Water Working Notes

Note No. 21, June 2009

DIRECTIONS IN HYDROPOWER: SCALING UP FOR DEVELOPMENT

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ABBREVIATIONS AND ACRONYMS

Bank	World Bank (IBRD/IDA)
Board	World Bank Group Board of Directors
CEIF	Clean Energy Investment Framework
CWRAS	Country Water Resources Assistance Strategy
EAP	East Asia and Pacific Region
ECA	Europe and Central Asia Region
FY	Fiscal Year
GDP	Gross Domestic Product
GW	Gigawatt
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IEA	International Energy Agency
IFC	International Finance Corporation
IHA	International Hydropower Association
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Management
LCR	Latin America and Caribbean Region
MDB	Multilateral Development Bank
MDG	Millennium Development Goal
MENA	Middle East and North Africa Region
MIGA	Multilateral Investment Guarantee Agency
MW	Megawatt
NGO	Non-governmental Organization
OECD	Organization for Economic Co-operation and Development
SAR	South Asia Region
SIAP	Sustainable Infrastructure Action Plan
TW	Terawatt
UN	United Nations
UNDP	United National Development Programme
UNEP	United Nations Environment Programme
WBG	World Bank Group
WWF	World Wildlife Fund for Nature

ACKNOWLEDGEMENTS

This report was prepared by a World Bank Group team led by Daryl Fields, including Lars Odegard, Laura French and Geoff Revell (Consultant), under the overall guidance of Jamal Saghir, Director Energy, Transport and Water and Abel Mejia, Water Sector Manager. The team gratefully recognizes the valuable comments and suggestions from numerous World Bank, IFC and MIGA staff from regional operations as well as sector specialties. The Water, Energy, Environment and Social Development Sector Boards provided additional guidance. We acknowledge in particular the advice of Amarquaye Amar, Vahid Alavian, Darius Lilaoonwala, Maher Abu-Taleb, Guy Alaerts, Susan Bogach, Moez Cherif, Elena Correa, Ousmane Dione, Pankaj Gupta, Rafik Hirji, Ron Hoffer, Iftikhar Khalil, Peter Kolsky, Fernando Lecaros, Roger Morier, Dejan Ostojic, Alessandro Palmieri, Judith Plummer, Bob Taylor, Dana Younger, Susanne Scheierling, Marcus Wishart, Heather Worley, and Mi Hyun Bae.

EXECUTIVE SUMMARY

The role of hydropower and multi-purpose water infrastructure is expanding, with important opportunities for poverty alleviation and sustainable development. The World Bank Group, encompassing the World Bank, IFC and MIGA, recognizes this timely and important period for hydropower.

Since the 2003 commitment of the World Bank to re-engage in water infrastructure, lending has increased significantly. This document, *Directions in Hydropower,* outlines the World Bank Group's (WBG) further commitment. It summarizes key issues in scaling up hydropower: 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 out priorities for both lending and non-lending activities to strengthen the foundations of the industry. The goal is to maximize the strategic value of hydropower investment to economically, environmentally and socially sustainable development.

Hydropower Infrastructure in Development and Poverty Alleviation

The role of hydropower infrastructure in development and poverty alleviation is increasingly multi-faceted. In addition to bringing electricity to the 1.6 billion people who lack access, hydropower offers a hedge against volatile energy prices and can play an important role in energy trade and regional power pools. The imperatives of water management are also repositioning hydro infrastructure. A deeper understanding of potential harmful impacts of significant hydrological variability on economic growth puts a premium on better water resources management and infrastructure, especially in the world's 260 international river basins. Hydropower infrastructure also plays two critical roles in meeting the climate change challenge: renewable hydro energy offers an alternative to fossil fuels, and well planned, high-quality water resources infrastructure can help countries adapt to changes in hydrology.

