

# DIRECTIONS IN Hydropower

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THE WORLD BANK GROUP

## A MESSAGE FROM THE DIRECTOR

In a world of growing demand for clean, reliable, and affordable energy, the role of hydropower and multipurpose water infrastructure, which also offers important opportunities for poverty alleviation and sustainable development, is expanding. Beyond its traditional role in providing electricity access, which remains critical, hydropower has a powerful contribution to make to regional cooperation and development and to the allocation of increasingly scarce water resources. Hydropower as a renewable energy also plays a unique dual role in climate change: as an adaptation strategy for growing weather variability and as a renewable resource to move economies to a lower-carbon future.

Hydropower is complex and brings a range of economic, social and environmental risks. Some are inherent in the sector; many can & must be addressed by thoughtful implementation of good practices and a commitment to a sustainable, triple bottom line approach.

The World Bank Group is keenly aware of this timely and important period for hydropower. Since 2003, our lending, analytical work, knowledge sharing, and policy dialogues have increased. This document, *Directions in Hydropower*, outlines the World Bank Group's second-phase commitment. We believe in the need to dedicate efforts to exploit the maximum strategic value of hydropower resources in an environmentally and socially sustainable manner. The goal is to bring tangible benefits to developing economies and to strengthen the overall sector for continued sustainable practices that benefit the poor.

We believe that you will find in these pages a clear exposition of the World Bank Group's views on the value of hydropower, and we invite your contributions to help in our continuing reflection on this critical subject.

— *Jamal Saghir, Director  
Energy, Transport, Water  
The World Bank, March, 2009*

### A WORD ON TERMINOLOGY

*The scope of the WBG's Directions in Hydropower extends beyond single-purpose energy infrastructure. Given the increasing importance of climate change, water security, and regional cooperation, the plan encompasses water infrastructure that serves multiple objectives, among which energy may be a subsidiary goal. For this reason, the terms "hydropower" and "hydropower infrastructure" are used to encompass single and multipurpose investments.*

**H**ydropower accounts for one fifth of the world's electricity supply and has helped shape and promote economic growth in such countries as Canada, Norway, and the United States. Environmental and social concerns, coupled with financial constraints, resulted in a decade of stagnant investment in the 1990s and critical assessment of the role of hydropower in development. Now, lessons from the past, together with emerging global dynamics, are recasting the role of hydropower and stimulating a renaissance in investment and rehabilitation. The opportunities and challenges are complex, and ultimately dependent on the resources, skills, and will to invest responsibly, with due regard to all aspects of sustainable development.

This document summarizes key issues in scaling up hydropower for poverty alleviation and sustainable development. It outlines the rationale and context for sector expansion, as well as the risks. It describes the World Bank Group's role in scaling up and sets priorities for supporting sustainable hydropower in a two-track approach comprising lending and nonlending activities.

**World Bank Group lending for hydropower has increased in recent years,** driven by demand from developing countries and hydropower's multidimensional role in poverty alleviation and sustainable development. At the core of this role is a contribution to energy security. Accounting for about 20 percent of the world's supply of electricity, hydropower is a critical renewable energy resource, bringing light and heat to 1.6 billion people who currently lack access—a crippling 94 percent of the population in some African countries. Hydropower also offers a hedge against volatile energy prices and risks of imported supply. Looking more broadly, recent global trends are expanding opportunities for hydropower and multipurpose water infrastructure to assist in meeting a range of key development challenges.

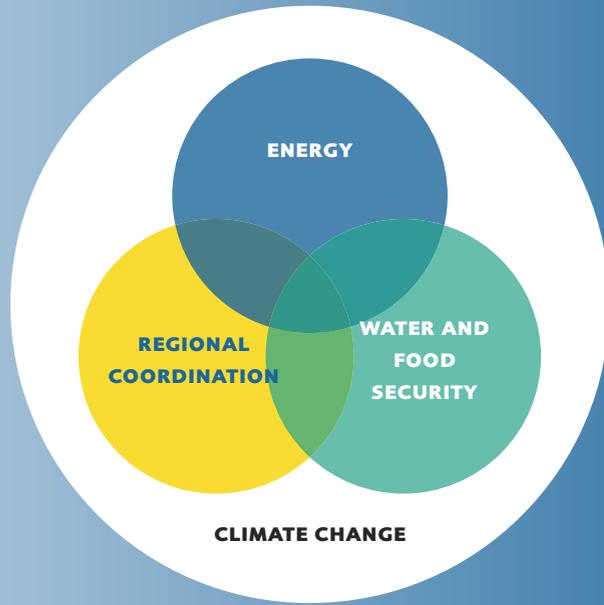
The demands of water management, for example, are repositioning hydro infrastructure. A deeper understanding of the link between hydrological variability and economic growth—and of the cost of being “hostage to hydrology”—puts a premium on better water resources management and infrastructure, especially in the world's 260 international river basins. As part of a flexible, well-planned water resources infrastructure, hydropower can help countries manage floods and droughts, and improve water resources allocation across a complex set of users.

