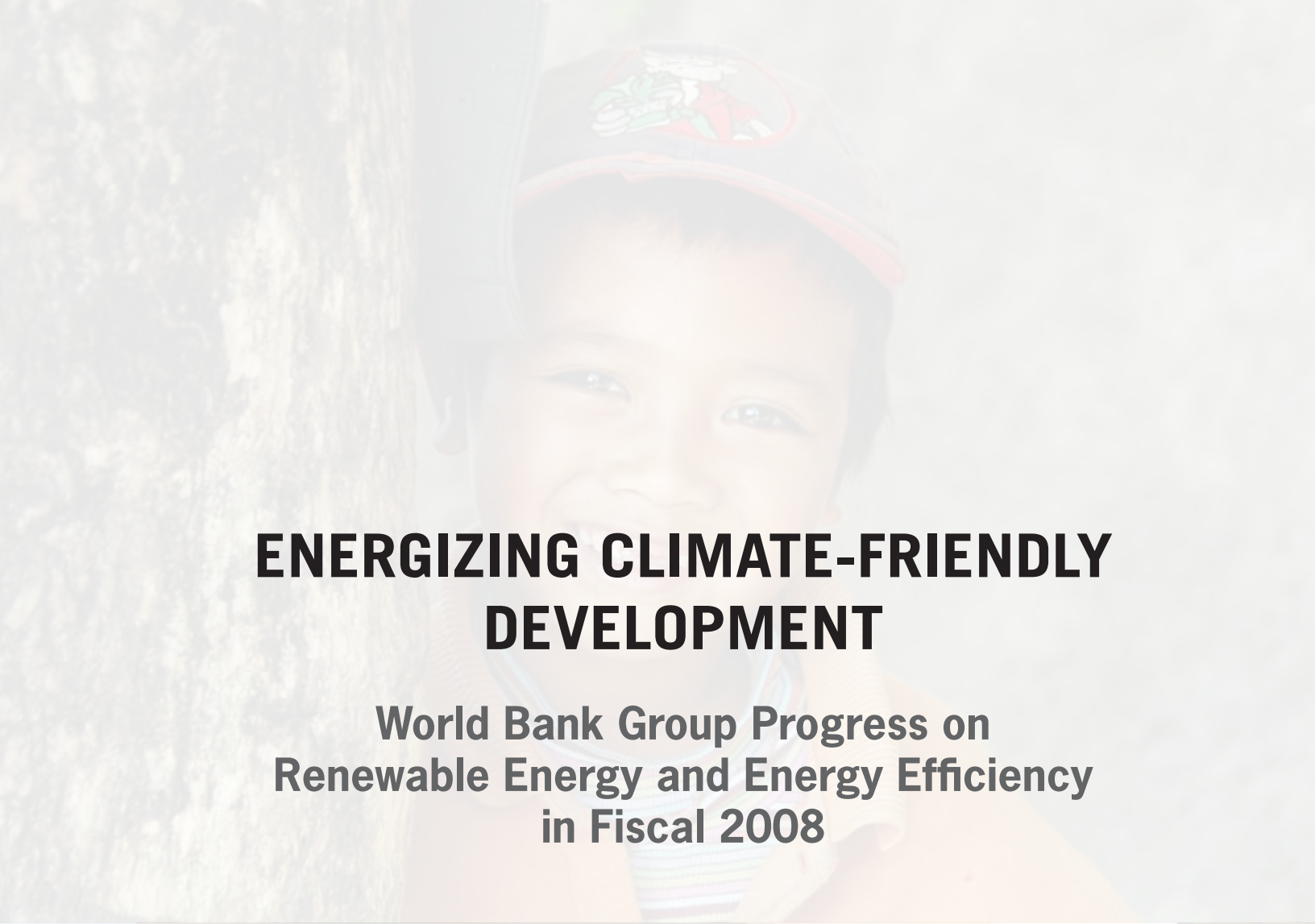
ENERGIZING CLIMATE-FRIENDLY DEVELOPMENT:

World Bank Group Progress on Renewable Energy and Energy Efficiency in Fiscal 2008

THE WORLD BANK

IFC International Finance Corporation World Bank Group

M.I.G.A. Multilateral Investment Guarantee Agency



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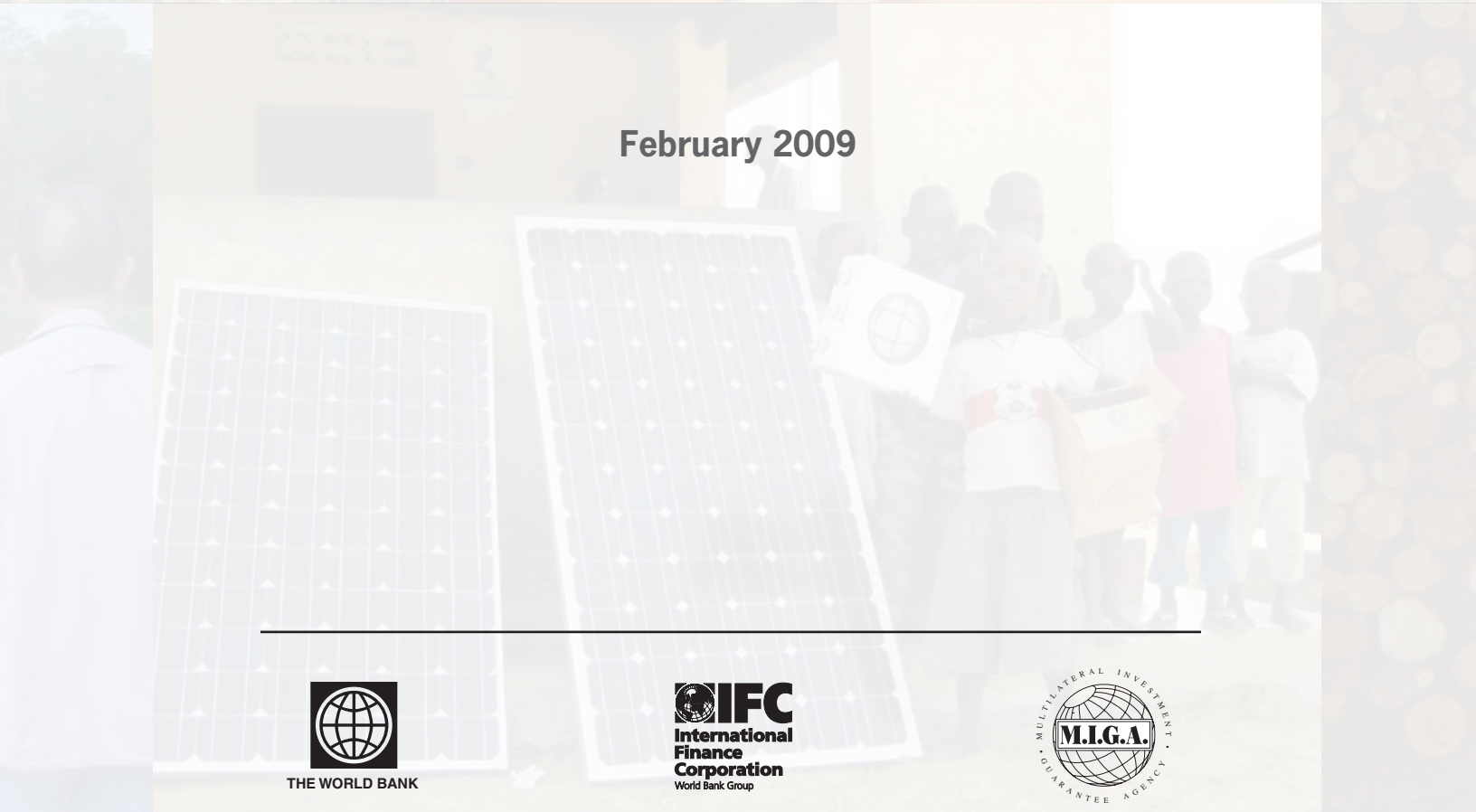
February 2009



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MULTILATERAL INVESTMENT GUARANTEE AGENCY M.I.G.A.

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Acronyms and Abbreviations

AAA	Analytical and advisory activity
AFR	Africa Region
ASTAE	Asia Sustainable and Alternative Energy Program
BEEF	Bulgaria Energy Efficiency Fund
BISCO	Baotou Iron and Steel Company
CDM	Clean Development Mechanism
CFL	Compact fluorescent lamp
CFU	Carbon Finance Unit
CG	Competitive Grant
CPF	Carbon Partnership Facility
CSP	Concentrating Solar Power
DCCSF	Development and Climate Change: A Strategic Framework for the World Bank Group
DG	Distributed Generation
DSM	Demand-side management
EAP	East Asia and Pacific Region
ECA	Europe and Central Asia Region
EDTIP	Electricity Distribution and Transmission Improvement Project (Pakistan)
EE	Energy efficiency
EFCC	Externally Fired Combined Cycle
ESCO	Energy service company
ESMAP	Energy Sector Management Assistance Program
FCFI	Fuel Cell Financing Initiative
FINESSE	Financing Energy Services for Small-Scale Energy Users Project
FY	Fiscal Year—July 1 to June 30
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse gas
IBRD	International Bank for Reconstruction and Development
IDA	International Development Agency
IEA	International Energy Agency
IFC	International Finance Corporation
IGCC	Integrated Gasification Combined Cycle
IPCC	Intergovernmental Panel on Climate Change
LCR	Latin America and Caribbean Region
LED	Light-emitting diode
LPG	Liquefied petroleum gas
M&E	Monitoring and evaluation
MIGA	Multilateral Investment Guarantee Agency
MNA	Middle East and North Africa Region
NEA	Nepal Electricity Authority
NGO	Nongovernmental organization
O&M	Operations and maintenance
OECD	Organization for Economic Co-operation and Development
PEM	Proton Exchange Membrane
PPP	Public-private partnership
PROGEDE	Sustainable and Participatory Energy Management Project (Senegal) Project
PV	Photovoltaic(s)
QR	Quick response
RD&D	Research, development, and deployment
RE	Renewable energy

REDP	Renewable Energy Development Project (China)
RERED	Rural Electrification and Renewable Energy Development Project
RSEEP	Russia Sustainable Energy Efficiency Program
SAR	South Asia Region
SDN	Sustainable Development Network
SIAP	Sustainable Infrastructure Action Plan
SIDA	Swedish International Development Agency
TF	Trust Fund
UNFCCC	U.N. Framework Convention on Climate Change
VBNRM	Village-Based Natural Resource Management
WASP	Wien Automatic System Planning Package
WBG	World Bank Group

Units of Measure

kW	Kilowatt
kWh	Kilowatt-hour
MW	Megawatt
Mtce	Million tons of coal equivalent

Foreword

Renewable energy and energy efficiency offer vital solutions in the face of global climate change and pressing energy needs for development. Climate changes and energy price shocks can wreak havoc on the lives of the poorest in developing countries, strike at the foundations of energy security and economic growth, and put years of hard-earned development at risk. The World Bank Group (WBG) addresses these various challenges by putting renewable energy and energy efficiency at the heart of its energy agenda.

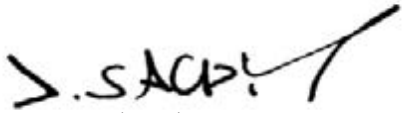
Since 1990, we have committed more than US$14 billion to renewable energy and energy efficiency, adding US$6.3 billion in the last four years to meet the increasing demand for these clean energy options. Millions across the world have gained a better quality of life through the WBG's support of solar, wind, hydro, geothermal, biomass, and biogas energy, as well through greater efficiency in energy use. The number of beneficiaries who have made the switch from traditional forms of energy to renewable and efficient energy options through our projects continues to grow, which provides a strong indication of our progress.

Going forward and building on the success of our projects, we will continue to leverage our technical expertise, policy advice, and financing resources to foster transformative change in the use of renewable energy and energy efficiency by our partner countries.

This annual report is the fourth in the series since the promise we made at the Bonn International Renewable Energies Conference in June 2004, to increase renewable energy and energy efficiency lending 20 percent per year, and to report on the progress toward that goal. The report highlights our achievements in fiscal 2008 and demonstrates how we are meeting our pledge to improve the lives of those who are most vulnerable and the least able to cope with climate change and energy price shocks.

We would like to thank our partner countries, our development partners, and the WBG staff for their valuable contribution, hard work, and dedication toward expanding the use of renewable energy and energy efficiency.

Greg Radford, Director
Environment and Social Development
International Finance Corporation
The World Bank



Jamal Saghir, Director
Energy, Transport and Water Department
Chair, Energy and Mining Sector Board

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Please address questions or comments to Alan Miller (*amiller2@ifc.org*) or Anil Cabraal (*acabraal@worldbank.org*).

Executive Summary

Meeting the energy needs for development and addressing climate change are two of today's defining global issues. In addressing both, renewable energy (RE) and energy efficiency (EE) offer tangible solutions for reducing greenhouse gas (GHG) emissions and concomitantly providing energy needed to usher billions of people onto the path of economic development and towards a better life.

In developing countries, the progress of large populations is held up because of a lack of access to the energy required for long-term economic and social development. This past year has seen dramatic volatility in oil prices. Volatile energy prices are impacting energy security, balance of payments, inflation, and economic growth.

Because of their potential to provide energy that is low-carbon, clean, safe, reliable, and close to consumers, renewable energy and energy efficiency technologies play an important role in addressing these challenges.

In fact, volatile fossil fuel prices and energy security concerns have increased their attractiveness in a large number of diverse applications. Energy efficiency measures, for example, through energy-efficient lighting, are a highly effective tool not only in reducing energy costs, but also in quickly reducing peak loads and therefore power generation requirements to address the acute power crises many developing countries are currently experiencing. Renewable energy technologies are least-cost energy alternatives in many rural, sparsely populated areas where grid electricity connections remain elusive and the economics of diesel generators—the most widespread distributed electricity technology—are affected by high fuel costs. As a result, demand for such solutions has grown significantly in client countries in recent years.

> *Climate change policies cannot be the frosting on the cake of development; they must be baked into the recipe of growth and social development. The World Bank has already been building on synergies between climate action and development—working on energy security and efficiency, encouraging renewable energy, protecting urban air quality, helping with the management of arid lands, and assisting with adaptation of agriculture.*
>
> —Robert B. Zoellick, President
> World Bank Group
> Opening Plenary Session Statement to
> the 13th Conference of the Parties to the
> UNFCCC
> Bali, Indonesia
> December 12, 2007

In response, the World Bank Group (WBG)—comprising the World Bank, International Finance Corporation (IFC), and Multilateral Investment Guarantee Agency (MIGA), as well as co-financing from the Global Environment Facility (GEF) and Carbon Finance—has in recent years considerably increased its investment and advisory services to help its partner countries exploit renewable energy and energy efficiency opportunities.

This report summarizes the progress that has been made in renewable energy and energy efficiency projects at the WBG during fiscal 2008 (July 2007–June 2008), and presents case studies and analyses from several noteworthy projects.

Table 1: WBG Commitments for Renewable Energy and Energy Efficiency in Fiscal 2008

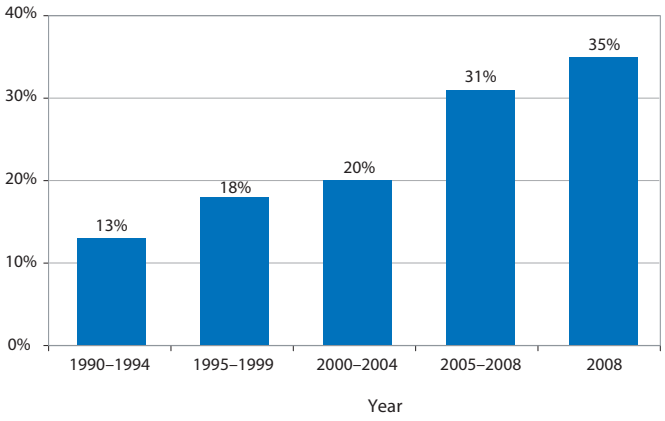
	Commitments in fiscal 2008 (millions of US$)			
Source of funds	*New RE*	*Hydro > 10 MW*	*EE*	*Total*
World Bank	272	625	719	1,616
IBRD/IDA	117	601	624	1,343
GEF	90	—	55	145
Carbon Finance	65	24	40	128
IFC	115	361	473	949
Own Funds	72	361	473	906
Carbon Finance	39	—	—	39
GEF	4	—	—	4
MIGA	88	21	—	110
Total	476	1,007	1,192	2,675

Note: Some columns may not add up exactly because of rounding.
Source: WBG data.

World Bank Group Financial Support for Renewable Energy and Energy Efficiency

In fiscal 2008, total WBG financial commitments for renewable energy, including hydropower of all sizes, and energy efficiency rose to US$2.7 billion (Table 1). Ninety-five renewable energy and energy efficiency projects in 54 countries, as well as two cross-border projects, were supported in fiscal 2008, which accounted for 35 percent of the total WBG energy lending commitments in fiscal 2008 (see Figure 1).[1] This represents an 87 percent rise in financing for renewable energy and energy efficiency from US$1.4 billion in fiscal 2007.

Figure 1: Share of Renewable Energy and Energy Efficiency
(percent of total WBG energy lending)



Source: WBG data.

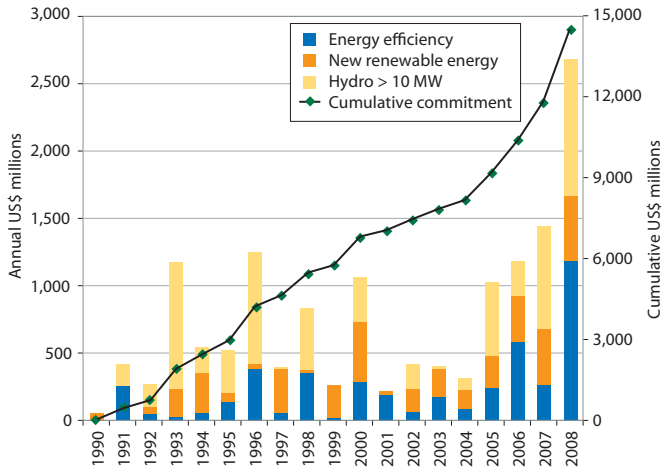
As shown in Table 1, in fiscal 2008 commitments for new renewable energy and energy efficiency were US$1.7 billion, and an additional US$1 billion was committed for hydropower projects greater than 10 MW per facility. Cumulative WBG financial commitments for renewable energy and energy efficiency from fiscal 1990 to fiscal 2008 now exceed US$14 billion (Figure 2).

In fiscal 2008, out of 95 renewable energy and energy efficiency projects, 34 provided improved energy efficiency on the demand

[1] In addition to renewable energy and energy efficiency, total WBG energy lending includes thermal electricity generation; oil, gas, and coal production and transport; electricity transmission and distribution; and policy reform projects.

side to households and industry, thereby reducing energy costs (Figure 3). Moreover, by reducing electricity loads, these projects play an important role in mitigating acute power crises and reducing the need for investments in additional electricity generation capacity. 28 projects employed renewable energy solutions to improve access to rural communities, thereby allowing people to benefit from improved living standards and productivity through modern lighting, irrigation, and other productive uses of modern energy. 19 projects employed renewable energy technologies to generate power for electricity grids, while the remaining 14 improved energy efficiency on the supply side, for example, through power plant rehabilitation and reductions in transmission and distribution losses.

Figure 2: WBG Renewable Energy and Energy Efficiency Commitments, Fiscal 1990–2008

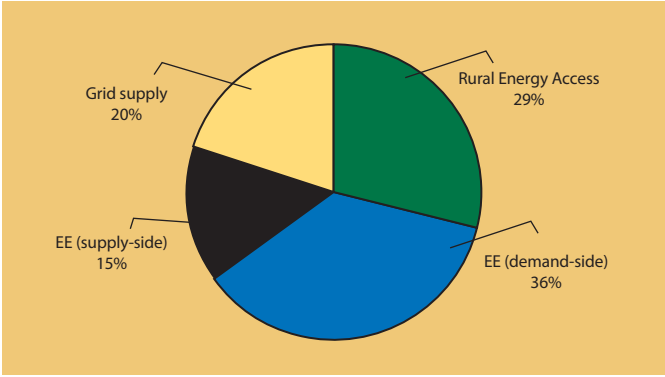


Source: WBG data.

At the Bonn International Conference on Renewable Energies in 2004, the WBG made a commitment to accelerate its support for new renewable energy and energy efficiency.[2] It pledged to increase its financial commitments for new renewable energy and energy efficiency at a rate of 20 percent per year between fiscal 2005 and 2009, compared to a baseline commitment of US$209 million (equal to the average of the previous three years). This baseline methodology was selected to allow a meaningful interpretation of investment trends that would balance the lumpy nature of investments in the energy sector. As in previous years, the WBG has outperformed its Bonn commitment. From fiscal 2005 to 2008, the WBG committed close to US$3.8 billion for new renewable energy and energy efficiency compared to the Bonn commitment goal of US$1.3 billion for the same period.

High energy prices and acute power shortages have led to an increased demand for energy efficiency projects. Projects that comprehensively increase energy efficiency on both the supply and demand sides—for example, through improved capacitors, automated meter reading systems, and efficient lighting measures—are being implemented in a number of countries, including Argentina, Burundi, China, Pakistan, Ukraine, and Zambia.

Figure 3: Share of Renewable Energy and Energy Efficiency Projects by Outcome, Fiscal 2008



Source: WBG data.