A decade of learning about environmental and social risks has shifted the definition of sustainable hydropower infrastructure. The World Commission on Dams, the followup work of the UN Dams and Development Program, sustainability initiatives of both industry and nonindustry organizations, and the requirements of financing institutions have redefined the standards for environmental and social management. On this basis, there is a growing openness in the NGO community to consider hydropower a tool in a low-carbon future.

However, hydropower is and will remain risky and sometimes controversial. Implementation of good practices is challenged by lack of capacity throughout the industry and in client countries, and by weak regulatory and policy frameworks. Inherent complexities and the multisectoral, multi-objective nature of hydropower projects further emphasize the importance of a strong risk management approach to the sector. This framework has to encompass both careful project preparation and supervision (including efficient decision making) and strengthening of the sector's basic foundations along the entire life cycle of hydropower investments.

Current Opportunities and Constraints

Hydropower currently accounts for about 20 percent of the world's electricity supply and over 80 percent of the supply from (nonbiomass) renewable resources. Scaling up hydropower is not limited by physical or engineering potential: OECD countries have exploited over 70 percent of economically feasible potential. Yet only 23 percent of hydropower potential in developing countries has been exploited. Indeed, 91 percent of unexploited economically feasible potential worldwide is located in developing countries, with one quarter in China. In absolute terms, the 1330 GW of the conservative

estimate of unexploited potential in developing countries far exceeds the existing installed capacity of 437 GW in developing countries and 315 GW in North America and Europe.

The challenges are to define hydropower's strategic role at the country, basin, and regional levels, and to mobilize adequate resources and skills to realizing its value in an environmentally and socially sustainable manner. Key constraints in scaling up hydropower infrastructure lie in lack of financing, lack of comprehensive planning and adequately assessed project pipelines, limited hydrological data and analysis, and unsettled conditions that discourage private sector participation.

The World Bank Group's Role in Scaling-up Hydropower

New dimensions of value for hydropower projects, rising standards for environment and social management and governance, and the active participation of a wider range of players create new opportunities to assist the client countries of the World Bank Group (WBG). This document describes two parallel but reinforcing tracks for action by the WBG: increased investment and sector strengthening.

On the first track, the WBG must lead its own scale-up through direct investment in good-quality projects, executed in a timely manner. After a decline in lending during the late 1990s and early this decade, WBG lending for hydropower has increased from a three-year average of US$250 million per year (2002–04) to US$500 million per year (2005–07) to more than US$1 billion in fiscal year (FY) 2008. Consistent with industry-wide trends, the World Bank Group's lending prospects in hydropower shows renewed strength, with more than US$2 billion in possible projects for the next several years. Strong programs are emerging in Africa and South Asia, but greater focus is needed in Central Asia and Latin America, and in accelerating broad basin-level plans. These projects must be measured not only in terms of lending volumes but also in terms of sustainability and the triple bottom line of economic, social and environmental value.

On the second, parallel track of sector strengthening, the WBG has an important role in leveraging sources of finance and broadening development benefits by strengthening the basic foundations of the sector. The WBG's *Directions in Hydropower* identifies five priorities for engagement:

1. **Scale up financing:** Address financial barriers and constraints to realizing projects, and increase resources to realize good practice in project preparation and supervision.
2. **Promote good practice**: Mainstream current knowledge and invest in continuous improvement, with specific emphasis on governance (for example, procurement), environmental management (for example, environmental flows), social inclusion (for example, indigenous communities) and hydrological data and analysis.
3. **Strengthen planning:** Support governments, through adequate planning and enabling policies, regulatory frameworks, and institutions, to help realize the strategic value of hydropower. This task calls for significant investment in prefeasibility studies, for development of a pipeline of quality projects, and for river basin planning to ensure identification of high-value storage sites.
4. **Leverage regional development**: Explore synergies among complementary projects and development opportunities for the benefit of local communities, either directly through benefits-sharing or indirectly through poverty-targeted revenue management.
5. **Build partnerships:** Enhance cooperation among internal and external players to strengthen financing options and maintain global dialogue on sustainability.

Specific attention to climate change is embedded in each element.