Hydropower's potential contribution to energy and water management goes beyond domestic electricity generation or local flood management. As both power and water issues spill over national boundaries, hydropower offers potential benefits to regional development. From the energy perspective, it can help

## WHY SCALE UP HYDROPOWER?

Emerging trends, driven by more sophisticated energy markets, volatile energy prices, climate change, and increased attention to water management and regional integration, are changing the value proposition of hydropower in development.

**Sustainable Hydropower:  
Four Drivers of Value**



stabilize regional electricity grid systems through unique services such as storage and regulating capacity and load following, and reduce costs through coordination with thermal plants. Good practice in managing water resources demands a river basin approach, regardless of national borders. Ensuring effective development and management of water infrastructure can help balance upstream and downstream interests and transform a potential source of conflict into a tool for regional cooperation and development.

Addressed early in planning, hydropower infrastructure offers multiple opportunities for local development. Investments in roads, social infrastructure, communications, and skill building in large projects can be leveraged to support local or regional economic development or to anchor growth poles across economic zones. The intent in such projects is not to overburden individual investment projects, but to recognize the potential synergies and efficiencies available when hydropower infrastructure is considered within the broader landscape of development and poverty alleviation.

Situated at the nexus of water and energy, hydropower can help meet the realities of climate change. As renewable energy, it contributes directly to a low-carbon energy future. Hydropower's flexibility supports the deployment of intermittent renewables such as wind or solar power. Multipurpose hydropower can also support adaptation to increasingly difficult hydrology by strengthening a country's ability to regulate and store water and so resist flood and drought shocks.

**WHAT ABOUT THE RISKS?**

**T**here are risks inherent in development and operation of hydropower, many of which were the focus of passionate debate in the 1990s. These risks cross the range of financial, geological, engineering, and market concerns, with particular attention to environmental protection, resettlement, social inclusion, and sharing of the benefits of development across all stakeholders.

As a consequence, the definition of acceptable hydropower has shifted to one that recognizes the core principles of sustainable development, with attention to social and environmental—as well as economic—“bottom lines.”

This shift has been supported by a decade of better understanding and addressing what used to be overwhelming environmental and social risks. Good practices, safeguards, and self-assessment measures have emerged from a range of players, including the World Bank Group, the Equator Banks, the International Hydropower Association, the International Energy Agency, the World Commission on Dams, and the United Nations Environment Programme. These efforts have established a knowledge base for sustainable hydropower. However, implementation experience and technical capacity is lacking in many countries.

Many NGOs remain critical and cautious of hydropower. They express serious concern about the risk and difficulties of hydropower and maintain a strong commitment to stringent guidelines. At the same time there is a growing openness toward hydropower’s potential contribution to meeting energy demands, especially as a low-carbon fuel. WWF, for example, has included 400GW of hydropower in its recent energy scenario for climate change, *Climate Solutions* (2007),\* covering the range of hydro projects (beyond small hydro and rehabilitation). The priority is shifting towards development “done right” and comprehensive environmental management and benefits sharing.

**A decade of research and dialogue has significantly enhanced the sector’s awareness and understanding of environmental and social challenges, but experience in implementing new practices is limited.**

\* WWF (2007) *Climate Solutions: WWF’s Vision for 2050*.



## WHAT ARE THE PROSPECTS FOR SCALING UP HYDROPOWER?

**T**here exists abundant physical and engineering hydropower potential in developing countries. In absolute terms, the total economically feasible potential hydropower capacity in developing countries exceeds 1,900 GW, 70 percent of which (1,330 GW) is not yet exploited. This is nearly four times the current installed capacity of 315 GW in Europe and North America, and not quite double the 740 GW installed worldwide.