[2] New renewable energy comprises energy from solar, wind, biomass, and geothermal, as well as hydropower from facilities with capacities up to 10 MW.

Solar lighting helps Fakhruddin, a beneficiary of the RERED project in Bangladesh, keep his tailoring business open after dark.

As examples of the innovative projects being supported by the WBG, the Kureimat Solar-Thermal Hybrid project in Egypt will demonstrate the operational viability of hybrid solar-thermal power generation technology and contribute to the replication of integrated solar combined cycle power generation technology in Egypt and elsewhere. In Bangladesh, the World Bank approved carbon emissions reduction agreements with Grameen Shakti, a renewable energy company, and IDCOL Ltd., an infrastructure financing organization, to purchase carbon emissions reductions from more than 1 million solar home systems that will displace kerosene lighting.

The growth in IFC's clean energy portfolio in fiscal 2008 was indicative of a shift from small, donor-supported, niche-market investments to an increasingly diversified and global market for clean energy across all sectors. In fiscal 2008, IFC's Financial Markets Group had nine clean energy financing investments in five countries, including some of the largest and most rapidly growing emitters of GHGs—Brazil, China, Russia, Turkey, and Ukraine. These projects will provide commercial lenders with more than US$280 million for dedicated credit lines for clean energy activities, an approach originally developed with donor funds more than a decade ago. The projects will also help address the diverse, profitable, but smaller-scale investment opportunities otherwise difficult to capture.

Going Forward

Renewable energy and energy efficiency feature very prominently in the WBG strategy going forward—most prominently in the Sustainable Infrastructure Action Plan (SIAP) that was

Beneficiaries of the EAREP II mini-hydro and solar project in Ethiopia

launched in July 2008[3] and in the comprehensive Development and Climate Change: A Strategic Framework for the World Bank Group (DCCSF) that was endorsed by the WBG Development Committee in October, 2008.[4]

Sustainable Infrastructure Action Plan. The action plan will significantly scale up infrastructure investment in developing countries to support their growth and poverty reduction efforts. The SIAP, to be implemented over the next three years, will help countries improve the reach and quality of infrastructure investments through increased financial and analytical support. The SIAP calls for a renewal of the WBG core energy sector approach, to respond to the emerging trends in energy security and climate change and to close the energy access gap. Renewable energy and energy efficiency will be important components of the SIAP for improving access to and affordability of modern energy services; improving macroeconomic and fiscal balances; promoting good governance and private sector development; and protecting the environment.

[3] See the SIAP website: http://go.worldbank.org/ZSB-5KSBU30

[4] See the DCCSF website: http://go.worldbank.org/HZ-77KYCI90.

Development and Climate Change: A Strategic Framework for the World Bank Group. The DCCSF is based on the recognition that an effective response to climate change must combine both mitigation, to avoid the unmanageable, and adaptation, to manage the unavoidable. The DCCSF is designed to make effective climate action a part of core development efforts that are mainstreamed into all WBG operations. In an effort to reduce the resource gap in addressing these issues, the DCCSF includes funding sources in the Climate Investment Funds (CIF). These funds, which were approved by the World Bank board on July 1, 2008, are intended to catalyze GHG emission reductions by helping developing countries finance the costs of deploying clean technologies.

Specifically, the CIF will include two trust funds designed to help developing countries in their efforts to mitigate GHG and adapt to climate change.

- The *Clean Technology Fund* (CTF) will provide new, large-scale financial resources to invest in projects and programs in developing countries that contribute to the demonstration, deployment, and transfer of low-carbon technologies. The projects or programs must have significant potential for long-term GHG savings.
- The *Strategic Climate Fund* (SCF) will be broader and more flexible in scope, and will serve as an overarching fund for various programs to test innovative approaches to climate change. The first such program is aimed at increasing climate resilience in developing countries.

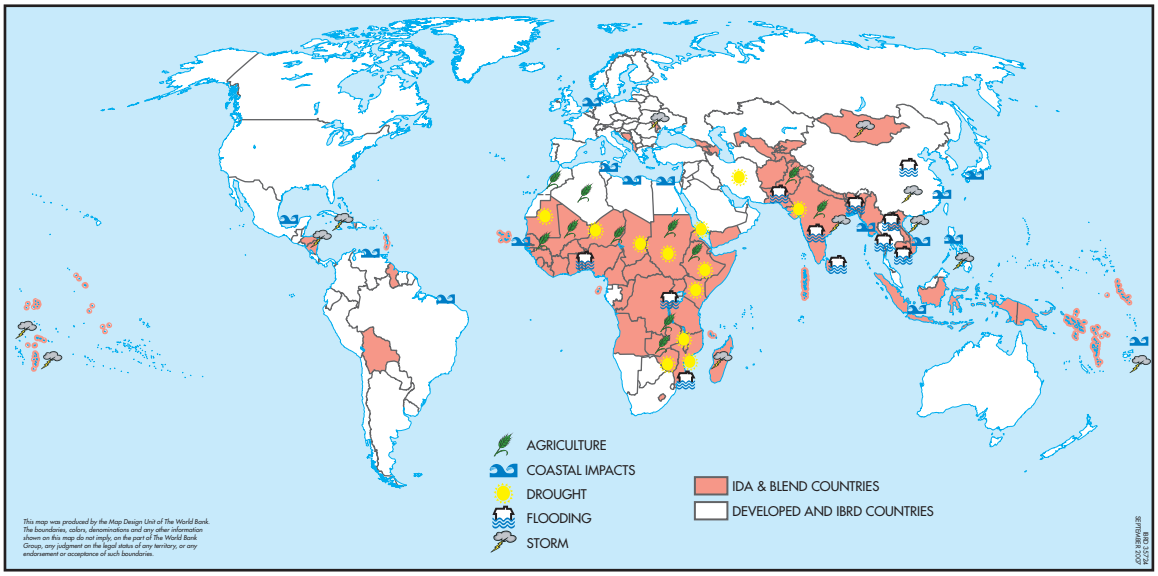
The funds, to be disbursed as grants, highly concessional loans, and/or risk mitigation instruments, will be administered through the multilateral development banks and the WBG for quick and flexible implementation of country-led programs and investments. Developing countries will have an equal voice in the governance structures of the funds, and decisions on the use of funds will be made by consensus. On September, 27, 2008, 10 donor countries pledged to fund the CIF with a total of US$6.1 billion.

Clean Energy, Development, and the Climate Change Challenge

The past year has brought unprecedented focus to the climate change issue. The latest report of the Intergovernmental Panel on Climate Change (IPCC), recognition of IPCC by the Nobel Peace Prize Committee, along with new evidence of accelerated Arctic melting and other signs of warming, brought about general agreement that climate change as the result of human activity is real, increasingly urgent, and a critical threat to addressing poverty and advancing development. Although our understanding of the risks and likely impacts of climate change is still evolving, there is a consensus that the poorest countries and communities are the most vulnerable and will suffer the earliest and to the greatest degree (Figure 4). Consequently, if unchecked, climate change may slow or even reverse the substantial development gains made in recent decades and the progress toward meeting the Millennium Development Goals for reducing poverty.

Accelerating the use of clean energy technologies is one of the best responses to climate change. As studies by the International Energy Agency (IEA), IPCC, McKinsey, and other authoritative sources document, a wide range of commercially available, clean energy technologies could be deployed that would be consistent with their full economic value and would substantially reduce the global growth of GHG emissions. Such opportunities exist in virtually all economies, can often be deployed in a relatively short time period, and continue to improve with new and advanced technology. The scope of opportunities is diverse and includes improving energy efficiency in buildings and transport, improving

Figure 4: Distribution of World Climate Risks



Source: World Bank. *IDA and Climate Change: Making Climate Action Work for Development* (Washington D.C.: World Bank, 2007)

the efficiency of power generation, fuel switching when cleaner fuels are available for power generation, and the use of hydro, wind, solar, and other renewable fuels. These technologies would also promote economic development by reducing oil imports and total energy costs, helping avoid or reduce power shortages, and improving economic competitiveness. However, the adoption of these technologies continues to be slower than economic and environmental goals would justify because of a number of barriers. Thus, WBG clean energy initiatives are central to linking development and climate change.

A further basis for WBG engagement in climate change is the need for unprecedented global cooperation. Developed countries have historically been the dominant source of cumulative GHG emissions and, accordingly, have accepted the initial obligation to reduce emissions under the Kyoto Protocol. Although gross domestic product (GDP) and energy use per capita remain in general much lower in developing countries than in the industrial countries, emissions from the former have been growing much more rapidly—in "business as usual" scenarios prepared by the International Energy Agency (IEA), more than two-thirds of global GHG emissions in 2050 are expected to come from developing countries. Consequently, keeping global emissions within the levels recommended by the IPCC cannot be achieved by reducing emissions from developed countries alone. Even if *all* GHG emissions from industrial countries were to cease *immediately*, cumulative emissions from developing countries would exceed those from the industrial countries in about 20 years, which would result in dangerous concentration levels soon thereafter. To avoid this worrisome future, developing countries will need technology, financing, appropriate policy environments, and human capacity.

The WBG has prepared 'Development and Climate Change: A Strategic Framework for the World Bank Group' to guide its response to climate change in response to a request of the Development Committee during the 2007 Annual Meetings. This Framework was approved by the Development Committee in October 2008 and includes several major initiatives to expand the WBG's role in promoting clean energy.[5] Building on the WBG's record of growing its clean energy portfolio, a more ambitious goal has been announced to increase financing for energy efficiency and new renewable energy by an average of 30 percent per year from a baseline of US$600 million in average annual commitments during fiscal 2005–07. In addition, the WBG will increase lending to hydropower. Overall, the WBG aims to increase the share of low-carbon projects from total energy lending from 40 percent in fiscal 2006–08 to 50 percent in fiscal 2011.[6] Some important new analytical tools are being developed, including carbon "footprinting" (a means of measuring carbon emissions from investments) and, at IFC, a pilot program to test the impact of using a "shadow price" for carbon (attaching a price to carbon to test its impact on project financial analysis). The Framework includes several action areas closely related to its clean energy goals, including mobilizing additional concessional resources.

As the Framework documents, unprecedented additional resources amounting to many billions of dollars will be needed for both mitigating and adapting to climate change. As most of this investment will necessarily come from the private sector; one objective will be to use financial instruments more creatively to channel private

[5] See the DCCSF website: *http://go.worldbank.org/HZ77KYCI90.*

[6] It should be noted that the share of projects that are not counted as low-carbon are by no means all thermal power generation or oil and gas projects, but rather include to an increasing degree transmission and distribution projects, as well as development policy loans. See Annex 1 for definitions used to guide the categorizing of projects.

investment in a more climate-friendly direction (see the paragraph on *Leveraging Private Sector Resources* below). However, in order to mitigate the cost of using climate friendly technologies in developing countries, increased donor funds for climate funds will also be essential. In July 2008, the WBG board approved a program for hosting a new program of donor-supported Climate Investment Funds (see Box 1). At an initial pledging meeting in September 2008, 10 donors collectively announced pledges of US$6.1 billion dollars for Climate Investment Funds programs.

Other objectives of the Strategic Framework include the following:

- *Facilitating development of market-based financing mechanisms*. The WBG has more than a decade's extensive experience in promoting the carbon market and other market-based instruments with the potential to increase climate-friendly investments (see Case One).
- *Leveraging private sector resources*. The U.N. Framework Convention on Climate Change (UNFCCC) estimates that 86 percent of the

Box 1: Climate Investment Funds

The Climate Investment Funds (CIF) aim at reducing the cost of climate actions for developing countries and catalyzing transformational technologies and project approaches for climate change mitigation and adaptation. Approved by the WBG board in July 2008 and supported by US$6.1 billion in donor funds, the (CIF) is an interim instrument with specific sunset clauses linked to agreements on the future of the climate change regime.

Funding and governance. By combining significant concessional financing with international financial institutions, public and private sector flows, and other climate financing (such as carbon finance and GEF), the CIF will demonstrate how multilateral development banks can help developing countries combine poverty reduction and growth objectives with climate action. Key features include Trust Fund Committees with a balanced representation of recipient and donor countries and project approval by multilateral development banks boards. A Partnership Forum—a broad-based meeting of stakeholders—would be convened annually to provide a forum for dialogue on the strategic directions, results, and impacts of the CIF.

Clean Technology Fund. The Clean Technology Fund (CTF) would provide scaled-up financing on a country-specific basis to contribute to demonstration, deployment, and transfer of low-carbon technologies with a significant potential for long-term GHG emissions savings. In order to maximize impact, the CTF would work with both the private and public sectors to bring sufficient technological know-how and capital to dramatically scale up clean technology deployment, while remaining technology neutral. It would provide grant elements and utilize a range of concessional financing instruments, such as grants and concessional loans, as well as risk mitigation instruments, such as guarantees and equity, to make projects economically viable.

Strategic Climate Fund. The Strategic Climate Fund (SCF) would provide financing to pilot new development approaches or to scale up activities aimed at a specific climate change challenge or sectoral response through targeted programs. The first program in the SCF would be *pilot national level actions for climate resilience* in a few highly vulnerable countries. Other programs under consideration would support renewable energy technologies to increase energy access in low-income countries, and investment to reduce deforestation and forest degradation and to promote improved sustainable forest management.

The World Bank's role. Together with other multilateral development banks, the WBG will be responsible for implementing programs and projects financed by the CIF, following the normal programming and implementation procedures of its constituent entities.

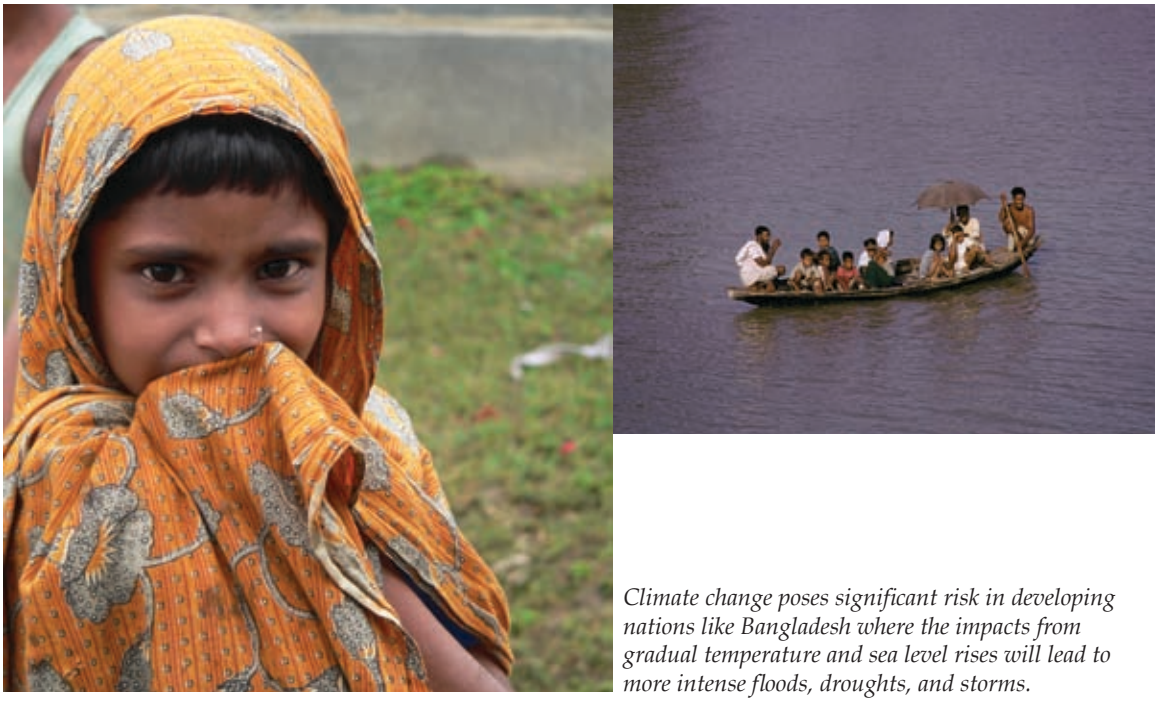
additional resources required to respond to climate change will come from private sources. The WBG contributes to this need through its core role in improving the overall investment climate in developing countries (see Box 2). Clean energy financing projects engage local financial institutions in identifying clean energy lending opportunities and, with rising energy prices, are attracting much more client interest (see Case Three). As clean energy technologies have increasingly become a global product, IFC has found increasing opportunities for "supply-chain" investments in materials, manufacturing, component suppliers, financing, and other parts of the renewable energy business in addition to provision of energy services (see Case Two).

- *Supporting accelerated development and deployment of new technologies*. The development and deployment of new technologies will be an essential part of the response to climate change, even allowing for greater success in promoting existing commercial clean energy options. The Strategic Framework describes the WBG's contribution to the technology cycle. The issues involved with this topic are reviewed in Chapter 4.

Box 2: Investment Climate Assessment for Renewable Energy in India

The WBG is working with the government of India to improve the investment climate for renewable energy by undertaking a comprehensive review and mapping exercise of the existing regulatory and policy frameworks, as well as of market interventions. It will provide recommendations for designing coherent policies, regulations, and guidelines for scaling up renewable energy development in India. India has a history of promoting renewable energy, but progress has been uneven in recent years. The Ministry of New and Renewable Energy (MNRE) set a guideline tariff for purchase of power by utilities from renewable generators that lapsed in 2004. State regulators then began to set purchase prices, as well as renewable quotas. As a consequence, the incentives for renewables came to depend on the accuracy of the regulators' estimation of the costs. The future energy market within which renewables will have to compete has become more uncertain. The National Electricity Act 2003 provides a framework for the introduction of wholesale competition and open access, and makes it mandatory for the state energy regulatory commissions to promote renewable energy-based generation. In addition, in 2008 the Government of India introduced the National Action Plan for Climate Change (NAPCC) which encourages the development of renewable energy based supply; MNRE has introduced output-based incentives for renewable energy (starting initially with grid-connected solar energy) and also plans to issue guidelines for tradable renewable energy certificates; and some states have introduced renewable energy-based surcharge funds and/or have issued competitive bidding for renewable energy sources. Although these actions are positive initiatives to encourage the uptake of renewables, the details of the design of the market structures and valuation of renewable energy-based generation are not clearly defined. However, they remain critical for the viability of the renewable energy projects, and in ensuring incubation and development of future renewable energy technologies (RETs) in India.

Given the considerable variation in policy and regulations across states, investments may not necessarily be taking place in the most economically viable technologies and locations. Furthermore, with the introduction of competition, existing mechanisms for encouraging renewables, such as quotas and regulation of purchase prices, may require modification of their scope or may become less applicable. Accordingly, the study seeks to allow policy makers to take full account of the considerable information available on costs, performance, and other aspects of renewable energy technologies to deliver coherent policy in this area, while facilitating involvement from a wide set of important stakeholders in the process. The understanding of the existing regulatory and policy framework, the mapping of market interventions and the determination of an indicative economic valuation of the elements in the renewable energy framework will be important for consistent design of policies that address gaps and inconsistencies and further strengthen incentives for the most viable investments.



Climate change poses significant risk in developing nations like Bangladesh where the impacts from gradual temperature and sea level rises will lead to more intense floods, droughts, and storms.

The chapters that follow describe several different ways in which the WBG is working to promote clean energy, each of which relates to climate change. Chapter 2 focuses on the WBG's increasing commitment to promote energy efficiency, including financing, policy reform, and capacity building. The link to climate change is to find scale-up strategies, such as leveraged financing and sector approaches that can make an impact on the scale required to make a meaningful difference in GHG emissions. Chapter 3 looks at WBG efforts to promote renewable energy in Africa. Sub-Saharan Africa is not a significant source of global GHG emissions, but it is at great risk from climate change. Development and poverty alleviation will require substantial increases in energy services; done with clean energy technologies, the increase in emissions and environmental cost will be modest. Chapter 4 reviews the critical importance of new technologies in addressing climate change and evolving WBG approaches to accelerate their development and deployment in developing countries. And Chapter 5 is a summary of WBG support of renewable energy and energy efficiency.

Case One

Promoting Clean Energy Through Carbon Markets—Mainstreaming the Clean Development Mechanism in WBG Projects

Carbon markets have been gaining momentum by leaps and bounds over the last few years. Globally, emissions reductions valued at US$64 billion were traded in 2007 in carbon markets which embodies an increasing focus on clean energy and is by far the most visible result of early regulatory efforts to mitigate climate change (Figure 5). The primary buyers of the Clean Development Mechanism (CDM) and Joint Implementation (JI) till now have been from the EU, with Japan continuing to develop as another major player.[1] China remains the largest carbon seller with 72 percent of the projects in 2007.[2]

Despite its strong momentum, the project-based carbon market faces challenges, including the absence of market continuity beyond 2012, which put at risk this additional source of financing for clean energy and other low-carbon investments in developing countries. Complex rules, capacity constraints, regulatory bottlenecks, and procedural inefficiencies have strained the ability of the CDM infrastructure to deliver certified emissions reductions (CERs) on schedule to many projects. Several of the WBG's existing and upcoming CDM activities aim to directly address these issues.

Through its family of carbon funds, the WBG has been a major player in the market for promoting GHG emission reductions. The World Bank launched its first public-private partnership, the Prototype Carbon Fund, in April 2000 (years before the Kyoto Protocol entered into force). Since then, carbon finance activities have grown to US$2.1 billion, through 10 funds, pooling stakes from 16 governments and 66 private companies. Carbon finance, with its significant leveraging, has become a major channel to support low-carbon investment. IFC's carbon finance unit has been engaged directly with the carbon market since 2002. Initially starting with intermediation efforts on behalf of the Dutch government, it has evolved to take long-term project and credit risk in emerging markets and to take carbon-related exposure for its own account.