1 INTRODUCTION

After a period of stagnation, the character of hydropower infrastructure is changing. Emerging global dynamics are recasting the role and value of hydropower in development, recognizing its potential contribution to a complex web of energy security, water security and regional development and integration. As a renewable energy resource, hydropower's dual role in climate change adaptation and mitigation is critically important. As new dimensions of value evolve, so does progress in managing the risks and negative impacts associated with development projects, particularly those related to ecosystem services and social inclusion. Increasingly, the international community is embracing sustainable development as the paradigm for hydropower investments.

Scaling up hydropower is not limited by physical or engineering potential. Rather, the challenges lie in defining hydropower's strategic value and managing risks in each country and basin which can involve complex trade-offs. This requires careful attention to project preparation and supervision as well as an improved enabling environment. These, in turn, require adequate resources, knowledge, and skills across multiple stakeholders.

The World Bank Group (WBG) has a clear role to play in maximizing the development potential of hydropower resources. It must lead its own scale-up through direct investment in development-driven, quality projects, executed in a timely manner. It has a specific role in addressing complex projects that demand transparent, well-informed trade-offs and integration of environmental and social values, alongside support to the range of hydropower infrastructure investments, including rehabilitation and across the range of sizes. In addition, its role in facilitating policy dialogue and integrating diverse players embraces the evolving roles and partnerships of the public and private sectors.

Hydropower is the quintessential sustainability opportunity *and* challenge in that its planning and implementation must attend adequately to economic, social, and environmental considerations. This document is structured to weave these three considerations together; it does not address them in separate chapters. A discussion of financing, for example, includes the possibility of green bonds, and sector planning encompasses strategic environmental assessment. The intent is to capture the benefits of integration without sacrificing attention to any contributing element.

This document is presented in three parts. The first part—Hydropower Infrastructure and Development—describes the role of hydropower in sustainable development. Potential benefits, risks, opportunities and constraints are discussed. The second part—the World Bank Group's Role in Scaling Up for Development—outlines the role of the World Bank, the IFC and MIGA in supporting sustainable hydropower infrastructure. It describes the World Bank Group's current activity and sets out a two-track approach for lending and non-lending activities. The third part draws overall conclusions in "Looking Ahead".

2 HYDROPOWER INFRASTRUCTURE AND DEVELOPMENT

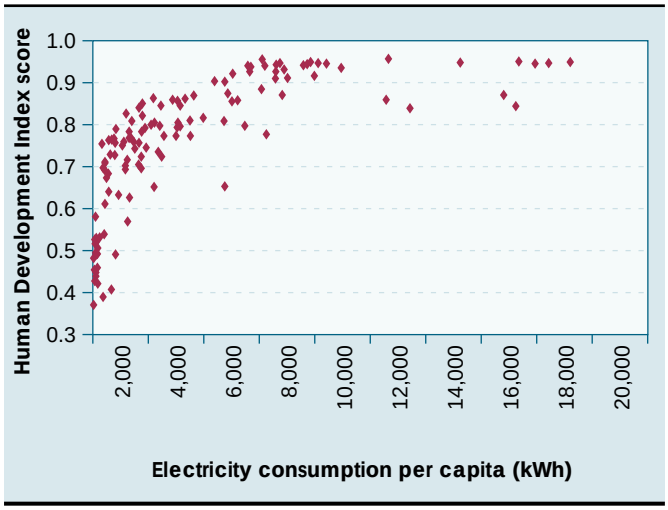
Hydropower in the Global Energy Context

Hydropower accounts for roughly 20 percent of the world's electricity supply and over 88 percent of (non-biomass) renewable energy produced. Production, however, is unevenly distributed: nearly 45 percent is in developed countries such as Norway, Canada, and the United States. In these countries hydropower is the backbone for both electricity supply and water management infrastructure, and has helped shape economic growth. Globally, only 30 percent of the hydropower potential that would be economically feasible to develop is operational; 91 percent of the unexploited potential is located in developing countries, with nearly 25 percent in China. The amount of potential power is tremendous. In Sub-Saharan Africa, for example, a potential 925 TWh/yr (about 250 GW) is unexploited. If Africa were to develop the same share of its hydropower potential as Canada has (66%), it would create an 800 percent increase in electricity supply and, with complementary investments in transmission and distribution, could make access to electricity universal on the continent with multiple additional benefits for water management and regional integration.

