720	720	720
Forced Outages	hrs/year	349	360	360	480	349	349
Capacity factor		0.88	0.88	0.88	0.86	0.88	0.88
Economic Life	Years	35	35	35	35	30	30
CO ₂ Releases	g/kWh	1,050	896	851	811	760	134

Table J.3. Benefits from Technology Shifts (China cost and performance data)

		Low efficiency Sub-Critical to super-critical	Higher efficiency Sub-Critical to super-critical	Low efficiency Sub-Critical to Ultra supercritical	Higher efficiency Sub-Critical to Ultra supercritical	Low efficiency Sub-Critical to IGCC	Higher efficiency Sub-Critical to IGCC	Low efficiency Sub-Critical to IGCC+ CC&S	Higher efficiency Sub-Critical to IGCC+ CC&S	Super critical to IGCC	Super critical to IGCC+ CC&S
Incremental efficiency		11%	6%	17%	12%	21%	16%	13%	8%	10%	2%
Incremental investment cost	US\$/kWh	62	33	164	135	374	345	1024	995	312	962
Fuel cost saving	US\$/kWh	1.13	0.31	1.47	0.64	1.62	0.80	1.24	0.42	0.49	0.11
Variable operating cost saving	US\$/kWh	0.00	0	-0.60	-0.6	-1.00	-1.00	-1.0	-1.0	-1.0	-1.0
Incremental fixed operating cost	US\$/kWh-yr	1.86	1.75	5.11	5	15.11	15.00	15.11	15.00	13.25	13.25
Incremental fixed operating cost	US\$/kWh	0.02	0.02	0.07	0.07	0.20	0.20	0.20	0.20	0.17	0.17
Net cost saving	US\$/kWh	1.11	0.29	0.80	-0.02	0.43	-0.40	0.04	-0.78	-0.68	-1.07
Annual cost saving	\$/kWh	85	22	60	-2	33	-30	3	-60	-52	-82
Carbon savings	g/kWh	489	177	551	239	602	290	1,228	916	113	739
Carbon revenues											
at \$8/tCO ₂ e	US\$/kWh	0.39	0.14	0.44	0.19	0.48	0.23	0.98	0.73	0.09	0.59
at \$10/tCO ₂ e	US\$/kWh	0.49	0.18	0.55	0.24	0.60	0.29	1.23	0.92	0.11	0.74
at \$15/tCO ₂ e	US\$/kWh	0.73	0.27	0.83	0.36	0.90	0.44	1.84	1.37	0.17	1.11
Annual carbon revenues											
at \$8/tCO ₂ e	US\$/kWh	30	11	33	14	37	18	76	56	7	45
at \$10/tCO ₂ e	US\$/kWh	38	14	42	18	46	22	94	70	9	57
at \$15/tCO ₂ e	US\$/kWh	56	20	63	27	69	33	142	106	13	85
Total annual savings and carbon revenues											
at \$8/tCO ₂ e	US\$/kWh	115	33	94	13	70	-13	79	-4	-46	-36
at \$10/tCO ₂ e	US\$/kWh	123	36	102	16	79	-8	98	11	-44	-25
at \$15/tCO ₂ e	US\$/kWh	142	43	123	25	102	3	145	46	-39	3
Present value of the savings and carbon revenue	10%										
Savings	\$/kWh	\$822	\$213	\$582	(\$16)	\$309	(\$286)	\$31	(\$564)	(\$495)	(\$772)
Carbon revenues											
at \$8/tCO ₂ e	\$/kWh	\$260	\$94	\$288	\$125	\$320	\$154	\$653	\$487	\$60	\$399
at \$10/tCO ₂ e	\$/kWh	\$325	\$118	\$361	\$156	\$401	\$193	\$817	\$609	\$75	\$498
at \$15/tCO ₂ e	\$/kWh	\$488	\$176	\$541	\$235	\$601	\$289	\$1,225	\$913	\$113	\$747
Carbon revenues (present value) as a proportion of incremental investment											
at \$8/tCO ₂ e		420%	283%	176%	93%	86%	45%	64%	49%	19%	41%
at \$10/tCO ₂ e		525%	354%	220%	115%	107%	56%	80%	61%	24%	52%
at \$15/tCO ₂ e		787%	532%	330%	174%	161%	84%	120%	92%	36%	78%