The World Bank's new Carbon Partnership Facility (CPF), approved in 2007, will promote GHG emission reductions on a large scale through long-term investments (such as power sector development, energy efficiency, gas flaring, transport, and urban development, including integrated waste management systems), help create an enabling environment for mitigation programs, and scale up the delivery of carbon finance through programmatic and sectoral initiatives that help catalyze a change in the way Bank client countries approach GHG mitigation. The CPF also addresses market continuity issues as the purchase of carbon credits might extend up to 2022. During fiscal 2009–11, 12–16 emissions reduction programs are expected to be developed under the CPF.

In fiscal 2007, the World Bank submitted new CDM methodologies for demand-side energy efficiency projects using "deemed savings"—related approaches to reduce unnecessary monitoring complexity. In addition, the Bank helped develop programmatic CDM approaches that could effectively enable aggregation of

[1] CDM and JI are mechanisms under the Kyoto Protocol that feed into the carbon market. Definitions are available through UNFCC at *http://unfccc.int/kyoto_protocol/mechanisms/items/1673.php*.

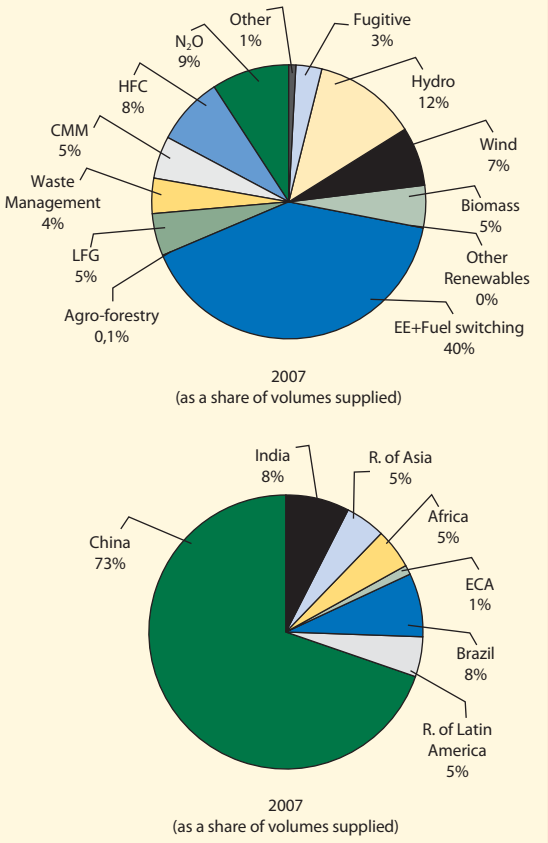
[2] Further trends and details can be found in the WBG report, "State and Trends of the Carbon Market 2008" (May 2008).

World Bank provided support in FY08 to the Rwanda electricity utility, to procure 400,000 CFLs that help address power shortages. The utility aims to bring efficient lighting to 250,000 new consumers by 2012.

small, dispersed, activities covering renewable energy and demand-side energy efficiency in larger numbers. In parallel, the World Bank's Carbon Finance Assist program continued to provide capacity building support in areas of carbon finance and CDM to multiple stakeholders in various countries, with a particular focus on Africa, which has, to date, had a very low global share of CDM projects (see Figure 5).[3]

On the financing side, new carbon instruments are also emerging. IFC Carbon Delivery Guarantee has helped maximize the price of carbon credits to project developers through back-to-back forward contracts. IFC provides credit enhancement and guarantees the certified emission reduction (CER) delivery obligation of compliance market projects to secondary market buyers, and the premium in pricing obtained by the investment grade sellers in the secondary market is passed on to the projects net of guarantee fees. During FY08, IFC signed innovative carbon delivery guarantee agreements with two chemical companies: Rain CII Carbon in India, the largest producer of calcined coke in the world, and South Africa's Omnia, one of the country's leading fertilizer producers. The investments underlying these transactions will reduce greenhouse gas emissions equivalent to 12.5 million tons of carbon dioxide over the estimated life of the assets.

Figure 5: Primary CDM Projects and Carbon Sellers, 2007



Source: World Bank, *State and Trends of the Carbon Market 2008* (Washington, D.C.: World Bank, 2008).

At the same time, institutions like MIGA insure against investor loss in the event that political events in the host country result in any breach of a CDM contract, which increases the confidence of potential carbon asset buyers and potential investors. A showcase of WBG involvement in aggregating CDM benefits through its energy efficiency projects is presented in Case Four.

[3] The Carbon Finance Assist program is implemented by the World Bank Institute (WBI).

Case Two
IFC Investments in the Solar PV Supply Chain

As the private sector arm of the WBG, IFC has been involved in financing solar photovoltaic (PV) technology since 1989. Most of this investment has been dedicated to household, off-grid applications to provide lighting and cater to small household needs in rural areas. However, in recent years the global PV market has had rapid growth as a result of energy and environmental policies in the developed countries leading to improving technologies, but also supply shortages and opportunities for new investments in manufacturing, materials, and components. PV production has been doubling every two years, increasing by an average of 48 percent each year since 2002, making it the world's fastest-growing energy technology.[1] Total installations reached a record high of 2,826 MW in 2007. Financing this growth has in turn become a significant global business with 84 identified financial transactions amounting to US$7.5 billion in 2007.[2]

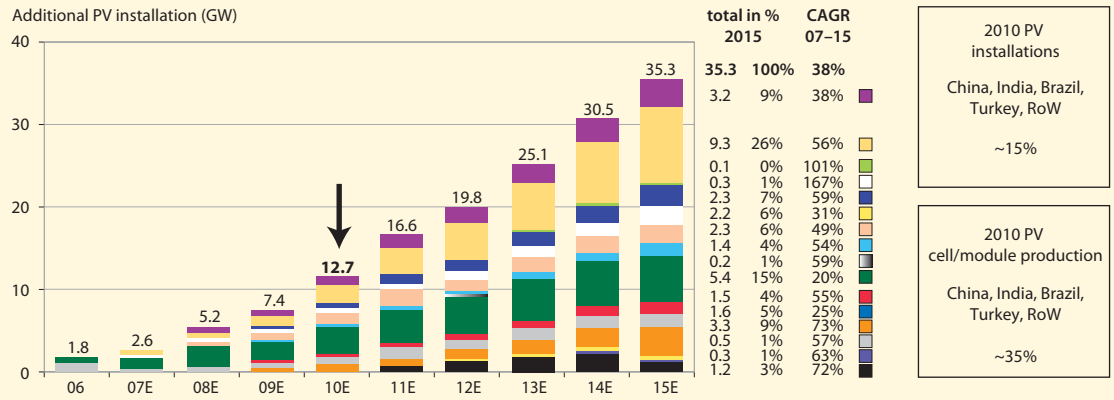
PV continues to be a relatively expensive albeit clean source of electricity, and recent demand growth has caused a short-term increase in prices despite improving production and product quality. However, even at current prices, solar PV is well suited as a niche, grid-connected source for fast-growing electricity markets in developing countries (Figure 6), many of which also benefit from high levels of solar irradiance. Associated with the growth of demand, a vibrant supply chain is expected to emerge, mostly in developing countries with competitive engineering and labor costs.

IFC has already made investments in PV materials and manufacturing and is evaluating numerous additional opportunities in this sector. The opportunity for IFC is to support the industry's shift to emerging markets. This will contribute to an acceleration in cost reduction and to the achievement of grid par-

[1] Earth Policy Institute (www.earth-policy.org, 2007). Solar Cell Production Jumps 50 percent in 2007.

[2] *www.Solarbuzz.com.*

Figure 6: Emerging Market Opportunities



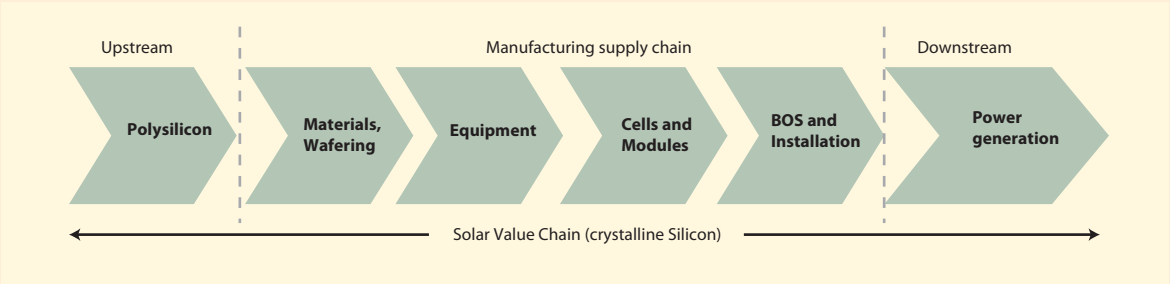
Source: Good Energies, *Emerging Markets in Emerging Markets: Financing Opportunities for Clean Technologies in Emerging Markets*, presentation given at *Financing for Climate Innovative Solutions and New Market*, 11-12 September, 2008. (Rüschlikon, Switzerland: Swiss Re Center for Global Dialogue, 2008)

Polysilicon for solar PV manufacturing from NITOL, Russia

ity, thereby helping the solar PV industry achieve its potential as a competitive source of renewable energy. A closely related opportunity is to support solar power projects in countries or situations where solar PV is already a competitive solution.

IFC is developing a solar strategy and emphasizes supply chain investments in mainstream technologies to help drive the cost of solar PV energy down by supporting the scaling of the supply chain in cost-competitive manufacturing locations.

Some examples of recent IFC investments in the PV supply chain include a polysilicon (key material for solar cell) manufacturer in Russia, a solar PV manufacturing facility in India, and a solar thin film maker in China.



Windmills, La Venta II in Oaxaca, Mexico

Energy Efficiency: Maximizing the Win-Win Opportunities

Enhanced energy efficiency is considered to be the single largest win-win opportunity to reduce global GHG emissions. Much energy is simply wasted, and energy savings options are available throughout our client countries—big and small—and across their different sectors—ranging from agriculture to households to industry. And, in fact, it offers a unique opportunity to address multiple challenges facing the world today: the challenge of pursuing sustainable economic development; the challenge of addressing rising energy prices; the challenge of enhancing energy security; and the challenge of mitigating global climate change.

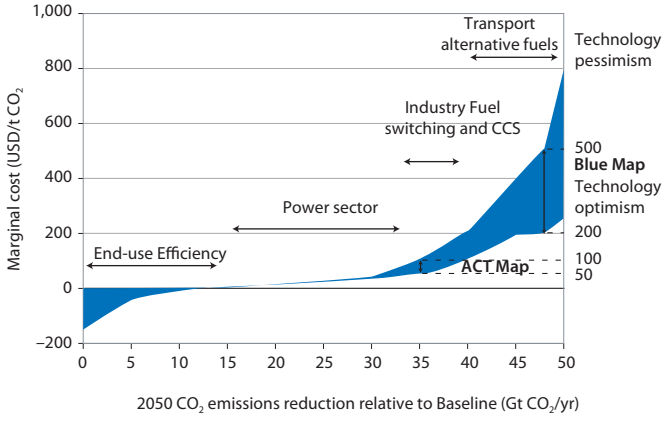
Many of our client countries, supported by energy efficiency policies, projects, and programs, have begun exhibiting trends of reduced energy intensities and decoupling of energy consumption from economic growth. These cost-effective energy efficiency improvements can achieve significant GHG emissions reductions, as recognized in recent assessments by the IEA, IPCC, and other authoritative sources' projections (see Figure 7).

Energy Efficiency opportunities exist across the entire chain of modern energy production, distribution and consumption. Disparities in energy intensities between the developing and industrialized countries are observed in both the supply and demand side and across various sectors and subsectors.

As illustrated in Table 2, considerable unexploited potential for energy efficiency improvements exists particularly along the delivery and end-use chains across various sectors of major energy-consuming countries.[7] For example, the IEA estimates that improved energy efficiency in buildings, industry, and transport could lower energy use in 2050 by up to 33 percent.[8] The potential for energy efficiency improvements is particularly great in the most energy-intensive industries in the industrial and developing countries, such as iron and steel.

Though these appear to be win-win solutions on the surface, energy efficiency is a complex business. Even more so than in high-income countries, energy efficiency investments in developing countries are subject to market failures and they face technical, financial, institutional, and policy barriers. The classic barriers to energy

Figure 7: Marginal Emission Reduction Costs for the Global Energy System, 2050



Source: IEA, *Energy Technology Perspectives 2008* (Paris: IEA, 2008).

[7] For example, existing coal-fired thermal power stations in China or India on average use 10–20 percent more fuel per kilowatt-hour than a comparable plant in the United States or Germany.

[8] IEA, *Energy Technology Perspectives 2006* (Paris: IEA, 2006).

Table 2: Energy Efficiency Opportunities and Measures in Key Consuming Sectors

Sector	*Energy Efficiency Improvement Opportunities*
Buildings	Integrated building design and measures such as better insulation, advanced windows, energy-efficient lighting, space conditioning, water heating, and refrigeration technologies.
Industry	Industrial processes, cogeneration, waste heat recovery, preheating, efficient drives (motor, pump, compressors).
Cities and Municipalities	District heating systems, combined heat and power, efficient street lighting, efficient water supply, pumping, and sewage removal systems.
Agriculture	Efficient irrigation pumping and efficient water use, such as drip irrigation.
Power Supply	*New thermal power plants*: Combined cycle, supercritical boilers, integrated gasification combined cycle (IGCC), and so forth. *Existing generation facilities*: Refurbishment and repowering (including hydro), improved operation and maintenance practices, and better resource utilization (higher plant load factors and availability). *Reduced transmission and distribution losses*: High-voltage lines, better insulated conductors, capacitors, efficient and low-loss transformers, and improved metering systems and instrumentation.
Transport	Efficient gasoline or diesel engines, urban mass transport systems, modal shifts to inter- and intra-city rail and water transport, improved fleet usage, CNG vehicles.
Households	Lighting, appliance efficiency, improved cookstoves.

efficiency scale-up arise from non-economic pricing of energy and the greater emphasis given by many consumers and investors to upfront (first) costs compared to recurring costs, such as fuel. Furthermore, a focus on return on investment often leads to greater investment in new production capacity rather than cost reduction opportunities, such as energy efficiency improvements. This is especially so where energy costs are a small proportion of production costs. There is also a generally higher-risk perception associated with demand-side energy efficiency projects (compared to supply-side projects) because of the lack of awareness and experience among investors and financiers. Finally, since these projects depend on revenues generated through energy savings, they also require robust systems of measurement, monitoring, and verification of energy savings, which can be a challenge.

The World Bank's contribution to scaling up both supply-side and demand-side energy comes through a variety of investment, technical assistance, and analytical advisory activities. These support the development of many well-tested energy efficiency technologies and approaches, including the following:

- Policy reforms (rational pricing or time-of-use pricing), often accompanied by the introduction of better metering systems; energy efficiency standards and labeling for appliances and building codes which lead to energy efficiency market transformation; vehicle fuel efficiency standards. For instance, the China Development of Pro-Poor National Heat Pricing and Billing Policy project piloted and developed a national policy framework in 2007 for heat pricing and billing adopted by the Ministry of Construction. It gave special attention to preserving access to quality heating services for low-income households. This project resulted in Tianjin becoming the first city to pilot the system of shifting from flat heating tariffs to usage-based tariffs.

- Utility incentive programs that promote investments in demand-side management interventions (efficient lightbulbs, such as compact fluorescent lamps [CFLs] to replace inefficient incandescent lamps in numerous countries, such as Argentina, Ethiopia, and Pakistan).
- Procurement based on life-cycle costing procedures for supply- and demand-side equipment; tariff policies and incentive mechanisms for efficient generation (such as supercritical, IGCC, and gas combined cycle); high-voltage transmission; distribution networks; and metering.
- Regulatory, legislative, and institutional development that creates an enabling environment for energy service providers and equipment manufacturers to finance more energy efficiency investments (see Boxes 3, 4, and 5).
- Information programs for creating awareness about energy efficiency in various sectors.

Advertisement for CFLs in Buenos Aires, Argentina. The Argentina Energy Efficiency Fund, approved by the Board in June 2008 aims to distribute 20 million CFLs and to replace incandescent bulbs currently in use.

WBG energy efficiency scale-up efforts have led to the quadrupling of its energy efficiency investments—covering both the supply and demand side—to US$1.2 billion in fiscal 2008. The portfolio includes diverse approaches consistent with the diverse needs and opportunities in our client countries. For example, the Electricity Distribution and Transmission Improvement Project (EDTIP) in Pakistan responds to severe power shortage problems and includes a demand-side energy efficiency component of US$15 million. These funds will be used for bulk procurement and distribution of energy-efficient lightbulbs (CFLs), end-use capacitors, and advanced consumer metering systems by four participating electricity distribution companies. The CFL program will build on the success of similar, Bank-supported practices in other countries, such as Uganda in 2006—where the program has helped

Box 3: IFC's Energy Efficiency Interventions through the Financial Sector

While energy efficiency opportunities exist as embedded components of larger projects across the entire spectrum of IFC's core industry sector investment business, perhaps the greatest opportunities exist as smaller discrete projects, including cogeneration systems, lighting renovations, motor retrofits, and control systems. These projects are typically too small for direct IFC investments. Since 1998, IFC has addressed this market opportunity by partnering with financial intermediaries to develop specialized financial products for promoting energy efficiency as a profitable, sustainable banking business—for example, the Russia Sustainable Energy Efficiency Program (RSEEP), which worked with eight financial institutions to introduce energy efficiency finance in the Russian market, with a collective target of US$60 million of energy efficiency lending. The efforts of one such bank, Center-Invest Bank, which disbursed a US$4 million credit line within the first three months of the project's launch in 2005, was recognized at the 2007 Financial Times–IFC Sustainable Banking Awards. Similar initiatives are ongoing in China, the Philippines, and Peru.

Source: IFC, *IFC Smart Lessons in Energy Efficiency* (Washington, D.C.: IFC, 2008).

Box 4: Developing Financial Intermediation Mechanisms for Energy Efficiency for Brazil, China, and India—World Bank Technical Assistance Activities

The objective of this technical assistance activity was to stimulate interest among local financial institutions in Brazil, China, and India to extend loans to commercial borrowers wishing to make energy efficiency investments in the commercial and industrial sectors. The activities included cross-exchange workshops, and market assessments, as well as aids for energy efficiency project appraisal and financial structuring.

Largely as a result of this work, there was strong support from stakeholders in China, Brazil, and India to enhance the role of commercial banks in energy efficiency. In China, a US$593 million Bank/GEF energy efficiency operation was recently approved by the Board (see Case Three). The focus of the project is to promote bank financing of medium-size and large energy efficiency projects, and its chief goal will be to establish sustainable energy efficiency lending businesses in Chinese banks.

In India, five banks—State Bank of India, Canara Bank, Union Bank, Bank of Baroda, and Bank of India—have launched new schemes for energy efficiency lending, and a Bank/GEF project is under preparation to facilitate increased use of commercial bank financing, particularly for financing energy efficiency projects in small and medium enterprises.

The technical assistance effort helped the Brazilian development Bank BNDES to launch a new Guarantee Fund (PROESCO) with its own resources with the participation of several local banks. This scheme is helping overcome some of the key barriers preventing financing of energy service company (ESCO) operations in Brazil through provision of increased comfort to the local lenders and easing of collateral requirements.

address power shortages in the short term—and in Rwanda in 2007 (see Case Four)—where it is also bringing additional revenues through the sale of carbon credits.

The design of WBG energy efficiency projects also responds to the influence of high and volatile fossil fuel prices, and energy security concerns in recent years have increased the attractiveness of energy efficiency for a large number of diverse applications. In many developing countries, power shortages are another compelling justification for energy efficiency measures (see Cases Three and Four).

One of the focal areas of increased importance within the World Bank will be to use cross-sectoral thematic groups to help break down the problem of "stovepipes" to mainstreaming energy efficiency projects across various sectors. The application of cross-sectoral perspectives will be facilitated by creating project teams with the breadth of skills needed to support cross-fertilization. For instance, the World Bank team is currently working with the Ministry of Water Resources and Irrigation in Egypt to prepare the Irrigation and Drainage Pumping Stations Modernization Project, which will help (a) improve the energy efficiency of the pumping stations and reliability of delivery of irrigation water and evacuation of drainage water to prevent the losses in crop yields resulting from aging stations; (b) increase the efficiency of operations and maintenance (O&M) of the pumping stations and thereby save public expenditures on O&M; and (c) implement pilot public-private partnerships (PPPs) in O&M services in conjunction with carbon finance opportunities. At IFC, a Community of Practice on Energy Efficiency and Water has been established, which brings together a cross-section of practitioners from different parts of the organization.

Box 5: The Bulgaria Energy Efficiency Fund

The Bulgarian economy has long suffered from extreme energy inefficiency. In response to the government's request to support the establishment of a dedicated PPP-based energy efficiency finance facility, in 2005 the GEF, through the World Bank, approved a US$10 million grant to provide the bulk of initial capitalization for Bulgaria Energy Efficiency Fund (BEEF). The strictly commercially oriented revolving fund became operational in early 2006 with seed capital of US$16 million, including contributions from the Austrian and Bulgarian governments and from private Bulgarian firms. Drawing on experiences with energy efficiency funds worldwide, BEEF has incorporated several innovative design features, including (a) flexible combination of financial products (primarily loans and credit guarantees) allowing market-driven financing; (b) public-private partnership both in the capitalization and management of the fund; (c) strong country ownership through significant upfront government cash contribution; (d) appointment of a fund manager with strong financial skills and local knowledge; and (e) building a strong pipeline of finance-ready projects earlier in the process.