New Dimensions of Value

Emerging trends, driven by more sophisticated energy markets, climate change, and increased attention to water management and regional integration, are changing hydropower's potential contribution to sustainable development. The electricity access agenda remains critical. Currently, the average rate of electricity access is below 50 percent in more than half of developing countries. Rates are particularly low in Africa (6 percent in the Democratic Republic of Congo, for example) where limited access is estimated to reduce GDP growth by 2–4 percent. Even in countries with higher rates, the absolute numbers of poor people without access are significant. In India, for example, where access exceeds 55 percent, some 500 million are still without power. The poverty and economic growth consequences are manifest in health, education, the investment climate, and environmental quality. Energy available to citizens in countries with the highest Human Development Index scores is up to eight times higher than in those with the lowest scores (Figure 1).

Figure 1 Human Development and Electricity Consumption



Source: Modified from Human Development Report 2006: Beyond Scarcity: Power, poverty and the global water crisis (UNDP, 2006).

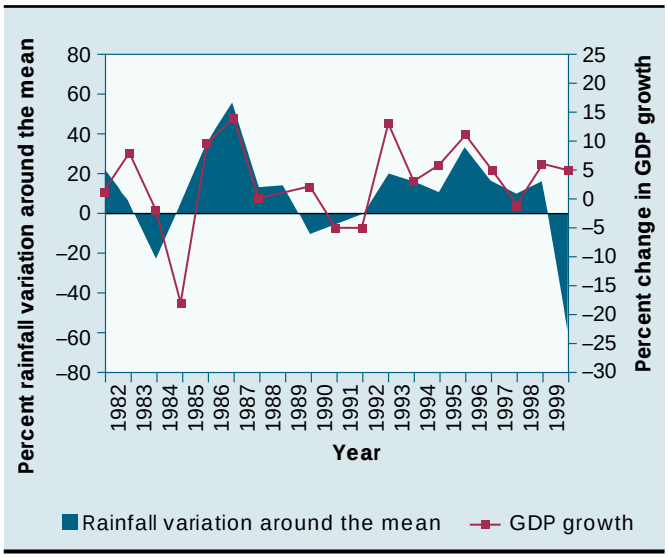
Volatile oil prices have disproportionate effects in poorer regions. Each US$10 increase in the price of a barrel of oil reduces GDP by 0.76 percent in countries with per capita GDP between US$300 and US$900, and by 1.47 percent—nearly double—in countries with per capita GDP less than US$300.[1] The implications for hy-

[1] World Bank. 2005. The Impact of Higher Oil Prices on Low Income Countries and the Poor: Impacts and Policies. ESMAP Knowledge Exchange Series.

dropower are twofold: first, in many countries, where hydro is already the least-cost option for power generation, volatile oil prices will further increase its cost advantages; second, in the face of both oil price volatility and foreign exchange pressures, locally sourced hydropower can be a meaningful protective hedge.[2]

The imperatives of water management also are repositioning hydropower infrastructure in the development equation. Developing countries heavily dependant on rainfed agriculture are particularly vulnerable to hydrological variability (Figure 2). Some can be considered "hostage to their hydrology," with very limited ability to manage extreme weather events[3] and an increasingly complex and contentious web of water demands. The Tanzania Country Water Resources Assistance Strategy (2006), for example, cites abundant water, but infrastructure that cannot meet increasing demand or provide the necessary buffer against shocks from floods and droughts.[4] In the developed world as well, the need to manage difficult hydrology is a cornerstone of major dam projects underway, and is increasingly driving revisions in operation.