On a regional basis, unexploited potential as a percent of total potential amounts to:

- ▶ 93 percent in Africa
- ▶ 82 percent in East Asia and the Pacific
- ▶ 79 percent in the Middle East and North Africa
- ▶ 78 percent in Europe and Central Asia
- ▶ 75 percent in South Asia
- ▶ 62 percent in Latin America and the Caribbean\*

As a matter of scale, if Africa were to develop the same share of hydropower potential as Canada, it would realize an eight-fold increase in electricity supply and, with complementary investments in transmission and distribution, bring electricity to the entire continent with multiple additional benefits for water management and regional integration.

These estimates cover potential new (greenfield) site developments only. Significant additional amounts of energy and capacity are available from rehabilitation of existing energy and water assets, from redesign of infrastructure to meet emerging demands and opportunities, and from modification of water allocations and management (reoperation) for a different set of outcomes.

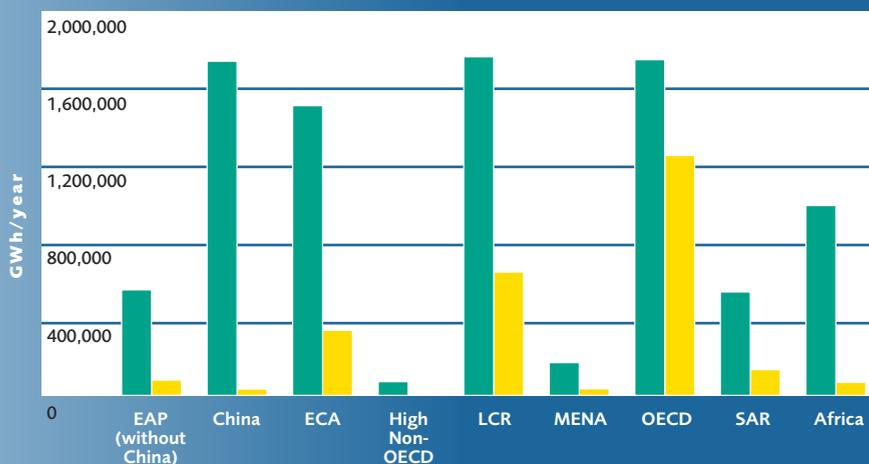
Notwithstanding the strong development rationale, the enormous technical potential, and the improved understanding of good practices, scaling up hydropower faces important constraints and barriers:

**The amount of untapped hydropower in the developing world is tremendous—nearly four times the capacity currently installed in Europe and North America.**

*\* Based on International Journal on Hydropower and Dams, World Atlas 2006 and various national statistics.*

### Economically Feasible Hydro Potential & Production (by World Bank Region)

- Economically feasible hydropower potential
- Production by hydro plants in 2004–5





- ▶ Identification and management of environmental and social risks is challenged by limited institutional capacity and experience in implementing new standards. This means refining regulatory and policy frameworks at the country/transboundary levels, building capacity among developers, as well as electricity companies and government, and enhancing transparency for stakeholders. It also means ongoing research into important environmental issues, such as emissions from reservoirs in shallow tropical sites and continuous improvement in avoiding and mitigating impacts.
- ▶ Infrastructure design based on poor hydrological data can severely compromise performance and decrease the very water management benefits the infrastructure is designed to generate. Climate change accentuates these risks for two reasons: (i) extrapolations of historical data are less reliable as the past becomes an increasingly poor predictor of the future; and (ii) hydrology is ever-changing, placing a premium on designs that maximize flexibility and operations that embrace adaptive management.
- ▶ While the potential for hydropower is known, there is a lack of planning and project prioritization. In particular, engineering studies completed years ago need to be updated with new knowledge (particularly of hydrology) as well as more sophisticated consideration of environmental and social values. As a public good, governments need to undertake strategic assessments and prefeasibility studies in order to develop a pipeline of projects and identify high-value storage sites.
- ▶ Against the demand for hydropower infrastructure is a shortage of financing, exacerbated by the current global financial crisis. This gap is most severe in the poorest countries, where the funds needed well exceed the resources of governments and donors/development banks. Yet increasing resources from the private sector requires a broad range of responses: better policies and institutions; improving payments from energy consumers; clarity in regulations for developing and operating hydro plants; and innovative financial structures that support public-private partnership projects with multiple (public and private) benefits.