BEEF has gotten off to a strong start, approving 67 projects so far for funding and becoming a high-profile player in the emerging energy efficiency finance market of Bulgaria. In the municipal sector, BEEF is the preeminent energy efficiency financier in the country.

The BEEF project brings efficient lighting and heating for an apparel factory in Pleven, Bulgaria

Case Three

China—Improving the Energy Efficiency of Medium-Size and Large Industrial Enterprises

In its 11th Five-Year Plan for Economic and Social Development, the Government of China pledged to reduce the energy intensity of the country's GDP by 20 percent from 2005 to 2010. A substantial amount of this avoided energy supply capacity is expected to come from technical improvements (as opposed to structural adjustments) in energy-consuming activities, especially in industrial sectors, which accounts for about two-thirds of China's total energy use. To compel the industrial sectors to achieve their share of the energy intensity reduction, the Government of China launched the "1,000 Enterprises Energy Conservation Program" in 2006, targeting the 1,008 largest industrial energy consumers. The goal is to realize about 100 Mtce energy savings among these industrial enterprises through technical innovations and energy efficiency investments.

The China Energy Efficiency Financing Project, approved by the World Bank Board in May 2008, was designed to enhance the financing of energy efficiency investments in China's medium-size and large industrial enterprises and support the Government of China's energy efficiency efforts in the 11th Five-Year Plan. It is by far the largest WBG project dedicated to scaling up energy efficiency in China with a US$200 million IBRD loan and a US$13.5 million GEF grant. The project is expected to leverage at least another US$200 million of funds for energy efficiency investment from participating domestic banks, as well as an additional US$170 million from beneficiary enterprises. This project builds on and expands the energy efficiency market development efforts of several previous and ongoing WBG and GEF energy efficiency projects in China.

Fiscal 2008 also saw another breakthrough in the Bank's energy efficiency financing business in China: the first ever district heating loan to China—the Liaoning Third Medium Cities Infrastructure Project. The US$191 million IBRD loan will improve the energy efficiency and environmental performance of heating and gas services in selected areas of participating cities in Liaoning Province. In the cold climate regions of China, development of modern demand-driven district heating systems is another priority in the government's energy efficiency agenda. There is large potential for increased Bank support in expanding energy-efficient modern district heating services in China.

The development of energy-efficient district heating systems is particularly important in the cold climate regions of China

Case Four
CDM Benefits for Energy Efficiency— An Illustration of the WBG's Recent Initiatives

Baotou Iron and Steel Energy Efficiency Project
China is the world leader in iron and steel production, and in 2006 it produced 422 million tons of crude steel, about 34 percent of the world's share. The iron and steel industry, one of the country's most energy-intensive sectors and largest GHG emitters, consumes about 16 percent of the country's primary energy supply and emits more than 10 percent of the country's total GHG emissions. Energy efficiency of China's iron and steel industry is on average around 20 percent lower than the world's best practice benchmark and a major cause of concern among policy makers. Without significant improvements in energy efficiency, China's iron and steel industry will continue to be a fast-growing major contributor to global GHG emissions associated with climate change.

The US$12.9 million carbon finance project approved by the World Bank in fiscal 2008, Baotou Iron and Steel Energy Efficiency Project at the Baotou Iron and Steel Company (BISCO) located in the Inner Mongolia Autonomous region in China, is expected to generate captive electricity, which will replace the equivalent amount of electricity and thereby reduce the GHG emissions from the coal-dominated North China Power Grid.

Sustainable Transport in China
In China, the urban transport sector is a large, fast-growing source of GHG emissions. The most powerful driver of the fast growth in transport CO_2 emissions is rapid motorization, particularly in urban areas. Dramatically increasing rates of motorization are also causing severe traffic congestion and worsening air pollution. Controlling these risk factors would also provide ancillary benefits by improving mobility and oil security.

As part of its efforts to reduce air pollution, congestion, and CO_2 emissions, China is studying the potential for a viable carbon market in transport with support from the World Bank. A transport methodology developed with Bank financing in Nanchang is currently under review. Field work is also under way to test the viability of fuel efficiency measures that have proved successful elsewhere (notably Japan) as CDM pilot projects in China.

Baotou Iron and Steel Company plant, Inner Mongolia

(*Case study continues to next page*)

Case Four
CDM Benefits for Energy Efficiency— An Illustration of the WBG's Recent Initiatives (*continued*)

Promoting Clean Energy Technologies, and Lighting Lives in Africa through Carbon Finance Synergies

Standardized technical specifications of energy-efficient lighting products, such as CFLs through the Efficient Lighting Initiative (set up by IFC) have helped replicate its successes in the 1990s to large-scale energy-efficient lighting programs in Ethiopia, Rwanda, and Uganda in recent years. Based on the lessons learned, the World Bank is developing operational toolkits and standardized approaches to further scale up energy efficiency lighting projects.

Based on the successes in Uganda, the World Bank provided support in fiscal 2008 to the Rwanda electricity utility and the Ministry of Infrastructure to help design a large scale energy-efficient lighting program. From September 2007 to the end of 2008, 400,000 CFLs have been distributed to consumers either free of charge or at a subsidized cost in exchange for inefficient, conventional incandescent lamps used in their households. The project is also expected to benefit from a proposed WBG carbon finance transaction through the CDM in the future.

In a similar effort for promoting clean, affordable, and efficient off-grid lighting applications using light-emitting diode (LED) technologies for replacing conventional fuel-based (kerosene) lighting measures in Sub-Saharan Africa, under the joint IFC–World Bank Lighting Africa initiative, innovative CDM methodologies using programmatic approaches are being prepared that would enable mainstreaming of carbon finance into the implementation of large-scale, off-grid lighting programs.

New lamps for old: consumers discard conventional bulbs used in their households, for free CFLs.

Sources: UERP Project Supervision documents, www.efficientlighting.net, www.lightingafrica.org; ESMAP Energy Efficiency Lighting Toolkit Activity Concept documents.

Renewable Energy in Scaling Up Access in Africa

The lack of electricity in much of the developing world deprives people of basic necessities, such as lighting, refrigeration, and communication. As a result, targets to reduce poverty are much more difficult to achieve. In the developing world, 1.6 billion people (24 percent of the world's population) lack access to electricity or other modern energy services. Only 26 percent of the population of Sub-Saharan Africa and 54 percent in South Asia have access to electricity.

Although Asia is the continent with the largest absolute number of people without access to electricity, the relative share of electricity access within the population is high (about 73 percent). This relative progress compared to Sub-Saharan Africa reflects the targeted efforts that many countries in Asia have pursued to achieve access to electricity. In 2005, the Government of India, where the majority of the country's households have no electricity, began an aggressive five-year program—the Rajiv Gandhi Grameen Vidyutikaran Yojana Rural Electrification Program—to electrify the whole population within several years.[9] In Asia, the World Bank has been supporting renewable energy-based rural electrification programs in China, Bangladesh, Laos, the Pacific Islands, Papua New Guinea, Philippines and Sri Lanka, among others.

In Sub-Saharan Africa the challenges are greatest.[10] The challenge is magnified by features specific to the region that render electrification more difficult than elsewhere. The population of Sub-Saharan Africa is highly dispersed across a huge continent, many countries are landlocked, and numerous countries have been subject to civil strife leading to damage to infrastructure (including power systems) and displacement of peoples within countries and across regions.

In response, the World Bank has articulated an Africa Energy Access Plan to provide for a new and credible way to expand access in Sub-Saharan Africa. With an aim to increase access in SSA to 47 percent by 2030, this plan is based on three overarching principles: (a) providing electricity for growth by increasing coverage for enterprises and households; (b) fulfilling the Millennium Development Goals to reduce poverty by connecting public facilities, such as clinics, community centers, and schools, while using a least-cost mix of grid extensions and decentralized solutions; and (c) meeting basic needs by equipping households with affordable, modern lighting and boosting the use of improved stoves, increasing access to cleaner fuels, and making biomass fuels sustainable.

The Africa Energy Access Plan is a partnership between the countries and the donor community. The commitment of the client countries is reflected in their development of realistic scale-up plans and self-financing instruments. These embody a strategic approach that enables a range of outcomes, promotes robust regulation and allows for multiple forms of access, with an appropriate private-public mix. On the donor side, a programmatic, sectorwide strategy is being sought that is in contrast to the traditional project-by-project and donor-by-donor approach. Donors need to commit to scaling-up

[9] Rajiv Gandhi Grameen Vidyutikaran Yojana Rural Electrification Program: *http://www.rggvy.gov.in*.
[10] The 2005 data came from IEA, *World Energy Outlook 2006* (Paris: IEA, 2006).

A health-care center powered by solar PV lighting in Uganda

and making funding more predictable. It is estimated that an increase of funding in the order of US$2–4 billion per year is needed to have a significant impact on the availability of modern energy services in Sub-Saharan Africa.

Renewable energy sources, which lend themselves more readily to decentralized installations than do conventional sources of energy, can play a particularly important role in providing electricity to people who live far away from the urban centers. Moreover, renewable energy sources, such as solar home systems, are often the least-cost source of modern energy. A World Bank technical and economic assessment of possible off-grid, minigrid, and grid electrification technologies compiled in December 2007 confirmed that renewable energy is more economical than conventional energy for small off-grid applications (less than 5 kW). Pico-hydro (very small systems to generate power from moving water), can deliver electricity for US$0.10–0.20/kWh, less than one quarter of the US$0.40–0.60/kWh for gasoline and diesel engine generators of comparable size. Several renewable energy technologies, such as biomass, geothermal, wind, and hydropower, may be the most economical choice for minigrids or grids, assuming that sufficient renewable energy resources are available.[11]

Building on the lessons learnt from experience, the promotion of renewable energy plays an important role in the WBG strategy to provide

[11] ESMAP, *Technical and Economic Assessment of Off-Grid, Mini-Grid and Grid Electrification Technologies* (ESMAP Technical Paper 121/07, Washington, D.C.: World Bank, 2007).

Granary operated using micro-hydro power in Andoya, Tanzania

access to modern energy services in Sub-Saharan Africa. For example, a new guidance note for best-practice, off-grid electrification gives hands-on advice on how off-grid activities are best fostered (see Box 6). Case Five shows the example of an on-going rural electrification project in Mali, where renewable energy is being used through solar PV. Another WBG approach is to catalyze markets for modern off-grid lighting products and services through the "Lighting Africa" initiative, which is market testing the use of high-efficiency LEDS and other products for use in rural Africa.[12]

World Bank support for the provision of modern energy is not limited to electricity. Worldwide, 2.5 billion people still rely on biomass stoves for cooking, mostly on primitive cookstoves, a number expected to rise to nearly 3.0 billion by 2030 if the levels of investments in new, cleaner cookstove technologies, fuels, and cooking methods are not ramped up substantially. Indoor air pollution from biomass and other solid fuel cookstoves is responsible for 1.3 million deaths annually, mostly among small children and women, and is also associated with deforestation from unsustainable biomass energy use.

In Sub-Saharan Africa alone, more than 575 million people—or 75 percent of the population—rely on biomass fuels for daily cooking. With the growing urbanization of countries in Sub-Saharan Africa, fuelwood for cooking is being increasingly replaced by charcoal, a cleaner and more convenient option. The majority of the people in Sub-Saharan Africa—even those supplied with electricity—are highly reliant on biomass for cooking and other household uses. Given the slow progress of electrification and the introduction of other modern

[12] See *http://www.lightingafrica.org.*

Box 6: Off-Grid Electrification Guidance

A significant portion of the population of the developing world lacking access resides in small or dispersed communities often far from national grids. Over the past 15 years, the WBG has supported a number of energy projects aimed at providing electricity to such communities using approaches that are independent of a national or regional grid. To maximize the chances of sustaining operation of off-grid electrification projects over the long term, their design must ensure that all key actors along the "value chain"—consumers, service and technology providers, financiers, and government—benefit. The following basic design principles and sound practices for efficient decision making have emerged out of the experience from these projects:

Government Ownership: To increase the likelihood that project outcomes will be sustainable, off-grid electrification projects must be consistent with a country's rural electrification plans. Off-grid electrification must complement grid expansion. The government's recognition of the role of off-grid options is important; its support, including subsidies, and use of well-designed regulation, is essential. If the government is to have a significant implementation role, the implementing agency should appoint competent and dedicated project management. If financing is necessary, but difficult to obtain, such options as partial guarantees or access to longer-term credit lines should be supported.

Technology Choices: Project design must not be technology driven. A cost-benefit analysis of alternatives (including grid extension) must be carried out to determine the least-cost solution. The final choice must be left up to the service provider.

Delivery Mechanism and Consumer Service: For off-grid projects that rely on private sector participation, the simplest delivery mechanism or business model in line with local realities should be applied. Whatever business model is chosen, care must be taken to ensure that users have access to quality products and services at affordable prices and access to qualified repair service and spare parts over the long term.

Community Awareness: Maximizing the awareness and involvement of the beneficiary community early in the assessment phase is vital to the success of off-grid project implementation.

Productive and Institutional Applications: Applications that improve lives and livelihood opportunities help those who cannot afford individual systems. Such applications increase the economic attractiveness of the total business package for the community.

International Co-financing: Opportunities for international co-financing should be explored, given the need for specialized demand studies, training of service providers, and other vital preparatory activities. The government's commitment to provide needed subsidies when external grant co-financing ends should be obtained to ensure that implementation momentum is not lost.

Source: Energy and Mining Sector Board, *Designing Sustainable Off-Grid Rural Electrification Projects: Principles and Practices* (Discussion Paper, Washington, D.C.: World Bank, November 2008).

energy options, it will take a very long time for modern energy to be ready to substitute for traditional biomass energy uses in urban, peri-urban and rural areas. Therefore, a combination of supply- and demand-side management of biomass energy is expected to have the most immediate and significant impact to improve livelihoods.

Case Six gives an overview of a number of ongoing projects in Sub-Saharan Africa, which promote the use of higher-efficiency stoves and better cooking fuels in Benin, Burkina Faso, Ethiopia, Mali, and Senegal. Case Seven illustrates how biomass supplies can be enhanced, through examples in Benin and Senegal.

Case Five
Solar PV Showing the Light in Rural Mali

In Mali, only about 7 percent of the rural population has access to electricity. Most rural households meet their lighting and small energy needs with wood and charcoal, kerosene, dry cells, and car batteries. Most villages in Mali with a school or health center are without any form of energy for lighting or for operating equipment. To improve living standards and enhance productivity, a spectrum of innovative service delivery mechanisms is needed with the active participation of communities, nongovernmental organizations (NGOs), and the private sector, in partnership with the public sector.

The World Bank–financed Mali Household Energy and Universal Rural Access Project presented to the Board in October, 2003 is the main energy access expansion project in the country. Capitalizing on past experiences, it was designed to increase access of isolated low-income populations to basic energy services and to accelerate the use of modern energies in rural areas in order to increase the productivity of small and medium enterprises, and to enhance the quality and efficiency of health and education centers. Overall IDA financing is US$35.65 million, with a US$3.5 million GEF grant, and US$5.25 million from the Government of Mali. In September 2008, additional financing of US$35 million was approved by the World Bank to further support the project.

Local private operators are the driving force of the project. They benefit from technical assistance from AMADER, the rural energy agency, and from financing through a rural electrification fund set up by the project. Increasingly, renewable energy subprojects are being developed in addition to more conventional energy subprojects. This is facilitated by the use of GEF funds to support the removal of barriers to the use of renewable energy technologies.

Solar PV initiatives are being implemented in remote rural communities far from the main grid. Solar PV initiatives have been implemented in about 40 communities, and about 2,350 solar home systems have been installed. In these regions, about 636 public institutions—such as city halls, administrative offices, and community centers, including 40 schools and 48 health centers—are also powered by solar.

The availability of energy services in rural communities is an important catalyst to the Government of Mali's administrative decentralization initiatives. Beneficiary communities are beginning to be empowered to improve their living conditions as they are becoming more and more connected to the rest of the world. Through the additional World Bank financing to the project and support from other donors, the Government of Mali intends to scale up not only solar PV subprojects, but also the use of other renewable energy technologies (biofuels, wind, and minihydro).

Solar PV initiatives have brought lighting solutions to critical public institutions such as schools in remote areas of rural Mali that are far from the main grid.

Case Six
What's Cooking? Projects in Support of Improved Cookstoves

In order to provide African families with more energy-efficient and less polluting options for cooking, the World Bank has been promoting the dissemination and commercialization of improved biomass (wood and charcoal) stoves as part of many of its energy projects. Ongoing experiences include Benin, Burkina Faso, Ethiopia, Mali, and Senegal.

In **Ethiopia**, the limited availability of modern forms of energy for cooking and the high costs of these relative to both the cost of traditional firewood fuel and to the low average per capita income (US$100) has reinforced the dependence of over 90 percent of the population on traditional biomass energy options. This has led to increasing deforestation and degradation of rural ecosystems, shortages of fuelwood, and continued exposure to indoor air pollution, particularly for women and young children. Without substantial mitigation measures, major fuelwood deficits are likely to accelerate and extend further throughout the country, eventually leading to widespread "energy poverty" with rural users moving to poor quality fuels, such as agricultural residues and dung, directly impacting rural women's health and potentially their workload.

The Energy Access Project in Ethiopia has trained close to 600 private producers of improved biomass cookstoves in Ethiopia. Most of these producers are women and close to 1 million units have been sold to date.

To counter this, the World Bank Energy Access Project supports demand-side energy efficiency management through the promotion of improved efficiency cookstoves, reducing fuelwood consumption while reducing emissions. To date, approximately 580 private stove producers—generally women—have been trained throughout the country, in urban and peri-urban areas, with sales of nearly 1 million units. Customer surveys indicate that the stoves have been well accepted because of their functionality and affordability. The conversion efficiency of the new stoves is about 50 percent higher than the traditional models, and they have significantly reduced indoor air pollution. New enhanced efficiency stove models are being tested and produced, and stove producers are being trained in their production and commercialization by various organizations, to broaden the market base.

In **Senegal**, the Sustainable and Participatory Energy Management Project (PROGEDE) includes several initiatives such as the dissemination of improved biomass stoves by the private sector and NGOs; the establishment of urban and peri-urban "energy boutiques" or energy shops; the provision of support for the continuation of interfuel substitution options, such as the execution of specific technical and market feasibility studies to support the promotion of liquefied petroleum gas (LPG) and kerosene as substitute cooking fuels; and the support for several research and pilot testing initiatives on renewable household cooking fuels, such as rice husks briquettes, liquid and gelfuel ethanol, jatropha oil, and solar cookers.

In contrast with some past failures, PROGEDE sought to support the establishment of viable stove production systems through the following:

- The training of new stove producers to increase in-country stove production capacity.
- Consumer awareness and marketing support to help stove dissemination.
- A sustainable financial intermediation system (stove producers revolving fund), which should enable certified new stove producers to set up production facilities and operate until they are able to capitalize themselves and qualify for regular banking loans.

To date the stove program has directly benefited 250,000 families in the principal urban and peri-urban areas of the country, allowing access to affordable, cleaner, improved charcoal stoves, and about 4,000 families with kerosene stoves. This is about 30 percent of the urban and peri-urban families of the country.

In **Mali**, the Household Energy and Universal Access project has disseminated more than 420,000 improved charcoal and wood stoves through small local enterprises and NGOs. The approach has focused on training these partners in the manufacture of cleaner cooking technologies and their sale through energy boutiques. The work being done in Mali also includes encouraging the private sector in the production and distribution of alternative cleaner fuels, such as LPG and kerosene, although these have not received an enthusiastic response from users because of their higher costs.

In **Burkina Faso**, the household energy demand component of the Energy Access Project is financing the establishment of private sector and NGO-based local production facilities for the production of improved stoves, as well as commercial distribution channels and marketing systems capable of selling about 250,000 improved stoves within five years.

In **Madagascar**, biomass stoves with an "eco" or "environment" label are sold by locally trained stove producers and are being used by at least 250,000 households, while in **Benin**, the Energy Service Delivery project aims to disseminate through the private sector and NGOs 3,000 improved fuelwood stoves and 1,000 LPG stoves.

Fruit and vegetable production for alternate income generation for rural women is being promoted through the PROGEDE program in Senegal

Case Seven

Power to the People—Community Forestry for Sustainable Energy in Senegal and Benin

Sustainable management of the natural forests for the production of fuelwood has traditionally been neglected in Sub-Saharan Africa because of unrealistic expectations from government authorities about users' rights, and because of taxation and forestry methods. In general, control by governments of the ownership of the forest resources,leaves the local rural communities without any benefit, although harvest rights are assigned to urban based traders of fuelwood and charcoal. Furthermore, the governments' revenues are not reinvested in sustainable management of these forest resources, which leads to the deforestation of thousands of hectares per year. Considering that in most countries in Sub-Saharan Africa, biomass-based energy is the main energy source, such biomass energy policies jeopardize the future supply of this important energy source, while neglecting the contribution that a sustainable supply could make on poverty alleviation at the rural communities surrounding these forest areas.

To reverse this perverse biomass energy policy, the World Bank has been promoting a new biomass energy policy approach that attempts to correct the economical injustices to the local rural communities and induces sustainable management of the natural forests, in which most of the energy needs for those countries are extracted from. This approach is called Village-Based Natural Resources Management (VBNRM).