Table J.4. Assumptions on China cost and Performance Data

Plant Characteristics		Sub-Critical Coal Plant (low efficiency)	Sub-Critical Coal Plant (higher efficiency)	Supercritical Coal Plant	Ultra-supercritical Coal Plant	IGCC	IGCC + CC&S
Capacity (net)	MW	50	100	600	500	600	600
Efficiency (LHV, net)	%	25%	30%	36%	42%	46%	38%
Unit Investment Cost (in Year 0)	US\$/kWh	496	525	558	660	870	1520
Fuel Cost	USc/kWh	3.62	2.80	2.49	2.16	2.00	2.38
Variable Operating Cost	USc/kWh	0	0	0	0.6	1.0	1.0
Fixed Operating Cost	US\$/kWh-yr	14.89	15	16.75	20	30	30
Planned Maintenance	hrs/year	720	720	720	720	720	720
Forced Outages	hrs/year	349	349	349	480	349	349
Capacity Factor		0.88	0.88	0.88	0.86	0.88	0.88
Economic Life	Years	35	35	35	35	30	30
CO ₂ Releases	g/kWh	1,362	1,050	873	811	760	134

ANNEX K. THE COSTS OF IMPACTS OF CLIMATE CHANGE AND ADAPTATION

1. The costs of combating climate change can be divided into three components:
 - Costs of mitigation actions
 - Incremental costs of impacts due to climate change
 - Costs of adaptive actions carried out to reduce the impact of climate change
2. These costs interact in that mitigation can reduce the extent of the hazards related to climate change and adaptation can reduce the cost of the impacts that result from any residual climate change hazards. The costs of adaptation can be reduced by simply not attempting to adapt to climate change, but this would lead to high impact costs. Mitigation costs could be reduced but this leads to higher impact and/or adaptation costs. The interlinkages are further confounded because most countries are not fully adapted to current climates and this inflates the estimation of the costs of impacts and the costs of adaptation. Finally, many of the costs are not readily monetized.
3. There have been many attempts to estimate the costs of impacts due to climate change but with widely differing methods, different levels of inclusion (i.e. the impacts and regions analyzed) and assumptions about the rate of climate change and time preferences. Results are expressed as the impact of a particular change in degrees C in monetary terms, as a percent of the GDP, or as the marginal damage costs of a ton of CO₂e. The most common conclusion is that, with adaptation, many developed countries will benefit by 1°C temperature change while developing countries will be marginally disadvantaged. For 2° to 3°C, the impact on developing countries increases rapidly, with estimates often up to 5—10 percent reduction in GDP or much lower. Tol (2005) has analyzed 103 such estimates from 28 separate studies. He concluded that it is unlikely that the marginal cost of greenhouse gas emissions exceeds \$50 per ton of carbon. However, the data is very variable with estimates ranging from marginal costs of over \$1000 per ton carbon to small benefits. The IPCC 2001 estimated this marginal cost to be between \$5 and \$125 per ton of carbon.
4. In another study, the cost of a 1°C rise with adaptation and benefits from economic growth was estimated (Tol 2005). The net effect globally was positive (net \$450B per year) mainly through improved agriculture, reduced energy costs and reduced mortality in cooler OECD countries and the FSU. However, for developing countries the effect was less positive or negative even at this small temperature rise (South & East Asia \$14B/y in costs and Africa \$17B/y representing about 1 percent and 3 percent of GDP respectively; China had benefits of about a 0.5 percent increase in GDP). These results are very sensitive to such assumptions as the value of life and gave much more negative results for developing countries under some assumptions.
5. The above estimates are for the costs of the impacts of climate change and the methods make widely differing assumptions about the amount of adaptation that will take place. There are a series of studies of the costs of adaptation in a particular region or to a particular sector. The sector that is most amenable to analysis is the cost of coastal protection against sea level rise, but the estimates vary widely due to different methods, inclusions in the cost, discounting and assumptions about the rate of change; for example in adapting to sea level rise in the USA estimates vary from \$20B to \$500B through to 2100 for a 0.5 m rise, and globally they vary from c. 5.6 percent of global income or \$1 trillion USD (1990) for a 1 m sea level rise over this century to \$4B to \$5B

per year in adaptation and losses, with 75 percent of this in developing countries. There is no coherent set of information for the costs of adaptation to climate impacts as a whole.

6. A ‘ball-park’ estimates of the costs of additional impacts and adaptation can be made as follows. Several studies have suggested that the costs of impacts of climate change without adaptation could amount to several percent of GDP to tens of percent annually in exposed developing countries. Taking 0.5 percent of developing country GDP as modest estimate of the identified additional costs of impacts of a 2 or 3°C temperature increase, this would amount to some \$40B per year but it could range from only a few billion to up to \$100B. This must be regarded as an order-of-magnitude estimate only. There will always be a difference in opinion as to what constitutes additional costs due to climate change, and what would have been the costs that would have occurred in the normal development process including adapting to climate variability. Moreover, these costs would not be fully realized for several decades.