**As future infrastructure will function in an ever-changing hydrology, flexibility and adaptive management skills will be critical.**

## WHAT IS THE ROLE OF THE WORLD BANK GROUP?

**T**he World Bank Group brings a diverse portfolio and renewed policy framework to these challenges.

The Water Resources Sector Strategy, approved by the Board in 2003, states that significant levels of investment in water infrastructure are required throughout the developing world. This need has subsequently been supported in the WBG's *Sustainable Infrastructure Action Plan* (2008), the *Clean Energy Investment Framework* (2007), and the *Strategic Framework on Development and Climate Change* (2008).

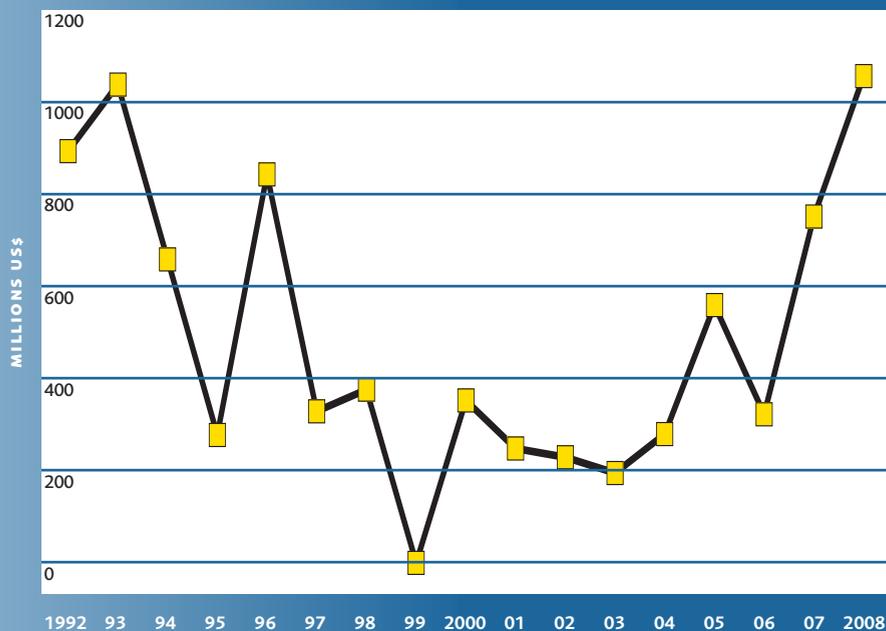
The WBG's recent lending reflects this re-engagement. Sixty-seven hydropower projects have been approved since FY2003, amounting to \$3.7 billion in WBG contributions (\$3.2 billion for hydropower components) to support a total of \$8.5 billion and nearly 9,700 MW\* in project investments. New lending increased significantly: from less than \$250 million per year from 2002-04, to \$500 million per year from 2005-07. In FY08, new lending exceeded \$1 billion.

Major projects have been approved in Africa (Senegal, Democratic Republic of Congo, Sierra Leone, and Uganda) and Asia (People's Democratic Republic of Laos, India), as have several rehabilitation projects in Eastern Europe (Ukraine, Macedonia, and Georgia). A range of new projects is under discussion in India, Vietnam, Rwanda/Nile Equatorial Lakes, Ethiopia, Guinea, Brazil, Ro-

*\* Includes rehabilitation that ensures availability of existing capability at Inga (1,300 MW) and plants in Niger (1,338 MW).*

### Hydropower Components by Approval Year

(Value of WBG Contribution to Multipurpose Hydropower Components per FY)

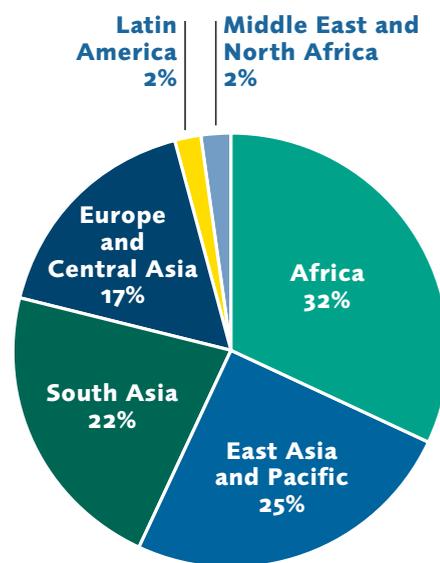


mania, Turkey, Georgia, and Tajikistan, as are carbon finance projects in Russia, Sri Lanka, and Madagascar. The new projects are larger and more complex.