VBNRM has found application in many countries in Sub-Saharan Africa through different projects, such as the Sustainable Energy Management Project in Burkina Faso; the Energy Sector Project in Madagascar; and the Household Energy Projects in Chad, Mali, and Niger; the Sustainable and Participatory Energy Management Project in Senegal; and the Energy Service Delivery Project in Benin. Here, the cases of Benin and Senegal are highlighted.

In **Senegal**, the World Bank–funded Sustainable and Participatory Energy Management Project (PROGEDE) has, since 1998, been organizing and promoting the sustainable management of more than 675,000 hectares of forests in the Tambacounda and Kolda regions, which is one of the most important sources of commercial wood energy in Senegal. First of all, PROGEDE has induced substantial policy changes, including transferring harvest rights for fuelwood to more than 345 rural villages surrounding the energy forests, and transformed the forest service from being a "paramilitary law enforcer agency" with extremely limited transparency and accountability to a technical assistance and rural capacity development agency, with a now recognized participatory vocation and significantly improved governance. Furthermore, the forest service has institutionalized a dual taxation system for charcoal production, penalizing charcoal produced in areas without proof of sustainable management. The forest service also were provided with a powerful tool to monitor and evaluate forest interventions, state-of-the-art forestry, and vegetation cover maps in Geographic Information System (GIS) formats.

The new approach also trained local entrepreneurs in more efficient charcoal production, so that the rural people would also sell their wood energy transformed into high-value energy products, such as charcoal to the urban traders, adding more value to the local economy.

PROGEDE's interventions have benefited nearly 250,000 people (21 percent of the population of Tambacounda and Kolda regions) with an additional gross income of US$18.0 million per year (2007 data),

while preventing the deforestation of nearly 40,000 hectares per year and contributing to a net reduction of 1.8 million tons per year of CO_2 emissions from previously unsustainable charcoal production.

In **Benin**, the World Bank recently launched the Energy Service Delivery Project, with a similar approach of that of Senegal with the aim of putting 300,000 hectares of natural forests under sustainable management. This would supply the biomass energy market with 675,000 tons of fuelwood per year (equivalent to 135,000 tons of charcoal). The outcome of this initiative should alleviate poverty in 180 rural villages, benefiting 400,000 people.

Given that charcoal is the most important final product from these regions forests, the project is in the process of introducing a higher-efficiency charcoal kiln than the traditional one used, by training 300 rural workers in the production of commercial charcoal through a more efficient "*meule Casamance*" or "Casamance kiln", and supporting the establishment of a minimum of 50 village-based charcoal producer groups.

(left to right) Jatropha cultivation by project beneficiaries at the village level. Bags of charcoal ready for market.

Supporting Innovations in Renewable Energy and Energy Efficiency Technology

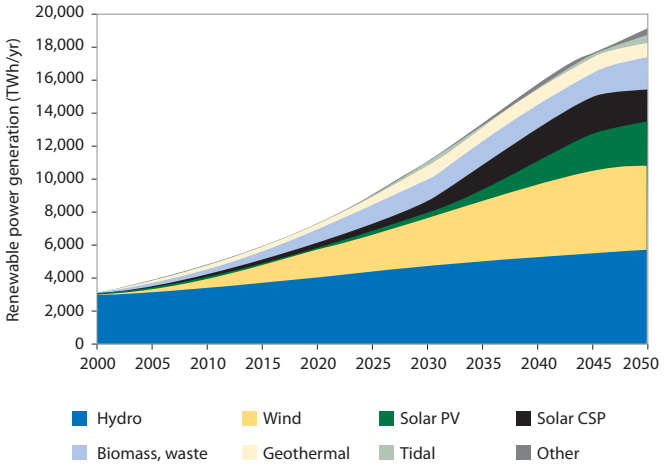
The Need for Enhanced Research Development and Deployment for Renewable Energy and Energy Efficiency

The rapid growth of renewable energy and energy efficiency allows them to make increasingly important contributions to meeting national and global energy goals. Renewable energy is the fastest growing source of energy supply worldwide. Renewable capacity (excluding large hydro) grew 32 percent from 2005 to 2007, with annual investment in new renewable energy capacity reaching US$71 billion in 2007[13]. The largest component of renewable energy generation, wind power, had a 28 percent increase in global capacity from 2006 to 2007. Solar PV had 50 percent annual increases in cumulative installed capacity in both 2006 and 2007. Energy efficiency is also playing an increasingly large role in national and international energy sectors.

Despite the very high rates of annual percentage growth, renewables remain a modest share of total global energy production. In 2006, new renewables provided 2.4 percent of global final energy consumption and 3.4 percent of the global electricity consumption. However, both renewable energy and energy efficiency have the potential to become major players in the energy sector, matching and then surpassing the contributions from fossil fuel technologies. For example, the IEA has projected a number of scenarios for achieving a sustainable energy future. In one such scenario, where global CO_2 emissions are reduced 50 percent from today's levels, renewable energy contributes 21 percent of total emissions reductions and end-use efficiency contributes 36 percent. The size of this combined contribution (57 percent of total emissions reduction) shows that renewable energy and energy efficiency will be absolutely essential in a sustainable energy future. Figure 8 shows the potential for expansion of renewable energy for power generation.

The scale of both the incremental energy demand in the coming years and the needed massive emission reduction will require more advanced renewable energy and energy efficiency technologies. These new, improved technologies must have more operating history, the ability to be scaled up and integrated into energy systems, and lower costs than today's technology options.

Figure 8: Growth Potential for Renewable Power Generation, 2000–50



Source: IEA, *Energy Technology Perspectives 2008* (Paris: IEA, 2008).

[13] REN 21, *Renewables 2007 Global Status Report* (Paris: REN21 Secretariat and Washington , DC: Worldwatch Institute, 2008)

A major concerted effort in research, development, and deployment (RD&D) will be needed to commercialize a new generation of renewable energy and energy efficiency technologies. A consensus is forming that the world requires a paradigm shift in the way energy is produced, transformed, and consumed. This will require new technology options that in turn will require greatly expanded global RD&D efforts in the public and the private sectors. All of the potential cited by the IEA and others *assumes an accelerated pace of commercialization*, without which these cleaner technologies will not be deployed in the scale or the time required for effective climate change mitigation. Figure 9 shows projected supply cost reductions that can be realized with RD&D efforts, for major power technologies over the next 20 years (until 2030), as estimated by the IEA.

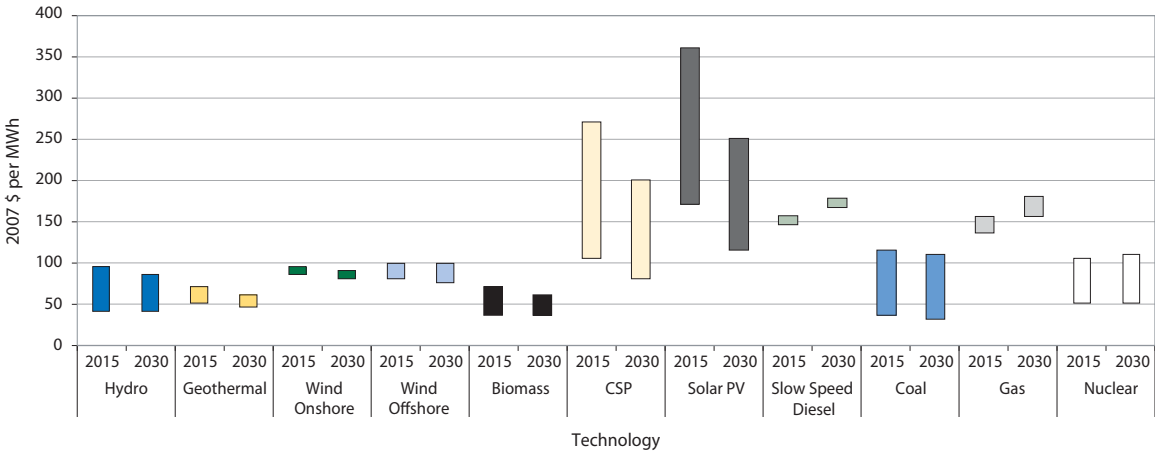
Importance of Renewable Energy and Energy Efficiency Technology Improvements for Developing Countries

Advanced renewable energy and energy efficiency technologies with lower costs and higher operational reliability will play an important role in developing country energy sectors and overall economic development. Developing countries will add an immense amount of energy infrastructure in the coming decade. As developing countries grow, their energy demand increases and an enormous amount of energy supply, transmission and consumption infrastructure must be put in place. Between 2006 and 2030, developing countries will require US$7.9 trillion of investment for the power sector alone, increasing their electricity infrastructure by an amount equal to 120 percent of current installed capacity of all OECD countries combined.[14] Developing countries will add nearly two times the amount of power infrastructure that OECD countries will add.

Improvements in renewable energy and energy efficiency technologies from the current state of the art will greatly increase their deployment, allowing them to better meet the coming energy infrastructure boom. Existing renewable energy and energy efficiency technologies can and should be deployed to the greatest extent possible and thus confer their many benefits

[14] IEA, *World Energy Outlook 2008*, (Paris: IEA, 2008).

Figure 9: Grid Power Supply Cost Trends over the Next 20 Years



Source: Compiled from tables in IEA, *World Energy Outlook 2008* (Paris: IEA, 2008). World Bank staff estimate for slow speed diesel based on IEA crude oil price forecast.

in the short to medium term. Improvements in cost and performance of these technologies will inevitably lead to their meeting a greater share of the coming energy infrastructure boom in developing countries.

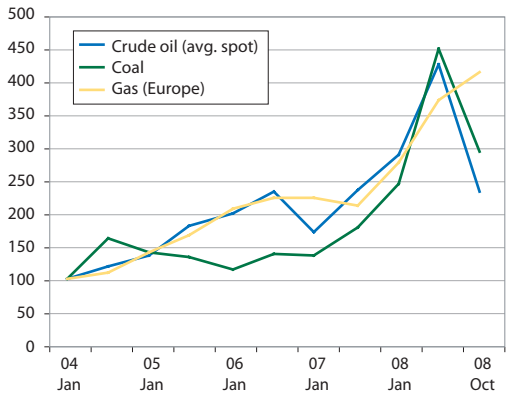
Widespread deployment of renewable energy and energy efficiency technologies will allow developing countries to meet their key energy objectives. The model of energy supply and consumption used by the OECD economies throughout the 20th century has been remarkably successful in promoting economic growth. This model was (a) designed with centralized production and generation, (b) based on fossil fuel use, (c) supply-side driven, and had little or no concern for emissions. However, this paradigm may not be optimal for developing countries going forward, because of concerns about CO_2 emissions, volatile fossil fuel prices, and the particular conditions in developing countries (for example, off-grid demand). Widespread embrace and deployment of these technologies would allow developing countries to meet their energy objectives better with the following results:

- Energy supply security through supply diversity and demand response (see Box 7 for importance of supply diversity).
- Low-carbon growth.
- Expanded energy access.

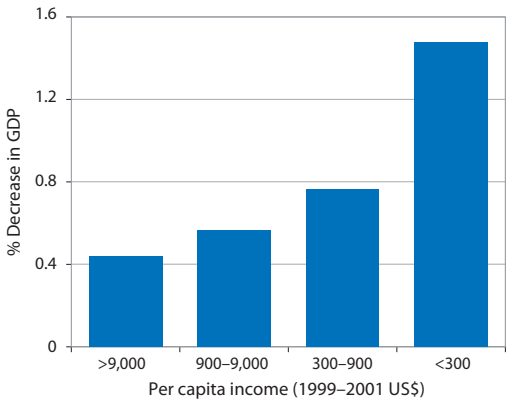
Box 7: Advanced Energy Technologies Reduce the Economic Vulnerability of Poorer Countries to Fossil Fuel Prices

Advanced energy technologies can increase diversity of supply beyond reliance on fossil fuels. Dependence on fossil fuels leaves countries at the mercy of fuel price fluctuations, which disproportionately harms the poorest countries. Increasing the share of clean energy technologies will provide an important co-benefit to protect poor countries from volatile fuel markets. The figures below show recent fuel price trends and the harm that price increases of one fuel (oil) can have.

Global Major Energy Price Index (Base = Jan. 2004)



% Decrease in GDP Due to a $10/BBL Oil Price Increase



Source: WBG data.

Developing countries participating in the development and manufacture of new advanced energy technologies can also realize economic growth and job creation.

Barriers to Renewable Energy and Energy Efficiency Innovation for Developing Countries

Many market failures and other barriers can deter the needed RD&D and innovation for renewable energy and energy efficiency technologies, particularly in developing countries. Development of new and advanced technologies is an inherently risky process for any industry with numerous market failures that deter timely and effective commercialization of new products. However, clean energy technologies (including renewable energy and energy efficiency) face additional barriers specific to the sector that make it particularly difficult to produce innovation.[15] These include:

- *The uncertain future value of GHG emissions abatement.* The absence of a reliable, long-term CO_2 price decreases clean energy RD&D.
- *The "valley of death",* where new technologies languish between public and private sector RD&D efforts.
- *Centralization of energy sector.* Energy is traditionally run by major players who enjoy dominant positions using conventional technologies and have little incentive for change.
- *Management short-termism.* Managers will support programs most likely to produce technical advances within a timeframe that benefits their careers and departments.
- *The energy sector's low share of turnover to RD&D (that is, R&D intensity).* By some accounts, this is equal to 0.15 percent of turnover, compared to an average for all sectors of just above 2 percent.

However, *additional* barriers make development and transfer for developing countries especially challenging. Some of these, listed below, relate directly to renewable energy and energy efficiency technologies, while others are more general:

- *Public energy R&D funding*. Government funding for energy R&D is substantially lower in developing countries than in OECD countries. The combined spending of the "Plus Five" countries in 2006 was just 13 percent of the OECD countries with the largest such budgets.[16]
- *Fewer support schemes for Renewable Energy and Energy Efficiency technologies.* Many OECD countries have schemes to support existing Renewable Energy and Energy Efficiency technologies (such as feed-in tariffs) while developing countries tend not to have such support schemes in place.
- *Subsidies for conventional energy products.* Many developing countries have subsidies supporting conventional, more polluting energy products.
- *Intellectual property rights.* Many companies are concerned about protecting the intellectual property rights of their newer technologies in many developing counties.
- *Support networks.* To service them, new energy technologies require operations and maintenance (O&M) networks, which are less mature in developing countries.
- *Access to financing*. Venture capital, on which entrepreneurs who would develop renewable energy and energy efficiency rely, is much more predominant in OECD countries than in developing countries.

[15] For a discussion of these barriers, see Patrick Avato and Jonathan Coony, *Accelerating Clean Energy Technology Research, Development, and Deployment. Lessons from Non-Energy Sectors* (World Bank Working Paper No. 138, Washington, D.C.: World Bank, 2008).

[16] This comparison is based on market foreign currency exchange rates. Using purchasing power parity, the combined budgets of the "Plus Five" countries (Brazil, China, India, Mexico and South Africa) are 28 percent of their OECD counterparts (Canada, France, Germany, Japan, and the United States).

- *Technical capacity.* The base of technical capacity among individuals and firms in developing countries has yet to match that in OECD countries.
- *Market entry.* OECD companies—still the source of much renewable energy and energy efficiency innovation—can be reluctant to enter developing country markets.
- *Consumer base.* OECD country consumers are wealthier, with more demonstrated willingness to pay price premiums for "green" products.

Current and Planned WBG Support for Innovation in Renewable Energy and Energy Efficiency

A variety of WBG projects have supported needed innovation in the renewable energy and energy efficiency sector by addressing some of the aforementioned market failures and other barriers to commercialization. These projects have addressed different aspects of the innovation chain and different barriers to each. In every case, the project was able to substantially advance an innovative technology or concept at a time when both the private sector and governments were not in a position to do so.

Productive industry flourishing under Imaoyathenna micro-hydro mini-grid of Sri Lanka RERED project

The strategies employed by the WBG differ for "newer" technologies that have scarce cost and operating history and whose resulting risk profile make them inappropriate for conventional investment vehicles. A phased approach is being adopted and donor funds are more critical. However, greater buy-in and active participation on the part of investment departments is sought, and a more robust supervision and monitoring and evaluation (M&E) framework is evolving. There is also an emphasis on follow-on projects, possibly through IFC investments, and a lowering of the concessional or grant element. A view is taken that early WBG intervention (often with donor funds) is taking initial steps to commercialize these technologies. Thereafter, either at a more mature stage of the project, or in a follow-on project, WBG investments would work alongside those of the donor and private sector sponsor.

The specific hurdles and maturity of each technology will dictate how early the WBG investment can be made. The strategy is to support not pure research projects, but rather those technologies languishing between research and full commercial viability. The role of donor funds, such as the GEF, is critical to putting together a private sector partnership. The WBG can play the role of an honest broker,

and lead the charge in structuring and bringing together different market participants with different appetites for risk.

Innovation in support of renewable energy and energy efficiency technologies must also include new ways of looking at government policies and regulations that play a key role in whether and how different technologies enter the market. Most policies and regulations were developed in an energy paradigm dominated by large, centralized projects driven by fossil fuel. Supply-side considerations drove policy development, often at the expense of proper consideration of attractive demand-side options. The WBG works with governments to develop policies that create a "level playing field" for renewable energy and energy efficiency technologies. Such policies require creative thinking and innovative approaches to policies and regulations to get beyond conventional policy frameworks.

Highlights of innovative projects include the China Renewable Energy Development Project (REDP) (Box 8), and those featured in Case Eight, Structuring Private Sector Advanced Technology Initiatives, and Case Nine, Improving Tools for Planning Power Systems in an Increasingly Volatile Economic Environment. Going forward, the WBG is envisioning a more comprehensive approach to accelerating technology commercialization. The WBG recognizes the need for improved and more cost-competitive renewable energy and energy efficiency technologies for client countries, as well as the barriers to developing such technologies. As such, it is enhancing and expanding the scope of its efforts in this area, focusing on leveraging the relative strengths of the World Bank in policy and regulatory advice with IFC's experience with structuring private sector incentives to mitigate market barriers to the development of new technologies for developing countries and to technology transfer.

The WBG is currently investigating ways in which it can develop its activities to expand innovation for renewable energy and energy efficiency technologies. Through these activities, the WBG recognizes the important role of the private sector in driving technical innovation, but it also understands and seeks to mitigate the many barriers that deter the commercialization process. The new activities would build on successful WBG technology innovation projects in the past (such as the ones described here), as well as successful models of technical innovation drawn from other sectors, such as agriculture and computer software.

In line with this approach, a study is being conducted in India to address the need for augmenting electricity generation and ensuring better quality of supply in rural areas through distributed generation (DG) and supply of power under a public-private partnership (PPP) model. The study is examining the interest of all the stakeholders to identify the scope for developing viable business models where interested renewable energy generation companies and potential electricity distribution franchisees may take up rural service delivery with suitable subsidy support (if needed) from the utility, state government, or central government. The various barriers and ways to address them are being investigated and recommendations for the necessary policy, regulatory, subsidy delivery and institutional arrangements will be provided as outputs of the study.

Box 8: Technology Improvement Support to Boost Innovation in Photovoltaics in China—Helping Technologies Bridge the "Valley of Death"

The World Bank- and GEF-assisted China Renewable Energy Development Project (REDP) employs an innovative approach to technical innovation for PV technology. The approach has catalyzed small and medium enterprise investments in PV development, led to significant improvements in quality, and helped reduce PV costs.

The Technology Improvement component of the REDP offers Chinese PV companies assistance in research, development, demonstration, and innovation through a Competitive Grant (CG) Facility, a Quick Response (QR) Facility, and Technology Improvement Program Support. The CG and QR Facilities enable enterprises to submit proposals for research and development of PV components and systems. Competitively selected proposals can receive a grant to cost share up to 50 percent of the total project cost.

Under the CG Facility, annual tender rounds are organized with proposals evaluated and ranked. Bidding companies can provide cost-sharing in the form of staff labor cost, consultants, travel, testing, certification, training, materials, software, and R&D equipment. Four CG Facility rounds of bidding have been conducted (2002–05) with 144 CG Facility projects contracted valued at US$10.2 million for which a total CG Facility grant of US$2.85 million was provided. Fifty-seven QR Facility projects were contracted between 2002 and 2006 with a total value of US$1.39 million for which a total QG Facility grant of US$460,000 was provided.

Many supported projects have directly introduced high-quality and innovative PV products into the Chinese and international markets. Surveys have found that these two facilities contributed directly to the improvement of the quality and reduction of cost of PV components and systems.

Beneficiaries of the REDP Project in Gansu province, China

Case Eight
Structuring for Private Sector Advanced Technology Initiatives

The International Finance Corporation (IFC), the private sector arm of the WBG, has nearly a decade of experience with the promotion of new technologies using donor funds. Early initiatives used donor funds for technology demonstrations that had minimal participation from IFC's own investment departments. More recently, IFC has successfully sought to "mainstream" GHG reduction projects by combining IFC investment with donor funds.

The following sections describe three initiatives where funds were used to promote advanced green power generation technologies, and where a wide gamut of risks has been addressed. While all three projects are funded under the same operational program of GEF that promotes new low GHG energy technologies that are not yet cost-effective (Operational Program 7, OP7), the development cycle, risks, scale, and structuring of each technology project are tailored to suit each unique set of circumstances.