Figure 2 Ethiopia: Rainfall Variation around the Mean and GDP Growth



Source: Ethiopia: Managing Water Resources to Maximize Sustainable Growth. Country Water Resources Assistance Strategy (World Bank, 2006)

In this context, hydropower projects, and particularly those combined with storage projects, should adopt the principles of integrated water resources management (IWRM) to take into account multiple users of water and multiple objectives in managing and regulating it. IWRM should be pursued to maximize hydropower's environmental, social, and broader economic ("triple bottom line") benefits. These benefits may be public or private, revenue- or non-revenue generating. IWRM calls for project identification, design, and operations to take into account such diverse water uses as irrigation, navigation, fisheries, and drinking water. While multiple uses require careful financing and project management, building on synergies can generate broader benefits at small incremental cost.

Hydro infrastructure has important spatial dimensions, with potential benefits to regional development. Hydropower's contribution to

Box 1 A word on terminology

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

[2] Without appropriate management, high oil prices can also lead to overexploitation of hydro resources, with environmental, social, and longer-term economic consequences.
[3] Grey, D. and C. Sadoff (2007), "Sink or Swim? Water Security for growth and development" in Water Policy 9 (2007) 545–571.
[4] The World Bank. 2006. United Republic of Tanzania. Water Resources Assistance Strategy: Improving Security for Sustaining Livelihoods and Growth.

energy access extends beyond additional generating capacity to regional, national and transboundary systems integration and efficiency. Increased regional integration, through emerging power pools and coordinated electricity grids—particularly in western and southern Africa, on the Indian subcontinent, in the Mekong region of East Asia, and in Europe and Central Asia—takes advantage of hydropower's differentiated services and capabilities to stabilize power grids and increase the efficiency of the system as a whole. Additional value is derived from:

- Ancillary services such as black start capability,[5] load following, fast-responding reserves
- Balancing generation across areas with different water flow reliability
- Coordinating with thermal units to minimize operational costs of the system as a whole.

The expansion of pumped storage investments in Eastern Europe, for example, demonstrates the value of hydropower's regulating capacity and load-following capabilities.

A corollary to regionalization of energy systems, water management is increasingly focused at the river basin level, regardless of national borders. A regional development approach addresses both upstream and downstream riparian needs, expanding the scope and benefits of water management beyond physical distribution of water and setting a foundation for regional cooperation. Africa, in particular, is addressing the political reality of its multiple states, markets, and natural resources and is increasingly interested in moving hydropower and water infrastructure investments from its national to its regional agendas. Water management also has broader security implications in many parts of the world. The potential of regional hydropower as a tool for regional cooperation and development is an increasingly important dimension of value.

Hydropower infrastructure investments offer entry points for broadbased community, regional, and transboundary development. Investments in roads, social infrastructure, communications, and skills-building in large projects can be leveraged to increase benefits to 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 development landscape.