The WBG now supports a range of hydropower investments, from small run-of-river to rehabilitation to multipurpose projects. Run-of-river projects currently account for the largest portion of the portfolio in both value and number of projects. Storage and rehabilitation account for about half the portfolio. Two significant rehabilitation projects, totaling \$480 million, have been approved recently, bringing the total since 2004 to \$865 million over 14 projects, mainly in Africa and Eastern and Central Asia.

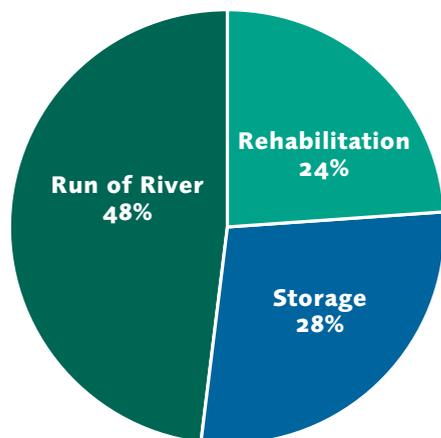
The WBG's role extends well beyond lending, to technical assistance, knowledge sharing, policy dialogue, economic and sector work, and the range of support provided during project preparation. Building on services and safeguards developed even during the downturn in hydropower lending in the 1990s, the WBG now advises both government and developers within the realigned model, with its focus on environment, social values, and transparent trade-offs.

The World Bank Group has adapted financial instruments over time to meet changing needs and opportunities. The share of lending from the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA) has fallen from 99 percent of the lending portfolio to 58 percent. Over the same period, a range of new instruments were introduced: IFC increased support (now 20 percent), carbon finance (now 5 percent), and guarantees (now 17 percent). The Multilateral Investment Guarantee Agency (MIGA) has played an important role in major new projects, such as Nam Theun 2 and Bujagali, with total guarantees of \$315 million since 2005.



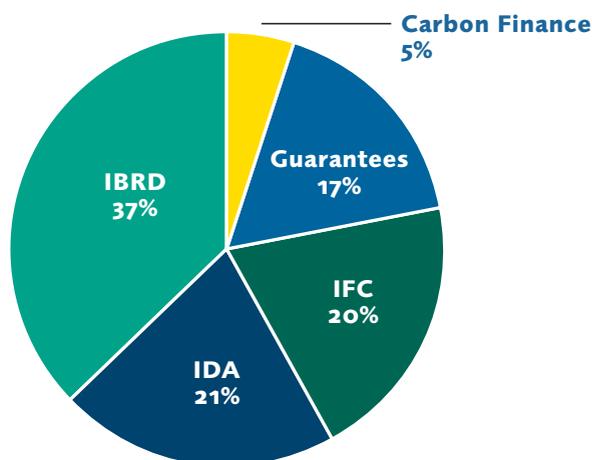
**Hydropower Components by Region**

(FY 2003-2008)



**Type of WBG Projects**

(Breakdown by Value)



**WBG Support of Hydropower Components**

(Approvals FY 2003-2008)

## HOW CAN THE WORLD BANK GROUP CONTRIBUTE TO EFFECTIVE, SUSTAINABLE HYDROPOWER DEVELOPMENT?

**T**he ultimate objective of the WBG's engagement is to assist countries to maximize the value of their hydropower resources, fully integrating the principles of sustainable development. This task embodies good practice in energy planning and development, as well as links with the multiple dimensions of water management and environmental and social protection. It encompasses choices among storage, run-of-river and rehabilitation projects, as well as finding the right balance of public and private allocation of risks, responsibilities, and benefits.

The World Bank Group's contribution to scaling up hydropower for development is structured along two reinforcing tracks.

**TRACK 1: Investment Lending.** The WBG will lead its own increase in direct investment in high-quality projects, executed in a timely manner. A promising pipeline of around \$2 billion in projects under preparation for the next several years has been indentified across the World Bank and IFC. This amount does not include projects under preliminary discussion with clients.

Long-term sustained lending will require a strong focus on energy and water planning at the country and regional levels. It will also require a concerted focus on early preparation of prefeasibility and feasibility studies, and an increase in resources for project preparation. Partnerships among financing sources, such as private financiers and emerging players from China, India, and Brazil, will be needed to leverage direct WBG financing.

### What are the different types of hydropower projects?

There are many types of hydropower projects being implemented around the world, ranging from small to large, and solely hydropower to multi-purpose infrastructure. The World Bank Group's portfolio includes run-of-river, rehabilitation, and water storage projects that feature hydropower.