1. CEPALCO Grid Connected Photovoltaic Project in the Philippines where a 1 MW greenfield PV facility was constructed to demonstrate conjunctive use of PV and hydro plants within a grid. This project, constructed by Sumitomo Corporation, with equipment supplied by Sharp, was inaugurated by President Arroyo and has been in operation since December 2004. It has been instrumental in raising the profile of the sponsor company, CEPALCO, and the application of PV in the context of the developing world. It has also been a significant feature in encouraging IFC to undertake upstream investments in the PV manufacturing sector through investments in companies, such as Moser Baer (see Case Two in Chapter 1).

2. Fuel Cell Financing Initiative for Distributed Stationary Power Applications in South Africa (FCFI), uses a US$3 million cost buy-down subsidy to promote early market entry experience with the technology. Fuel cells offer high-quality, modular power and include a range of technologies with differing combined heat and power efficiencies that can go as high as 90 percent. FCFI in South Africa focuses on 5 kW Proton Exchange Membrane (PEM) fuel cells in backup (and later baseload) applications. The cost buy-down element is ratcheted down, thus forcing the company toward a lower-cost trajectory as more units are deployed. The PEM cells are manufactured by Plug Power, a U.S. company, and deployed by IST, a South African company that procures, sells, deploys, and services fuel cells. More than 40 such fuel cells have now been deployed under the initiative, and the company is seeking to expand manufacturing to low-cost centers. Besides Plug-IST, FCFI has also completed detailed due diligence of two other companies, and is seeking new proposals for two additional grants. The initiative, which is currently in its fourth year, has played an important role in understanding the fuel cell market, its range, and the technical and commercial risks associated with it.

GenCore Fuel Cell installation at the Vodacom Skinner Street site inSouth Africa

3. Externally Fired Combined Cycle Technology in Brazil (EFCC) represents a true scaling-up of a disruptive cogeneration technology that promises to increase power production from a given amount of bagasse by over 70 percent. The project is an ambitious US$187 million project financing of a "first-of-its-kind" 100 MW power plant, to be assisted by US$44 million of GEF funding in two tranches. The project sponsor is a well established Brazilian power company with more than 1,000 MW of generation capacity, and the "new technology components" have been developed by a U.S. firm. The structuring of project risks and the testing of technical design elements are to be funded under Tranche I, co-financed 50–50 by the project sponsor. Tranche II will provide the bulk of the funds, structured in order to provide appropriate comfort on the technical and commercial risks in order to attain financial close. This project has been in the structuring phase since 2005, when the GEF Council approved the project. Implementation activities are expected to commence in 2009, with Tranche II submission in 2010. If successful, this technology will have huge potential within Brazil, and will be able to be replicated in other sugarcane-producing countries, such as India, Jamaica, and Peru. In Brazil alone, EFCC has the potential to add more than 2,600 MW of new generation to the grid.

1 MW solar PV panels at CEPALCO in the Philippines

Case Nine

Improving Tools for Planning Power Systems in an Increasingly Volatile Economic Environment

The volatile and generally rising fuel prices during recent years have demonstrated the economic vulnerability of countries whose electricity supply costs depend on conventional thermal power generation. In contrast, countries that have power supplies largely based on the fixed costs of "free-fuel" renewable power generation technologies, such as hydro, wind, or geothermal power, have a more stable cost environment for electricity. Regardless of whether power generation is centrally planned or investment in new generating capacity is market based, the choice of generation portfolio (technology) and the choice of contract structure for power purchasing (fixed price– versus fuel cost–based) have important consequences for the parties that ultimately bear fuel price costs and risks.

This is analogous to the situation in financial markets: Investors who primarily hold high-yielding securities are usually facing much greater volatility in returns than those who have primarily invested in lower-yielding, fixed-income securities. Sophisticated and prudent financial investors, such as pension funds, will diversify their financial portfolio in order to maximize their return at an acceptable level of risk.

World Bank client countries conventionally plan their choice of future power generation plant using computer-based power systems planning models such as WASP (Wien Automatic System Planning Package). WASP calculates the least-cost expansion path for generation capacity, which also meets electricity demand. Uncertain aspects, such as future fuel prices, have to be dealt with, for example, by rerunning the model using different price forecasts.

A basic shortcoming of this type of least cost–based power planning is that in its basic form it is essentially the mirror image of an investor who only looks at the expected yield of a financial investment, disregarding the volatility and risk associated with the yields of various assets. In the case of free-fuel renewables, virtually all future costs of electricity may be known with certainty once the plant is built and financed (the electricity can be traded on a largely fixed-price contract). On the other hand, electricity from conventional thermal technologies may have two-thirds or more of its cost determined by volatile and uncertain

Run-of-river hydropower, Andoya, Tanzania

future fuel prices. Some of the risks related to future electricity costs, such as prices of different grades of fuel, tend to be highly correlated over time.

A simple "expected least-cost" analysis will consequently neither reveal nor quantify the higher costs and risks inherent in owning a fossil fuel–dominated power supply portfolio (either in the form of owning thermal power plant or fuel cost–based power purchasing agreements) versus owning a free-fuel, power-dominated portfolio (for example, a wind or hydro plant with fixed price–based power purchasing agreements). Current analysis of power systems planning in most countries does not treat this issue quantitatively, with a few exceptions, such as a recent major World Bank study on Mexico.[1]

ESMAP is in the process of developing an improved standard modeling framework and an accompanying methodology to deal with the issue of adequately accounting for risk in power systems planning. The model is based on modern financial portfolio theory, and its output will be compatible with the WASP framework. In conjunction with the model, the modeling team will develop a historical database of regional fuel prices to allow for simplified calculation procedures and to estimate historical fuel price volatility. In addition to model and database development, the work will involve testing the model on two client countries, a workshop with power systems planners and task managers, presentation seminars, and an outline for a training program for users of this cost and risk modeling tool.

The first phase of this project deals with modeling fuel price risk, but the modeling framework will have flexibility for future upgrading to deal with other types of risks, for example, in relation to the construction phase and in relation to the non-dispatchability of free-fuel renewables, such as run-of- river hydro- and wind power.

The model will be applicable to power systems planning in general, and it is expected that the methodology will have a substantial impact on the valuation of free-fuel renewables, such as hydro, wind, and geothermal power. The concept will likewise be applicable to quantitative assessment of the tradeoff between risk and cost in implementing various types of electrical energy efficiency.

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[1] Antonius Andrés, Shimon Awerbuch, Martin Berger, Donald Hertzmark, Jorge M. Huacuz, and Gustavo Merino, *Mexico: Technical Assistance for Long-Term Program of Renewable Energy Development*, ESMAP Technical Paper 093/06 (Washington, D.C.: World Bank, 2006). ESMAP held a seminar on this issue in June 2006, the proceedings of which have recently been published in the ESMAP publication Risk Assessment Methods for Power Utility Planning: http://esmap.org/filez/pubs/4252007115319_Risk_Assessment_Method.pdf.

Renewable Energy and Energy Efficiency Portfolio Review

In fiscal 2008, the WBG committed US$2.7 billion to the promotion of renewable energy and energy efficiency in developing countries.[17] This corresponds to an increase of 87 percent from the previous year and underlines the WBG's role as one of the largest financiers of sustainable energy in the world. Through piloting new approaches, overcoming market barriers, and providing technical assistance, the WBG has been able to act as a catalyst for the development of renewable energy and energy efficiency in client countries and thereby leverage large additional investments by both public and private sectors.

Financial Commitments

Volatile fossil fuel prices and energy security concerns, along with environmental considerations, have further increased the attractiveness of clean energy solutions and validated the increased focus on renewable energy and energy efficiency of the WBG in recent years. This is reflected in the increased demand for renewable energy and energy efficiency by our client countries. In fiscal 2008 the WBG supported 95 renewable energy and energy efficiency projects in 54 countries with a total commitment of US$2.7 billion.[18] This represents an 87 percent scale-up in commitments from fiscal 2007. The WBG support can be broken down into US$476 million for new renewables, US$1 billion for hydropower greater than 10 MW, and US$1.2 billion for energy efficiency (Table 3).

Thus, with combined commitments of US$1.7 billion for new renewable energy and energy efficiency, **the WBG outperformed its Bonn Commitment by a wide margin, as in previous years**. Cumulatively, between fiscal 2005 and fiscal 2008, the WBG has exceeded its Bonn Commitment target almost threefold—committing US$3.7 billion against the cumulative target of US$1.3 billion over the same timeframe (Table 4).

Since 1990, the WBG has committed about US$14.5 billion toward renewable energy and energy efficiency (see Figure 10). Of this amount, US$4.4 billion was for energy efficiency and US$3.8 billion was for new renewable energy. Another US$6.2 billion went to hydropower projects with capacities greater than 10 MW per facility. During the same period, the share of total WBG energy lending devoted to renewable energy and energy efficiency has been steadily increasing. The average share of renewable energy and energy efficiency of total energy commitments has more than doubled since 1990–94 to 31 percent in fiscal 2005–08 and

[17] The World Bank Group periodically reviews projects from previous fiscal years to ensure that our projects conform to the definitions of energy efficiency and renewable energy used by the World Bank Group, available in Annex 1. This review revealed that World Bank Group commitments towards energy efficiency and renewable energy were underreported in FY2004, FY2005 and FY2006, and the associated Progress Reports for those years. Additionally, pumped storage projects are no longer considered large hydro projects; this definitional change means the Group overreported its FY2003 large hydro commitment amount in earlier Progress Reports. Tables in this edition of the report correctly convey these changes and supersede any prior reporting. A complete list of projects affected by the review is available on request.

[18] Details of these projects are provided in Annexes 1, 2, and 3.

Table 3: WBG Commitments for Renewable Energy and Energy Efficiency, Fiscal 2008

	Commitments in fiscal 2008 (millions of US$)			
Source of funds	*New RE*	*Hydro > 10 MW*	*EE*	*Total*
World Bank	272	625	719	1,616
IBRD/IDA	117	601	624	1,343
GEF	90	—	55	145
Carbon Finance	65	24	40	128
IFC	115	361	473	949
Own Funds	72	361	473	906
Carbon Finance	39	—	—	39
GEF	4	—	—	4
MIGA	88	21	—	110
Total	476	1,007	1,192	2,675

Note: Some columns may not add up exactly because of rounding.
Source: WBG data.

reached 35 percent in fiscal 2008 (Figure 11).[19] It should be noted that, in addition to renewable energy and energy efficiency, total WBG energy commitments include not only thermal power generation, as well as oil, gas, and coal production and transport, but also transmission and distribution projects and development policy loans. The latter two project categories are an integral part of the WBG energy practice and highly complementary to investments in renewable energy and energy efficiency investments. Leaving out these essential and technology neutral energy categories, renewable energy and energy efficiency actually represent 57 percent of energy commitments in fiscal 2008.

Clean energy has experienced substantial increases in commitments in recent years across the board. As in recent years, commitments for large hydropower projects have been prominent, reflecting the still vastly underexploited hydropower resources that offer large potential as a low-carbon solution to increasing energy access in many countries. The WBG has renewed its efforts to help countries benefit from this resource while at the same time continuing to maintain and refine its stringent and comprehensive environmental and social safeguard policies. The Rampur Hydropower project in India by the IBRD and the Enerjisa project in Turkey by IFC

[19] IBRD-IDA energy sector investments include oil, gas, and coal (including coal mine closing or rehabilitation; transmission and distribution of oil, gas, and electricity; power generation and associated environmental controls and plant rehabilitation; district heating and plant rehabilitation; renewable energy; and energy efficiency and conservation). IFC investments in the energy sector include investments from IFC's own account; MIGA investments refer to gross liability exposure. IFC and MIGA investments in the energy sector consist of investments in the power sector, oil, gas, and coal mining, as well as electricity and gas services. Previous IFC assessments referenced only "stand-alone" projects whose sole focus was energy efficiency or renewable energy, thus missing the full scope of investment in sustainable energy undertaken as a component of larger investments in various sectors. Subsequently, IFC has identified additional renewable energy and energy efficiency investments in commitments IFC had made in other sectors, such as agriculture, water supply, and industry, and in corporate loans to financial intermediaries. For more details, see *Choices Matter: 2005 Sustainability Report* at *www.ifc.org/SustainabilityReport*.

Table 4: Measuring Progress in New Renewable Energy and Energy Efficiency Lending against the Bonn Commitment
(*millions of U.S. dollars*)

	FY02	*FY03*	*FY04*	*Average*	*FY05*	*FY06*	*FY07*	*FY08*	*FY05–08*
Actual	204	178	245	**209***	490	928	683	1,668	3,769
Bonn Commitment Target					251	301	361	434	1,347

*The baseline of US$209 million was set as the average annual lending commitment for new renewable energy and energy efficiency made by the IBRD and IDA, CFB-IBRD, and the GEF (IBRD and IDA) in FY02, FY03, and FY04. This baseline methodology was selected to allow a meaningful interpretation of investment trends that would balance the lumpy nature of investments in the energy sector. It comprises exclusively new renewable energy and energy efficiency.

Source: WBG data.

accounted for the majority of large hydropower commitments in fiscal 2008.

Energy efficiency has been the category marking the single largest increase in funding on a year-to-year basis. In fact, rising energy prices, acute power crises in a number of client countries, and climate change concerns, have increased demand for energy efficiency programs. The WBG responded to these demands through a considerable scale-up in its efforts, leading to a quadrupling of its energy efficiency investments—covering both supply and demand side—to almost US$1.2 billion in the last fiscal year. The largest project this year was the IBRD's China Energy Efficiency Financing project. In addition to investments, the World Bank has made significant strides in helping client countries in areas ranging from institutional development to the formulation of policy reforms and regulations, such as rationalization of tariffs and preparation of building energy conservation codes, which have helped create enabling environment for the private sector to ramp up energy efficiency investments.

From an organizational perspective, the IBRD and IDA provided the largest funding for renewable energy and energy efficiency of all the WBG institutions with US$1.3 billion of combined commitments. These commitments focused on energy efficiency and large hydro-

Figure 10: WBG Renewable Energy and Energy Efficiency Commitments, Fiscal 1990–08

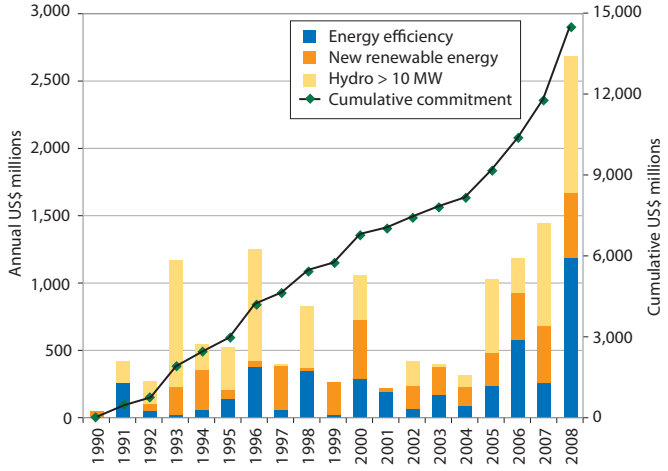
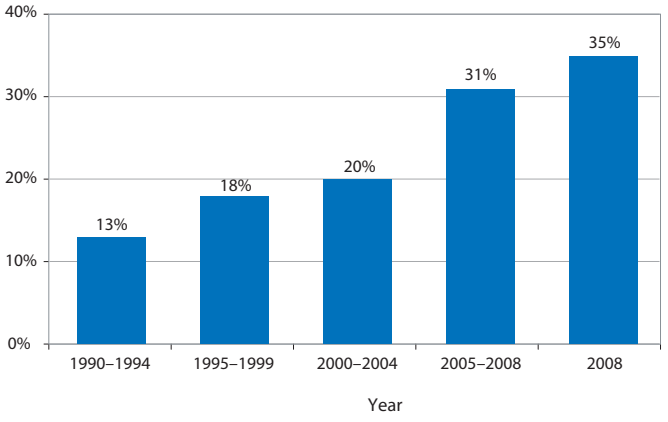


Figure 11: Share of Renewable Energy and Energy Efficiency Relative to the WBG's Total Energy Commitment



Source: WBG data.

power projects, which received US$621 million and US$601 million, respectively, followed by US$109 million for new renewable energy. In addition, the GEF has been an important partner by contributing US$145 million in co-financing for World Bank projects. IFC committed a total of US$949 million, with US$115 million going to new renewable energy, US$473 million to energy efficiency, and US$361 million to large hydropower projects. IFC's largest growth was in clean energy financing projects (Box 9). World Bank Carbon Finance activities contributed an additional US$128 million and MIGA contributed US$110 million.

East Asia and the Pacific received the largest share of total renewable energy and energy efficiency commitments in fiscal 2008, accounting for US$783 million or 29 percent of total commitments (Figure 12). These commitments are largely dominated by energy efficiency projects (84 percent), followed by large hydropower projects (13 percent). Sub-Saharan Africa received US$447 million in renewable energy and energy efficiency commitments for 22 projects, which accounted for 17 percent of total renewable energy and energy efficiency commitments. The majority of these commitments were devoted to new renewable energy projects, reflecting their great potential in off- and mini-grid applications. Europe and Central Asia accounted for 24 percent of the total number of projects with renewable energy and energy efficiency components. In South Asia, most of the commitments were in hydropower, which accounted for 84 percent of the total new renewable energy and energy efficiency commitments in the region. In Latin America and the Caribbean, there were similar shares of renewable energy and energy efficiency commitments, while in the Middle East and North Africa region, WBG activities were focused mainly on new renewable energy—most prominently solar thermal power generation. For further breakdowns of commitments and project numbers by region and sector, see Table 5 and Figures 12, 13, and 14.

A total of 34 projects with new renewable energy projects or components of projects were approved in fiscal 2008. For example, solar thermal power generation received two large commitments from GEF in Egypt and Morocco, with a combined value of US$55 million. The World Bank is scaling up support for large-scale, solar thermal, and PV systems (Box 10). Geothermal

Box 9: Mainstreaming Sustainable Energy at the International Finance Corporation

The growth in IFC's clean energy portfolio in fiscal 2008 is indicative of a shift from donor-supported and small, niche market investments to an increasingly diversified and global market for clean energy across all sectors. The largest growth was in clean energy financing projects. In fiscal 2008, IFC's Financial Markets Group had nine such investments in five countries, including some of the largest and most rapidly growing emitters of GHGs—Brazil, China, Russia, Turkey, and Ukraine. These projects will provide commercial lenders with more than US$280 million for dedicated credit lines for clean energy activities, an approach originally developed with donor funds more than a decade ago. The projects help address the diverse, profitable, but smaller-scale investment opportunities otherwise difficult to capture.

A second feature of IFC fiscal 2008 portfolio is the mainstreaming of renewable energy lending across sectors and regions. Excluding financing projects which encompass both energy efficiency and renewable energy, IFC made investments of over US$500 million in 13 renewable energy investments in 11 countries with a total value in excess of US$3 billion. These included biomass cogeneration and ethanol projects at sugar mills in Brazil and Nicaragua, quasi-equity investments in geothermal generation in Djibouti and Indonesia, and rehabilitating biomass plants in China and India. Originating sectors included agribusiness, infrastructure, global financial markets, and sub-national finance.

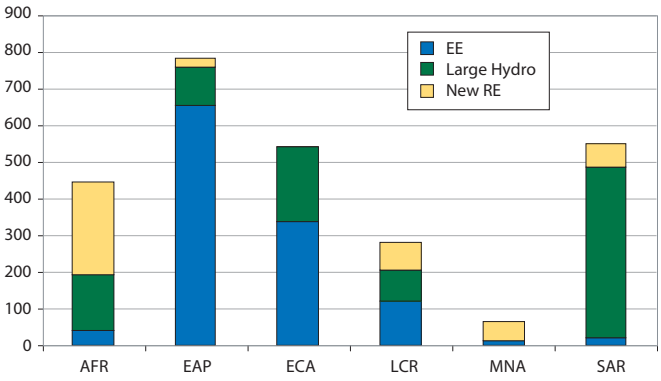
Table 5: Projects by Region, Fiscal 2008

Region	*EE*	*Hydro > 10 MW*	*New RE*	*Total*
AFR	4	5	13	22
EAP	13	1	5	19
ECA	17	5	1	23
LCR	7	1	7	15
MNA	2	0	2	4
SAR	4	2	6	12
Grand total	47	14	34	95

Note: Projects that contain both a new RE and an EE component have been divided and counted as 0.5 to avoid double counting. These projects include the Burkina Faso Energy Access Sector Investment Loan, the Multisectoral Water and Energy Infrastructure Project in Burundi, the joint Redevelopment of Tana Hydro and Optimization of Kiambere Hydro Project in Kenya, and the Increased Efficiency and Access to Electricity Sector Investment Loan in Zambia.

Source: WBG data.