7. An approach to estimating adaptation costs is set out below. It examines the core flows of development finance, makes an estimate of the proportion of the investment that is sensitive to climate risk and an estimate of the additional cost to reduce that risk to account for climate change. ODA and concessional finance is estimated as having the most climate sensitive component, with relatively less in FDI and GDI as the financing shifts from higher risk development spending in poverty reduction to commercial investment. The 10 to 20 percent ‘estimated cost of adaptation’ is purely an estimate. In most activities only certain components will need to be modified, often with relatively low costs and sometimes no additional cost. In other cases, new activities may have to be added (e.g. new irrigation, physical protection for roads as risk of extreme events increases). They are likely to be the starting point in negotiations about the obligations of developed countries to compensate developing countries for the costs of climate change. In discussions of the new adaptation funds to be administered by GEF, 20 percent is suggested as the minimum contribution for even the largest projects.

8. The results are obviously very rough estimates but may at least provide a ‘ball-park’ figure for the increased costs of achieving climate resilient development due to climate change. Note that this estimate does not specifically include additional investment that might be needed to reduce the exposure to current climate risks.

Table K.1. Preliminary Estimate of the Costs of Additional Impacts of Climate Change and Adaptation.

<i>Item</i>	<i>Amount per year</i>	<i>Estimated portion climate sensitive</i>	<i>Estimated costs of adaptation</i>	<i>Total per year [USD 2000]</i>
ODA & Concessional Finance	\$100B	40% ¹	10 to 20%	\$4B to \$8B
FDI	\$160B	10%	10 to 20%	\$2B to \$3B
Gross Domestic Investment	\$1500B	2 to 10%	10 to 20%	\$3B to \$30B
Total International finance				\$6B to \$11B
Total adaptation finance				\$9B to \$41B
Costs of additional impacts				\$40B
				(\$10B to \$100B)

Source: World Bank and OECD.

¹ Based on analyses of portfolios by the World Bank and OECD.

ANNEX L. OUTREACH AND COMMUNICATIONS

The Outreach Program will over the next two years:

- Act as an honest broker, facilitating dialogue and broader engagement on the technical and knowledge dimensions, and building confidence among key stakeholders, complementing what the UNFCCC does at the intergovernmental level;
- Emphasize the potential of R&D, technology development, and innovative financial vehicles that will benefit developing countries;
- Focus on the long term, but showcasing wins in the short term on the energy agenda, reducing greenhouse gas emissions and adapting to climate variability and change; and
- Promote creative, innovative market-oriented solutions that benefit developing countries and the global community.

Focus and approach

- The outreach program will make use of existing multi-stakeholder platforms and partnerships, and will engage a variety of constituencies, including the business community, civil society, legislators, opinion leaders, media, and the scientific community.
- The focus will be on a positive agenda based on actual and potential technological *solutions*.
- The program will introduce tracking poll data (benchmark over time on attitudes, activities, and trends of *solution-providers*).
- It will also showcase examples (large and small) of climate trends having human impacts and/or market consequences. Contrasting “old images” (smoke stacks and melting icebergs) against “new images” (farmers introducing climate resistant varieties, builders changing design in flood plains, etc).

Tools

- World Bank Group multimedia resources, products, and services;
- GlobeScan tracking poll on attitudes and behaviors of *decision-making solution providers* (5,000) around the world. Results will be provided twice a year; and
- Multi-Stakeholder Dialogue Series (legislators, business community, civil society, public opinion leaders) organized by *GLOBE* and *COM+*: *Alliance of communicators for sustainable development* (www.complusalliance.org) during the time period 2006-2008, shadowing the G-8 process.

Some key actions in the short term (2006)

- *Media launch* of the IF paper during Spring Meetings;
- *Multi-Stakeholder Seminar* (private sector, civil society, other IFIs, and Bank) during Spring Meetings;
- *Messages* from the IF disseminated during the 14th Session of the UN Commission for Sustainable Development (CSD), which is focused on clean energy and development, including an outreach event for governments and other stakeholders participating in the CSD;
- *Meeting* of the working group of Market Mechanisms of the GLOBE/COM+ Dialogue during the Carbon Expo, Cologne, on May 10, 2006;
- *Multi-stakeholder Globe/COM+ Climate Change Dialogue* in St. Petersburg, prior to the G-8 Summit;
- *NHK* (Japanese Public TV) film production on Climate Change Scenarios, and *BBC* production of a documentary on the energy agenda for development;
- *Stories from the field* – A series of forward looking examples of application of innovative mechanisms to increase energy access in developing countries on a sustainable and climate friendly way and on climate resilient approaches to adapt to climate variability and change;
- *Communications support* to the ongoing country-dialogue;
- *Multi-stakeholder side event* during Annual Meetings in Singapore; and
- Regular and continuous internal communication for Bank Group staff (“Today” articles, discussion forum, debate/discussion sessions, etc.).