#### ▶ **RUN-OF-RIVER**

Projects that do not affect the natural river flow more than for daily storage.

#### ▶ **REHABILITATION**

Upgrading, refurbishing, and changing operations at existing facilities, which can be run-of-river or storage projects.

#### ▶ **STORAGE**

Allows for seasonal collection of water, which can have multiple uses.



In addition to direct development benefits, WBG lending will help demonstrate the application of progressive approaches to hydropower and the WBG's role as a partner in developing sustainable water infrastructure projects. The portfolio is expected to maintain its blend of small, medium and large rehabilitation and complex transboundary investments. However, the size and the quality of the industry's scale-up will depend on both the investment environment the strength of the sector's foundations.

The second track focuses on building the foundations of the sector for increased WBG and non-WBG investments.

**TRACK 2: Strengthen Sectoral Foundations.** The second track of the WBG's approach to scaling up focuses on the environment for hydropower development. Sectoral foundations need strengthening through expanded policy development, cross-sectoral planning, capacity building, and the mobilization of funds. This track also addresses the importance of the public sector's role across the different phases of hydropower development, and of helping governments define their roles in planning, resource management, regulation, and direct investment (including public/private partnerships).

The WBG can help maximize the strategic value of hydropower supporting five key elements:

► **Scale up financing** by improving the environment for private sector development and encouraging new combinations of financing instruments to address loan tenures, local currency financing, and similar financial challenges. This task is even more important in the current financial crisis, and will need to go beyond new sources such as carbon credits and blended public/private sector investments for multipurpose projects. The recent extension in maximum maturities



on IBRD loans represents a positive development as these terms better match the requirements of projects like hydropower with long gestation periods.

▶ **Promote good practice** to address the challenges of cross-sectoral project design and development, with particular attention to environmental, social, and economic benefits—the “triple bottom line” generated by each project. This element focuses on development and application of operational policies, knowledge management and training, and a range of technical assistance activities.

▶ **Strengthen planning** by supporting governments in understanding the strategic value of hydropower through integrated cross-sectoral planning, identification of strategic storage sites, improvement of hydrological data and analysis, and mainstreaming hydropower into climate-change programs. A significant increase in funds and technical assistance for prefeasibility studies is recommended to develop pipelines of quality projects.

▶ **Leverage regional development** by exploring synergies among complementary projects and development opportunities that can benefit local communities and contribute to broader development objectives. Key mechanisms include multipurpose projects, revenue management, and benefits-sharing.

▶ **Build partnerships** for planning, financing, and promoting good practice through global dialogue and continuous improvement in sustainable hydropower. For example, the WBG’s support of the Hydropower Sustainability Assessment Forum\* follows an established tradition of contributing to multi-stakeholder initiatives.

**The two tracks—investment lending and strengthening sectoral foundations—support and reinforce each other.** For example, strengthening the enabling environment for the private sector will enhance opportunities to leverage WBG financing, while increased capacity in environmental and social management will reduce the transaction costs and time required for project preparation. Enhanced planning and strategic assessment of hydropower resources will have the dual impact of maximizing the value of storage opportunities and identifying companion investments for greater development impact.

**The private sector plays a critical role in providing the required financial management and technical skills.**

*\* The Hydropower Sustainability Assessment Forum is a multistakeholder group that aims to establish a broadly-endorsed sustainability assessment tool to measure and guide performance in the hydropower sector based on IHA Sustainability Assessment Protocol (2006). Participants include the governments of Zambia, China, Norway, Iceland, Germany, the Equator Banks, WWF, the International Hydropower Association, Transparency International, Oxfam International, The Nature Conservancy and the World Bank Group.*

## LOOKING AHEAD

**H** ydropower is called upon to play a strong, multidimensional role in sustainable development and poverty alleviation. Moving forward, hydropower development must adopt the dual perspective of integrated water resources management and energy development that takes into account the broad range of social, economic, and environmental issues. Scaling up also calls for mobilizing adequate financial resources, building capacity across all levels of the sector, and expanding the pipeline of high-value investments in each country or basin. The private sector brings critical resources and skills, but relies on effective public sector participation to ensure a stable and inviting environment for investments.

Building on its strong increase in lending over the last five years, the World Bank Group will continue to help governments maximize the value of hydropower investments, in an environmentally and socially sustainable manner, through lending and strengthening the basic foundations of the sector.







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