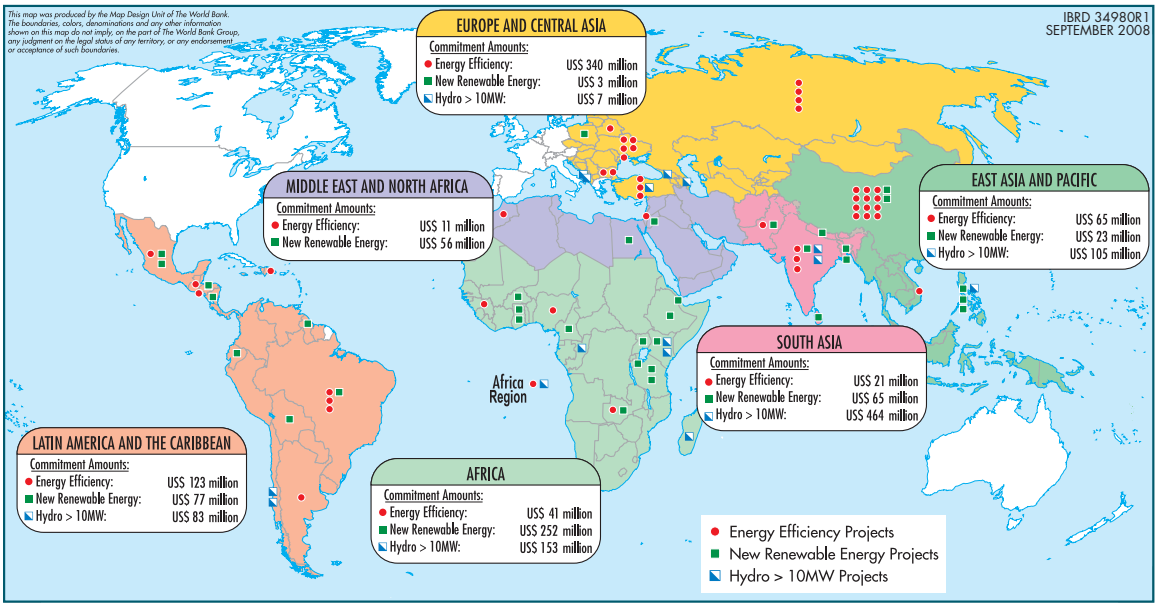
Figure 12: WBG Renewable Energy and Energy Efficiency Commitments by Region, Fiscal 2008



Source: WBG data.

power generation received more than US$100 million in commitments with a large MIGA project in Kenya and a series of other projects (IFC, Carbon Finance, and GEF) in Djibouti, Indonesia, and Poland. Wind power was supported by a GEF project in Jordan with US$6 million, and biomass energy received over US$70 million in commitments. In addition, the portfolio consisted of a variety of different new renewable

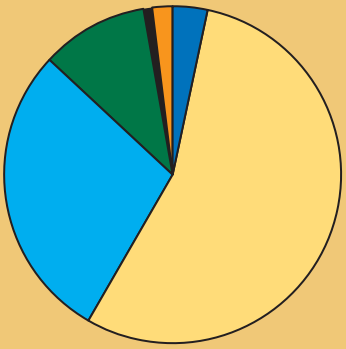
Figure 13: World Map with Distribution of Renewable Energy and Energy Efficiency Projects



Source: WBG data.

Figure 14: Commitments by Region, Fiscal 2008

Energy Efficiency Spending by Region
Total: $1192 million



AFR
US$41 million

EAP
US$655 million

ECA
US$340 million

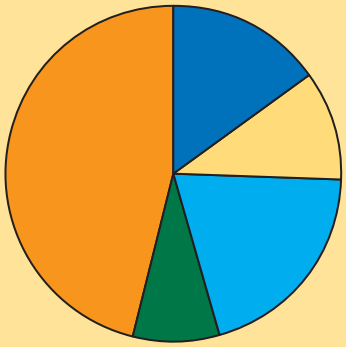
LCR
US$123 million

MNA
US$11 million

SAR
US$21 million

Energy Efficiency commitments scaled up, with a total of US$1,192 million in fiscal 2008. The EAP Region received the highest energy efficiency commitments—US$655 million, representing 55 percent of all commitments. The ECA Region similarly performed well with US$340 million. The majority of projects improved efficiency in the power transmission and distribution sector, followed by industry and demand-side approaches in the residential and commercial sectors.

Hydro > 10MW Spending by Region
Total: $1007 million



AFR
US$153 million

EAP
US$105 million

ECA
US$202 million

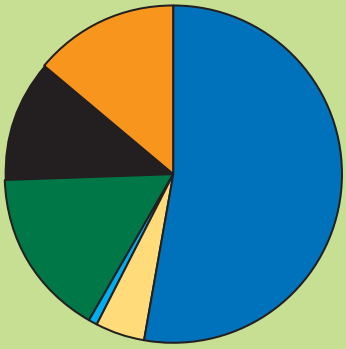
LCR
US$83 million

MNA
US$0 million

SAR
US$464 million

Major increase in large hydropower commitments, with a total of US$1,007 million in fiscal 2008. SAR approved the largest share of commitments, with a total of US$464 million. ECA was the second largest contributor of commitments, with US$202 million.

New Renewable Energy Spending by Region
Total: $476 million



AFR
US$252 million

EAP
US$23 million

ECA
US$3 million

LCR
US$77 million

MNA
US$56 million

SAR
US$65 million

Commitments for new Renewable energy totaled US$476 million in fiscal 2008. AFR made the largest contribution to the new renewable portfolio, with a total of US$252 million, accounting for 53 percent of the total investments. LCR and SAR followed, with commitments of US$77 million and US$65 million respectively. Solar thermal, geothermal, wind, and biomass power projects received the bulk of these commitments.

Source: WBG data.

Box 10: Mainstreaming Large-Scale Solar Energy

The World Bank is scaling up support for large-scale solar thermal and PV systems in a number of countries. The promotion of solar thermal power generation in Egypt and Morocco is an example.

Egypt's Kureimat solar-thermal hybrid project will increase the share of renewable power in the Egyptian generation mix and thereby contribute to the government's aim of diversifying electric power production. Similarly, the Ain Beni Mahtar Integrated Solar Combined Cycle project in Morocco will integrate a solar thermal component into a traditional combined cycle plant to sustain the growth in Morocco's energy demand and increase the share of renewable energy in its energy mix.

Both projects are expected to demonstrate the operational viability of hybrid solar-thermal power generation technology and contribute to the replication of integrated solar combined cycle power generation technology in Egypt and Morocco and elsewhere. The World Bank is also mainstreaming the deployment of PV systems for off-grid rural electrification. For example, in fiscal 2008 a carbon finance operation was implemented that consists of deploying solar home systems in rural areas of Bangladesh in cooperation with rural-based renewable energy company Grameen Shakti and IDCOL Ltd, an infrastructure financing agency. Under this project, more than 1 million solar home systems are expected to be installed over the next four years, reducing carbon emissions by roughly half a million tons.

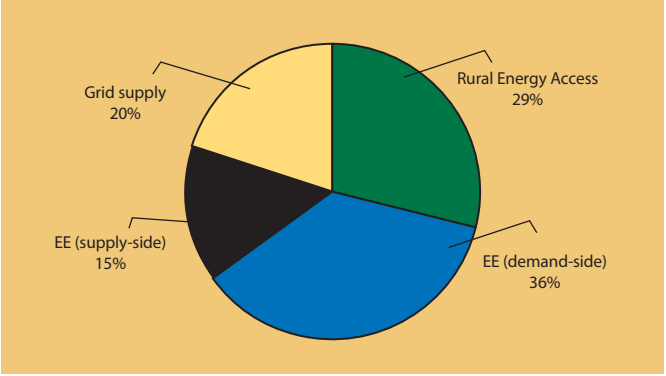
energy technologies, including solar homes systems, bioenergy, and small hydropower.

The WBG's investments in renewable energy and energy efficiency are essential to reach its development objectives and to transform people's lives. In fact, the outcomes of the WBG's renewable energy and energy efficiency projects directly impact the ability of households and businesses to access modern energy and improve the cost-effectiveness of their energy services.

In fiscal 2008, out of a total of 95 renewable energy and energy efficiency projects, 34 projects (36 percent) provided improved energy efficiency on the demand side (Figure 15). Projects, for example, in Belarus, China, India, Mexico, Morocco, and Turkey, have contributed to reducing energy needs in households and industry, thereby reducing energy costs and mitigating the impact of energy price fluctuations. Moreover, by reducing electricity loads, these projects play an important role in mitigating acute power crises and reducing the need for costly investments in additional electricity generation capacity.

Twenty-eight projects (29 percent) employed renewable energy solutions to improve access to rural communities. Distributed energy generation technologies, such as solar home systems, minihydro, biomass, and wind, increasingly compete with conventional technologies on costs. The WBG has employed them to bring power to previously unelectrified communities in countries as diverse as Bangladesh, Bolivia, Burkina Faso, Cameroon, and Sri Lanka, thereby allowing people to benefit from improved living standards and productivity through modern lighting, irrigation, and other productive uses of energy.

Figure 15: Share of Projects by Outcome, Fiscal 2008



Source: WBG data.

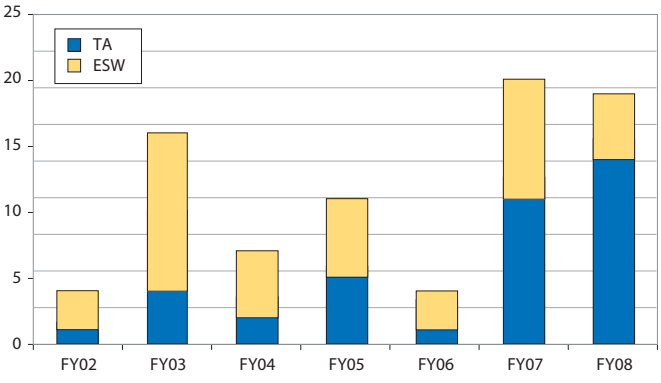
Nineteen projects in fiscal 2008 employed renewable energy technologies to generate power for electricity grids. They include a biomass electricity generation project in Mauritius, the promotion of wind energy in Jordan, solar thermal technology in Egypt, and hydro projects in the Kenya, the Philippines, and Turkey. By diversifying the energy mix and exploiting local resources, these projects mitigate fossil fuel price fluctuations and contribute to energy security.

Supply-side energy efficiency was supported in 14 projects. These projects reduce transmission and distribution losses and improve operating efficiencies of power plants, for example, through plant rehabilitation in such countries as Brazil, China, Moldova, and Pakistan.

Technical Assistance and Sector Studies

In addition to operational activities, the WBG engages in a variety of economic sector work and technical assistance focused on renewable energy and energy efficiency. This work is an integral part of WBG activities, which paves the way for additional investments by public and private sectors. As shown in Figure 16, Analytical and Advisory Activities in renewable energy and energy efficiency remained strong in fiscal 2008, with 19 activities completed. Activities performed in the past year include studies, reports, and policy notes on renewable energy policy in Brazil, Mexico, and Sri Lanka. The majority of the Analytical and Advisory Activities in renewable energy were in the form of non-lending technical assistance. As for energy efficiency, there were nine activities completed, out of which two were economic sector work in Mexico and Russia. These figures show increasing interest in activities related to renewable energy and energy efficiency on the part of client countries and pave the way for strong operational and lending activities in the coming years.

Figure 16: AAAs with Focus on Renewable Energy and Energy Efficiency, Fiscal 2000–08



Source: WBG data.

Energy Sector Management Assistance Program

The Energy Sector Management Assistance Program is a global knowledge and technical assistance partnership administered by the World Bank and sponsored by bilateral official donors since 1983. ESMAP's mission is to assist clients from low-income, emerging, and transition economies to secure energy requirements for equitable economic growth and poverty reduction in an environmentally sustainable way.

ESMAP follows a three-pronged approach to achieve its mission: think tank or horizon-scanning, operational leveraging, and knowledge clearinghouse (knowledge generation and dissemination, training and learning events, workshops and seminars, conferences and roundtables, website, newsletter, and publications) functions. ESMAP activities are executed by its clients and/or by World Bank staff.

ESMAP's work focuses on three global thematic energy challenges:

1. Expanding energy access for poverty reduction.

2. Enhancing energy efficiency for energy secure economic growth.
3. Deploying renewable energy systems for a low carbon global economy.

ESMAP supports regional activities that provide better service to individual developing countries, and cutting-edge research and global projects. The program also supports collaboration across the energy sector and shares ideas, good practices, and project experiences across regions.

In 2007, ESMAP provided US$1.6 million for 11 new energy efficiency activities and US$1.7 million for 11 new renewable energy activities. Overall, as of June 30, 2008, ESMAP's energy efficiency portfolio comprised 37 activities totaling US$5.8 million, while the renewable energy portfolio comprised 32 projects activities totaling US$4.4 million. Additionally, ESMAP is also helping prepare strategies to promote low-carbon energy economies through eight activities totaling US$1.8 million.

ESMAP is a major funder of the Lighting Africa program and its 2008 conference and development marketplace competition in Accra, Ghana. ESMAP also funded a variety of groundbreaking reports and studies in renewable energy and energy efficiency in 2007–08:

- *Women's Role in Renewable Energy in Bangladesh*, launched in March 2008, is a video documentary about an ESMAP-funded project in Char Montaz, a coastal island in Bangladesh.[20]
- *Financing Energy Efficiency: Lessons from Brazil, China, India, and Beyond*, launched on February 27, in conjunction with SDN Week 2008. The book notes that without significant gains from energy efficiency efforts, Brazil, China, and India will more than double their energy use and GHG emissions within a single generation. Another finding is that the most difficult problem in energy efficiency delivery is attributed to a "packaging problem"—and that is where efforts should focus. The book also suggests a three-part model for "projectizing" and financing energy efficiency projects, and presents 13 case studies to illustrate the issues and principles involved.[21]
- *Unlocking Potential, Reducing Risk: Renewable Energy Policies for Nicaragua*. This ESMAP report examined the potential of renewable energy in Nicaragua by making recommendations based on case study analyses of geothermal, wind energy, and small to medium hydropower generation in the country. By the end of 2005, Nicaragua's renewable energy policy and regulatory framework had many essential components in place. However, the country lacked quantified targets for renewable energy penetration, adequate natural resource laws, and appropriate power rules for tendering new generation. This report's recommendations have played an important role in showing the way forward for renewable energy in Nicaragua.[22]

Highlights of non-lending operations that are currently underway include three studies in Nepal:

- *Removing barriers to hydropower development*. The objective of the study is to identify barriers to hydropower development in Nepal and to propose recommendations to remove or reduce the impact of these barriers, as a contribution to the efforts of the Government of Nepal to facilitate the development of the country's untapped hydropower potential. The study will consider the different issues

[20] This report is available at *http://www.esmap.org/news/news.asp?id=46*
[21] This book is available at *http://www.esmap.org/filez/pubs/211200830655_financing_energy_efficiency.pdf*
[22] This report is available at *http://www.esmap.org/filez/pubs/10292007102111_Nicaragua_Enhanced_Report4-10-07.pdf.*

with respect to hydropower development projects for domestic supply (>10 MW), export supply and combined domestic/export.

- *Nepal Electricity Authority (NEA) Energy Efficiency.* The aim of this study is to identify and assess opportunities to help NEA improve its efficiency and quality of service, reduce peak capacity deficits, and to reduce the costs of power supply through implementation of demand-side management (DSM) measures.
- *Assessing the social impacts of rural energy services.* The broad objective of this study is to operationalize an M & E framework for micro-hydro schemes that utilize Nepal's vast hydro resources and can be executed in areas of the where the national grid is not expected to reach in the foreseeable future.

ESMAP and the World Bank continue to work together to find and strengthen energy solutions that benefit developing countries.

The Asia Sustainable and Alternative Energy Program

The Asia Sustainable and Alternative Energy Program (ASTAE) grew out of the Financing Energy Services for Small-Scale Energy Users (FINESSE) Project initiated by ESMAP and bilateral donors in 1989. Following a joint request from Asian borrowers and donor partners, the Bank acted to implement the FINESSE recommendations by creating ASTAE in January 1992.

ASTAE's current mandate rests on three pillars: improving energy efficiency, scaling up the use of renewable energy, and increasing access to energy to reduce poverty. In all three pillars ASTAE has developed a strong portfolio of activities in East Asian and Pacific countries, facilitating the development and supporting the implementation and effectiveness of large World Bank investment projects and GEF grants. These combined operations have had significant quantitative impacts. During the past 16 years, close to 2 million households have gained access to electricity, more than 1 GW of renewable energy generation capacity has been installed in the region, energy efficiency gains have replaced 1 GW of generating capacity equivalent, and total carbon dioxide emissions were reduced by more than 200 million tons.

Experience from all three pillars of ASTAE support—renewable energy, energy efficiency, and access to energy—show the consolidation of three essential functions of ASTAE:

1. ASTAE helps introduce *innovative investment delivery mechanisms*, as illustrated in China with ASTAE's support to developing onlending guidelines for energy efficiency project financing by Chinese commercial banks, or by the structuring of onlending funds for renewable energy development in Vietnam. In the Pacific Islands, ASTAE is supporting the introduction of an original financing mechanism that provides risk guarantees; it is expected to leverage substantial private sector financing.
2. ASTAE has over the years demonstrated its role in supporting the development of *institutional and regulatory frameworks* that provide the enabling environment for the successful scaling-up of investment projects. ASTAE's early support to the development of the Chinese Renewable Energy Law, ASTAE's work in Thailand on the development of energy policies, on heat pricing policies in Northern China, or on electricity distribution regulations in Mongolia provide further illustrations of this role. Innovative governing and management structures provided support to successful organization of the Philippines energy cooperatives and the Rural Energy

Services project in Vietnam. Improved policy, financial, and regulatory frameworks help attract capital from international financial institutions, export credit agencies, and from the private sector.

3. The third emerging, cross-country, and cross-sector role of ASTAE is in *training and knowledge sharing*. ASTAE has consolidated experiences gained in projects in Asia since 1992 and is able to draw from a pool of expertise to provide just-in-time advice on the design and implementation of projects across the region. ASTAE has organized training seminars for officials and policy makers—notably in China, Indonesia, Thailand, and Vietnam—and it has conducted workshops to share knowledge between countries of the region as in the case of exchanges between Chinese and Vietnamese ESCOs. Over the years ASTAE has developed a number of knowledge products, technical guides, and atlases made available to a wide audience.

In fiscal 2008, also, ASTAE extended its activities to the South Asia region with a project approved in India to support energy efficiency in small and medium enterprises. This restores ASTAE's initial mandate to operate as an Asia-wide program, while it had focused on the East Asia and Pacific region only in recent years. More projects are in the pipeline for fiscal 2009 in the South Asia region, covering the same three thematic areas of renewable energy, energy efficiency, and access to energy.

ASTAE work is currently supported by the World Bank, the Government of the Netherlands, and the Swedish International Development Agency (SIDA).

IFC and McKinsey Collaborate on Research Project

IFC and McKinsey undertook a collaborative research project in 2008 designed to test the business development opportunities implied by a widely circulated McKinsey analysis, "A global cost curve for carbon abatements". The McKinsey analysis highlights the large technical opportunities for profitable investments associated with reducing greenhouse gas emissions, primarily through clean energy products and services. This project looked at the potential for investments consistent with IFC eligibility criteria in one country (China) in one department (General Manufacturing).

The approach followed an iterative process engaging McKinsey and IFC departmental and field staff to identify several sub-sectors not already well known to IFC (e.g. cement) but thought to offer promising oppurtinities for GHG abatement and IFC investment. Four sub-sectors were chosen for detailed review: wind machines, solar cells, insulating materials for buildings and efficient lighting. A review of firms in these sectors and their financing needs revealed a robust pipeline of $300 to $600 million in potential IFC investment, with a large projected GHG abatement impact. This analysis was highly valued by regional and departmental staff and is being evaluated as a model for replication internally with continuing input from McKinsey staff on an informal basis.

Annex 1: Institutional Support for Renewable Energy and Energy Efficiency

This annex describes the various WBG institutions and units and the role that each plays in contributing to renewable energy and energy efficiency. It also provides definitions of renewable energy and energy efficiency. Last, it discusses the methodology used to compute the data in this report.

Roles of the Institutions

The World Bank Group

In this report, the WBG (World Bank Group) refers to four closely associated World Bank institutions that directly support renewable energy and energy efficiency activities. The four institutions are the IBRD, IDA, IFC, and MIGA. There are six operational regions under the IBRD and IDA. The report disaggregates the commitments made by these regions and institutions. In addition, the WBG is an implementing agency for the GEF. This report provides information on WBG-administered GEF projects. The WBG's Carbon Finance Business (CFB-IBRD) is reported separately because it is a unique business line that purchases emissions reductions and does not directly invest in projects.

The IBRD

The IBRD (International Bank for Reconstruction and Development) aims to reduce poverty in middle-income and creditworthy poorer countries by promoting sustainable development through loans and guarantees and, in the nonlending area, analytical and advisory activities (AAAs; *http://www.worldbank.org/ibrd*).

IDA

Contributions to IDA (International Development Association) enable the World Bank to provide approximately US$6–9 billion a year in highly concessional financing to the world's 80 poorest countries (home to 2.5 billion people). IDA's interest-free credits and grants are vital because these countries have little or no capacity to borrow on market terms (*http://www.worldbank.org/ida*).

IFC

IFC's (International Finance Corporation's) mandate is to further economic development through the private sector. Working with business partners, it invests in private enterprises in developing countries and provides long-term loans, guarantees, and risk management and advisory services to its clients (*http://www.ifc.org*).

MIGA

MIGA (Multilateral Investment Guarantee Agency) provides political risk insurance against noncommercial risks to eligible foreign investors and commercial banks for qualified investments in developing member countries (*http://www.miga.org*).

Carbon Finance

Both the IBRD and IFC have Carbon Finance Units (CFUs) that leverage public and private investment for projects that generate GHG emission reductions. This helps to grow the market by extending carbon finance to both developing and transition economies. The

funds are provided by private companies and governments seeking to purchase emission reductions to learn how to originate transactions in this complex emerging market. The Carbon Finance Business (CFB-IBRD) is divided into separate business lines—the IBRD CFU (*http://carbonfinance.org/*) and IFC CFU (*http://www.ifc.org/carbonfinance*).

ESMAP

ESMAP (Energy Sector Management Assistance Program) is a global technical assistance program and knowledge partnership sponsored by a group of donors, including Canada, Denmark, Finland, Germany, the Netherlands, Norway, Sweden, the United Kingdom, the United Nations Foundation, the United Nations Development Programme, and the World Bank. ESMAP is managed by the World Bank (*http://www.worldbank.org/esmap*).

ASTAE

In 1992, the World Bank and donor partners established ASTAE (Asia Alternative Energy Program) to support the transition to environmentally sustainable energy use in developing countries in Asia. ASTAE supports upstream economic and sector work, much like ESMAP, and it also provides assistance in renewable energy and energy efficiency project identification, preparation, and supervision (*http://www.worldbank.org/astae/*).

The GEF

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 is an independent financial organization that provides grants to developing countries for projects that benefit the global environment and promote sustainable livelihoods in local communities. The GEF is the WBG's largest partner in the area of renewable energy and energy efficiency investments (*http://www.thegef.org*).

Definitions

Following are the definitions used for reporting on the WBG's activities. Commitment amounts used in the report were prorated to include only those project components that clearly fall into one of the following categories.

New Renewable Energy

Projects or project components were classified as new renewable energy if support was provided for: solar energy for heat and power, wind energy for mechanical and electrical power generation, geothermal and biomass energy for power generation and heat, hydropower of 10 MW or less per installation, and waste-to-energy, if it generates electrical power or heat for productive uses.

Energy Efficiency

Energy efficiency covers both demand side efficiency and supply side efficiency components.

- **Demand-side efficiency** includes improvements in efficiency as a result of load management, demand response programs, and direct load control; improvements in end-use energy efficiency in residential, commercial, industrial, public-municipal, agricultural and transport sectors; and energy conservation. Also included are energy efficiency improvements through institutional development, regulatory reforms, and improvements in utility management performance, introduction of improved building codes and appli-

ance energy efficiency standards and labeling systems, retrofits to meet new standards, energy audits, waste heat recovery, improved fuel-efficiency standards for automobiles, use of drip irrigation or irrigation pumping in agricultural systems, municipal water pumping, energy efficiency financing through financial intermediaries, and implementation of consumer awareness programs.

- **Supply-side energy efficiency** encompasses transport systems (including modal shifts from cars to mass transit systems); district heating enhancements; improved power transmission and distribution, including enhanced metering systems, capacitors, and substation rehabilitation; power system optimization; plant rehabilitation (including plants that offset conventional fuels, installation of supercritical boilers); improved O&M; and combined heat and power plants.

The projects or project components for energy efficiency include investments in rehabilitation of transmission and/or distribution networks only when the share of energy efficiency improvements in such projects can be clearly disaggregated from other objectives, such as network expansion and load increase. Interventions in Development Policy Loan commitments are included only when the share attributable to energy efficiency can be clearly demarcated.

Hydropower Greater Than 10 MW

The World Bank considers hydropower, regardless of scale, to be renewable energy. However, for reporting purposes, hydropower projects in which the installed capacity at a single facility exceeds 10 MW are reported separately.

The WBG supports projects that may be cross-sectoral in nature. For example, renewable energy and energy efficiency components may be embedded within an agricultural, health, or power project. In such blended projects, sometimes it is not easy to specify precisely what the size of each sectoral component is. In this report, as far as possible, great care has been taken to show only the commitment amount associated with new renewables, energy efficiency, or hydropower greater than10 MW. For example, in a particular project the total commitment made by the IBRD and IDA may be US$100 million. This project may have three different sectoral components: agro-industry, 50 percent; health, 30 percent; and new renewables, 20 percent. In such a case, only US$20 million has been included as the project's contribution to renewable energy.

Different Reporting Styles

The various World Bank institutions have differing styles of reporting their data because of their different kinds of business. For example, MIGA provides guarantees to projects against various kinds of risks, whereas the IBRD and IDA provide project finance and guarantees. Emissions reductions purchases by carbon finance are a revenue stream. IFC provides both equity and loan financing, as well as guarantees. For the purposes of this report and to arrive at an estimate of the WBG's total commitments toward renewable energy and energy efficiency, we have added commitments made by each WBG institution. The following distinctions should be kept in mind when reading this report.

The IBRD and IDA

For IBRD- and IDA-assisted projects, commitment amounts toward renewable energy, energy efficiency, or both for each project have been used to estimate the cumulative total for the WBG. Only those project components that could clearly be attributed to a renewable energy and energy efficiency category were counted.

IFC

The report shows IFC (International Finance Corporation) net investments from its own account for renewable energy and energy efficiency investment. Previous IFC assessments referred only to stand-alone projects whose sole focus was energy efficiency or renewable energy, thus missing the full scope of investment in sustainable energy undertaken as a component of larger investments in various sectors. IFC has since revised its methodology, so that it now identifies renewable energy and energy efficiency investments in commitments it has made in other sectors, such as agriculture, water supply, industry, and transport, and in corporate loans to financial intermediaries. The new methodology assesses the percentage of IFC investment in proportion to the full project cost and applies that proportion to the full renewable energy or energy efficiency project value. This methodology has been used to update IFC's fiscal 2005 renewable energy and energy efficiency commitment amounts. For more details, see "Choices Matter: 2005 Sustainability Report" at *www.ifc.org/SustainabilityReport*.

MIGA

MIGA (Multilateral Investment Guarantee Agency) normally reports the maximum liability of its guarantee and the foreign direct investment that the guarantee leveraged. For the purposes of arriving at a cumulative total for the WBG, this report added together only the MIGA maximum liability.

Carbon Finance

For purposes of this report, to compare carbon asset purchases and regular project financing, this report considered signed Emission Reductions Purchase Agreements to be the appropriate measure and added those amounts to arrive at the total commitment—that is, the Carbon Finance Business (CFB-IBRD) equivalent of board approval for World Bank loans.

The GEF

For approved GEF (Global Environment Facility) projects, this report uses the commitment amounts for each project.

Annex 2. Annual Renewable Energy and Energy Efficiency Portfolio Review

Annual Table 1: WBG Renewable Energy and Energy Efficiency Commitments (US$ millions)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Grand total
New Renewables	53	2	56	227	300	59	47	336	15	239	444	26	169	206	138	246	344	421	476	3,804
Energy Efficiency		265	54	10	59	148	380	56	356	26	295	193	67	177	92	244	584	262	1,192	4,457
Hydropower (greater than 10 MW)		150	161	938	186	317	819	15	461		320		181	23	83	538	250	751	1,007	6,199
Grand total	53	417	271	1,174	545	524	1,245	407	832	264	1,059	219	416	406	313	1,028	1,178	1,434	2,675	14,459

Annual Table 2: WBG Renewable Energy and Energy Efficiency Commitments (US$ millions) by Institution or Unit

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Grand total
GEF			3	36	56	35	10	78	28	56	111	14	37	55	46	100	51	128	145	990
GEF-IFC/TF							37	33		30	5		19	28	1	8	23		4	186
IBRD Carbon Finance												2	8	10	21	39	35	144	128	388
IBRD/IDA	53	392	196	1,113	303	452	1,108	146	534	137	691	197	340	200	245	506	420	549	1,340	8,920
IFC		25	72	26	186	7	36	135	206	15	1	6	13	113	—	275	633	450	906	3,102
IFC Carbon Finance														—	—	10	13	7	39	69
MIGA						30	35	15	65	26	252			—	—	91	2	155	110	780
Special Financing							20							—	—				3	23
Total Commitment	53	417	271	1,174	545	524	1,245	407	832	264	1,059	219	416	406	313	1,028	1,178	1,433	2,675	14,459

Annual Table 3: WBG New Renewables Commitments (US$ millions) by Institution or Unit

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Grand total
GEF			3	26	30	10	7	39	6	56	66	9	36	6	14	47	48	121	90	614
GEF-IFC/TF							30	30		14				10	1	1	0	0	4	90
IBRD Carbon Finance												2	4	10	10	8	19	68	65	186
IBRD/IDA	53	2	20	201	270	19	8	132	10	128	127	9	128	165	114	128	253	70	117	1,953
IFC			33					135		15		6	1	15	—	51	9	154	72	491
IFC Carbon Finance														—	—	10	13	7	39	69
MIGA						30	2			26	252			—	—	0	2	0	88	401
Total Commitment	53	2	56	227	300	59	47	336	15	239	444	26	169	206	138	246	344	421	476	3,803

Annual Table 4: WBG Energy Efficiency Commitments (US$ millions) by Institution or Unit

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Grand total
GEF			10	26	25	3	39	22	1	45	5	1	49	33	53	4	7	55	376
GEF-IFC/TF						7	3		16	5		19	18	—	7	23	0	0	96
IBRD Carbon Finance													—	3	6	13	10	40	72
IBRD/IDA	265	54		33	123	350	14	328	9	244	188	35	34	56	3	97	49	621	2,505
IFC								6		1		12	75	—	175	446	156	473	1,343
IFC Carbon Finance																			—
MIGA													—	—	0	0	39.6	0	40
Special Financing						20							—	—	0	0	0	3	23
Total Commitment	265	54	10	59	148	380	56	356	26	295	193	67	177	92	244	584	262	1,192	4,456

Annual Table 5: WBG Hydropower (> 10 MW) Commitments (US$ millions) by Institution or Unit

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Grand total
IBRD Carbon Finance												4	—	8	25	3	66	24	129
IBRD/IDA	125	122	912		310	750		196		320		177	—	76	374	70	430	601	4,462
IFC	25	39	26	186	7	36		200					23	—	49	177	140	361	1,268
IFC Carbon Finance																			—
MIGA						33	15	65					—	-	91	0	115	21	339
Total Commitment	150	161	938	186	317	819	15	461	—	320	—	181	23	83	538	250	751	1,007	6,199

Annual Table 6: WBG Renewable Energy and Energy Efficiency Commitments (US$ millions) by Region

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Grand total
AFR		127	73	203		3	12	30	201	7	124		78	104	40	96	196	735	447	2,473
EAP	51		121	410	310	367	400	145	123	139	513	8	124	28	61	459	255	143	783	4,438
ECA		290			33	140	381	14	238	15	68	186	75	155	155	262	431	117	545	3,104
LCR	2		75	340	199	10	2	41	186	79	219	6	30	51	34	127	235	133	283	2,054
MNA					2	4									0	10	12	121	67	216
OTH							32	148		25		12	1	10			4			231
SAR			2	222			419	29	85		135	7	108	58	22	75	46	183	550	1,942
Grand total	53	417	271	1,174	545	524	1,245	407	832	264	1,059	219	416	406	313	1,028	1,178	1,433	2,675	14,458

Annual Table 7: WBG New Renewables Commitments (US$ millions) by Region

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Grand total
AFR		2	18	3		3	8	30	5	6	124		16	104	33	41	27	20	252	691
EAP	51				300	49		112	2	139		3	18		56	127	144	93	23	1,118
ECA							7		9	6	6	2		3	44	10	9	12	3	112
LCR	2		37	2		3	2	20		78	204	6	26	31	5	53	135	100	77	781
MNA						4										1	5	65	56	131
OTH							30	145		10		12	1	10						209
SAR			2	222				29			110	2	108	58		13	24	131	65	762
Grand total	53	2	56	227	300	59	47	336	15	239	444	26	169	206	138	246	344	421	476	3,803

Annual Table 8: WBG Energy Efficiency Commitments (US$ millions) by Region

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Grand total
AFR						4		1	1					6	3	10	79	41	145
EAP		54	10	10	8		33	121		193	5	1	28	5	75	89	24	655	1,309
ECA	265			33	140	374	14	229	9	62	183	65	144	51	81	421	97	340	2,510
LCR				14			6		1	15		0	5	22	63	42	24	123	314
MNA				2										0	9	6	16	11	45
OTH						2	3		15							4			23
SAR								6		25	5	1		7	13	11	21	21	111
Grand total	265	54	10	59	148	380	56	356	26	295	193	67	177	92	244	584	262	1,192	4,456

Annual Table 9: WBG Hydropower (> 10 MW) Commitments (US$ millions) by Region

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Grand total
AFR	125	55	200					196				62			51	159	636	153	1,637
EAP		67	400		310	400				320		105			257	22	26	105	2,012
ECA	25											10	8	61	170		7	202	483
LCR		39	338	186	7		15	186				4	15	8	11	58	10	83	959
MNA																	40		40
SAR						419		79						15	49	11	32	464	1,069
Grand total	150	161	938	186	317	819	15	461	—	320	—	181	23	83	538	250	751	1,007	6,199

Annex 3: FY08 Renewable Energy and Energy Efficiency Projects (millions of U.S. dollars)

No.	Country	Project name	Energy type	Financing sources	RE or EE component financing
		Africa Region			
1	Africa	Niger Basin Water Resources	Hydro > 10MW	IDA	109.8
2	Africa	Evolution One	EE (demand side)	IFC	10.0
3	Burkina Faso	Energy Access Project	Biomass	IDA	18.7
4	Burundi	Multisectoral Water and Electricity Infrastructure Project	EE Small Hydro	IDA	8.3
5	Cameroon	Energy Sector Development Project	Small Hydro, Solar	IDA	48.8
6	Congo	Emergency MS Rehabilitation and Recovery	Hydro > 10MW	IDA	0.3
7	Djibouti	InfraV-REI Djibouti	Geothermal	IFC	4.0
8	Ethiopia	Electricity Access (Rural) Expansion Project, Phase II	Small Hydro, Solar	IDA	5.2
9	Ghana	Energy Development and Access Project	Biomass, Small Hydro, Wind	IDA	6.3
10	Ghana	Rural Energy Access	Solar	IDA	5.5
11	Guinea	Electricity Sector Efficiency Improvement	EE (supply-side)	GEF	3.6
12	Kenya	Olkari II Geothermal Expansion	Geothermal	MIGA	88.3
13	Kenya	Optimization of Kiambre Hydro Project Redevelopment of Tana Hydro Project	Hydro > 10MW	Carbon Finance	2.8 3.0
14	Kenya	Sondu Miriu Hydro	Hydro > 10MW	Carbon Finance	16.0
15	Madagascar	Hydelec Sahanivotry	Hydro > 10MW	MIGA	21.4
16	Mauritius	CTSAV Bagasse-Fueled Generation Project	Biomass	Carbon Finance	24.8
17	Nigeria	Nigeria National Energy Development Project	EE (supply-side)	Carbon Finance	5.1
18	Tanzania	Energy Development & Access Expansion	Solar	IDA	11.6
19	Tanzania	Energy Development & Access Expansion	Solar	GEF	6.5
20	Uganda	Kakira Bagasse Cogen	Biomass	Carbon Finance	5.2
21	Zambia	Increased Access to Electricity Project	Solar	GEF	4.5
22	Zambia	Increased Efficiency & Access to Electricity Project	EE (supply-side) Small Hydro, Solar	IDA	16.0 11.9
		East Asia and Pacific Region			
23	China	China Glass II	EE (demand-side)	IFC	28.6
24	China	Hubei Eco-Farming Project	Biogas	Carbon Finance	5.2
25	China	CHUEE II–Ind B	EE (demand-side)	IFC	103.0
26	China	CHUEE II–SPBD	EE (demand-side)	IFC	69.0
27	China	Energy Efficiency Financing	EE (demand-side)	IBRD	200.0
28	China	Energy Efficiency Financing	EE (demand-side)	GEF	13.5
29	China	World Bank Urban Transport Partnership	EE (supply-side)	GEF	13.0

(*continued on next page*)

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30	China	Liaoning Third Medium Cities Infrastructure	EE (supply-side)	IBRD	185.3
31	China	Baotou Iron & Steel Energy Efficiency Project	EE (supply-side)	Carbon Finance	12.9
32	China	Shandong Manure Biogas	Biogas	Carbon Finance	5.9
33	China	Meishan CDQ Project	EE (supply-side)	Carbon Finance	10.0
34	China	Shanshui III	EE (demand-side)	IFC	5.6
35	China	Tianrui Cement 07	EE (demand-side)	IFC	2.5
36	China	Weihui Tianrui	EE (demand-side)	IFC	1.8
37	Indonesia	Geothermal Power Generation Development	Geothermal	GEF	3.0
38	Indonesia	Lahendong Geothermal	Geothermal	Carbon Finance	4.9
39	Indonesia	InfraV-REI Indonesia	Geothermal	IFC	4.0
40	Philippines	Magat Hydro	Hydro > 10MW	IFC	105.0
41	Viet Nam	Hanoi Urban Transport	EE (supply-side)	GEF	9.8
		Europe and Central Asia Region			
42	Albania	ECSEE APL 5 for Albania Dam Safety	Hydro > 10MW	IDA	35.3
43	Azerbaijan	Azerenerji Hydro Optimization Project	Hydro > 10MW	Carbon Finance	0.9
44	Belarus	Social Infrastructure Retrofitting Project	EE (demand-side)	IBRD	14.1
45	Bulgaria	Drujba CPLP	EE (demand-side)	IFC	3.1
46	Bulgaria Ukraine	Drujba Bucha	EE (demand-side)	IFC	8.5
47	Georgia	Small Hydro Rehabilitation Project	Hydro > 10MW	Carbon Finance	1.20
48	Macedonia	ESM Macedonia	EE (supply-side)	IFC	37.2
49	Moldova	National Water Supply & Sanitation Project	EE (supply-side)	IDA	1.0
50	Montenegro	ECSEE APL 3 (Montenegro Project)	Hydro > 10MW	IDA	0.8
51	Poland	Walbrzyck Coke Oven Gas	Geothermal	Carbon Finance	2.8
52	Russia	Housing & Communal Services Project	EE (demand-side)	IBRD	104.0
53	Russia	NDB Bank	EE (demand-side)	IFC	8.0
54	Russia	Ursa Bank	EE (demand-side)	IFC	8.0
55	Russia	UVTB Energy Efficiency	EE (demand-side)	IFC	3.0
56	Tajikistan	Energy Emergency	EE (supply-side)	IDA	2.4
57	Turkey	Assan CPLP	EE (demand-side)	IFC	4.0
58	Turkey	Enerjisa	Hydro > 10MW	IFC	163.5
59	Turkey	Petlas	EE (demand-side)	IFC	29.3
60	Turkey	YKLEE	EE (demand-side)	IFC	16.7
61	Ukraine	Alchevsk Steel Mill Revamping and Modernisation	EE (demand-side)	Carbon Finance	12.0
62	Ukraine	ISD II	EE (demand-side)	IFC	41.1
63	Ukraine	ProCredit Ukraine EE	EE (demand-side)	IFC	20.0
64	Ukraine	Urban Infrastructure Project	EE (supply-side)	IBRD	28.0

(*continued on next page*)

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		Latin America and Caribbean Region			
65	Argentina	Energy Efficiency Project	EE (demand-side)	GEF	15.2
66	Bolivia	Decentralized Electricity for Universal Access	Solar	Recipient Executed	5.2
67	Brazil	Banco ABN AMRO Real SA	EE (demand-side)	IFC 	15.0 15.0
68	Brazil	Cemar-Maranho	EE (supply-side)	IFC	18.0
69	Brazil	Unibanco SCL	EE (demand-side)	IFC 	12.5 12.5
70	Brazil	USJ	Biomass	IFC	7.6
71	Chile	La Confluencia	Hydro > 10MW	IFC	83.0
72	Dominican Rep.	DO Electricity Distribution Rehabilitation	EE (supply-side)	IBRD	40.0
73	Ecuador	Favorita Fruit	Small Hydro	IFC	2.5
74	Guatemala	Pantaleon Sugar	EE (demand-side)	IFC	4.5
75	Guyana	GY Bagasse Cogeneration	Biomass	Carbon Finance	3.0
76	Mexico	Calidra III	EE (demand-side)	IFC	18.0
77	Mexico	Integrated Energy Services	Small Hydro	IBRD	4.8
78	Mexico	Integrated Energy Services	Small Hydro	GEF	15.0
79	Nicaragua	Monte Rosa Sugar	Biomass	IFC	11.7
		Middle East and North Africa Region			
80	Egypt	Kureimat Solar Thermal Hybrid	Solar	GEF	50.0
81	Jordan	Promotion of a Wind Power Market	Wind	GEF	6.0
82	Morocco	ONE Support Project	EE (demand-side)	IBRD	8.4
83	West Bank/Gaza	Electric Utility Management	EE (supply-side)	Special Funds	3.0
		South Asia Region			
84	Bangladesh	Grameen Shakti Solar Homes Project	Solar	Carbon Finance	4.7
85	Bangladesh	IDCOL Solar Home Systems Project	Solar	Carbon Finance	2.5
86	India	AllainDuhangan II	Small Hydro	IFC	9.3
87	India	Aloe 2	EE (demand-side)	IFC 	4.8 4.8
88	India	Himachal Pradesh Development Policy Loan	Hydro > 10MW	IDA IBRD	19.5 40.5
89	India	Owens Corning II	EE (demand-side)	IFC	1.0
90	India	Rain (Carbon Del Guart)	EE (demand-side)	IFC-Carbon Finance	39.0
91	India	Rampur Hydropower Project	Hydro > 10MW	IBRD	395.0
92	Nepal	Nepal Biodigesters	Biogas	Recipient Executed	5.0
93	Pakistan	AKRSP Renewable Energy Project	Small Hydro	Carbon Finance	6.0
94	Pakistan	Electricity Distribution & Transmission Improvement Proj.	EE (supply-side)	IDA IBRD	5 10.5
95	Sri Lanka	PADGO	Small Hydro	IFC-GEF	4.3

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The World Bank Group
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Washington, DC 20433
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