Box 2 Water, power, and regional cooperation in Africa

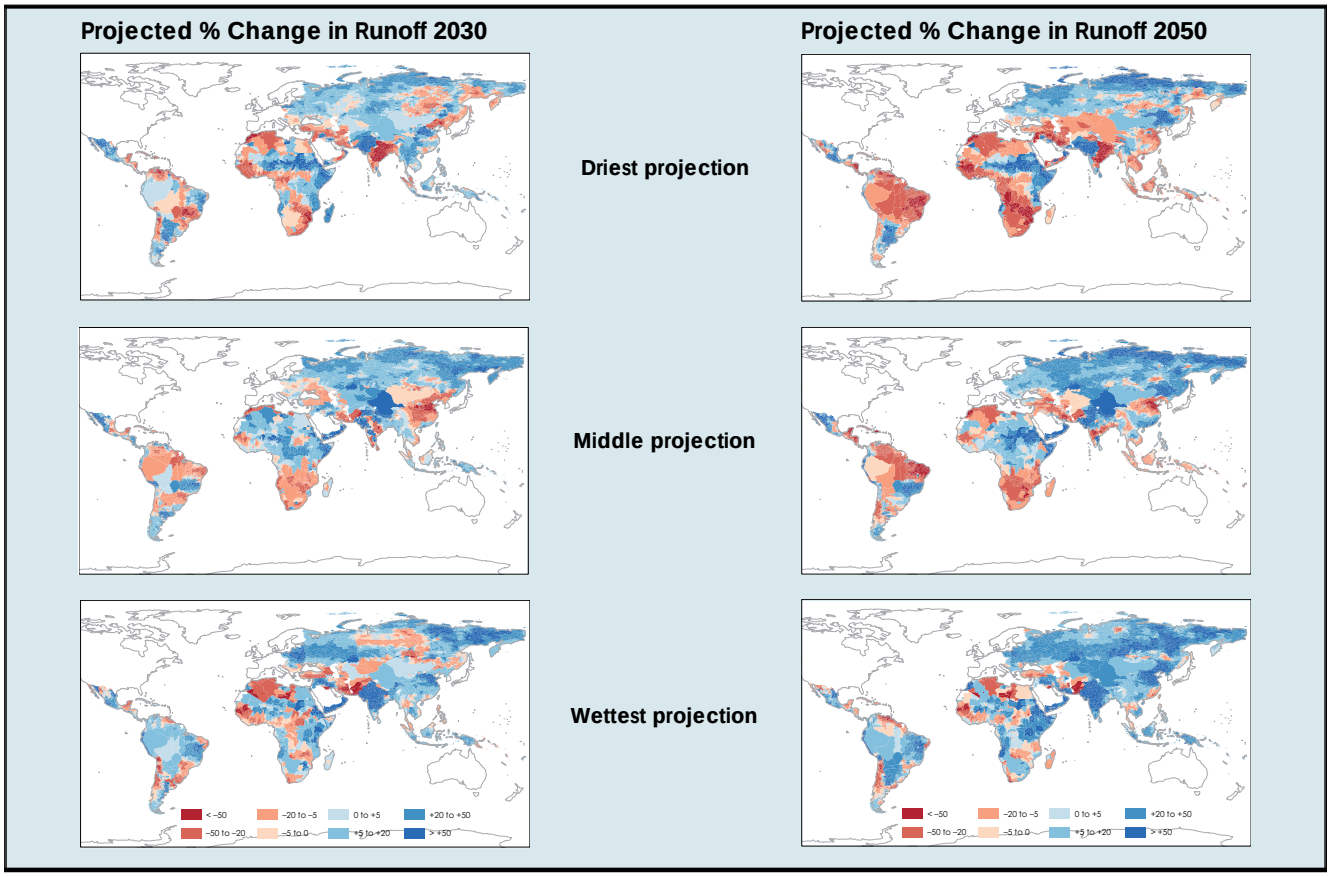
African countries share 34 rivers that cross at least one national border. As many as 28 are shared by 3 or more countries. In fact, every country in Africa has at least one international river. Not surprisingly, transboundary water resources management lies at the heart of development in many of these countries.

Ethiopia, for example, sits at the headwaters of three significant transboundary rivers whose waters are shared with numerous riparian states. Ethiopia's Country Water Resources Assistance Strategy (CWRAS) emphasizes the potential for regional cooperation in power production to strengthen regional relations and promote increased economic cooperation and integration. In addition to hydropower, the CWRAS outlines the downstream benefits of cooperatively constructed dams. These include regulation of sediment transport and the potential for storage in the Ethiopian highlands to reduce evaporation in the river system, thereby increasing the total volume of water available to the riparians.

Hydropower is and will remain an essential tool in managing both water and energy pressures—a regional opportunity and challenge. Beyond project development, scaling up hydropower in Africa must be accompanied—or preceded—by investments in diplomacy and institution building across national boundaries. As in the Nile Basin, the Senegal River Basin, and the Zambezi, regional programs and visions for development need to be nurtured to ensure hydropower development brings security and peace, and avoids externalities and resource management conflicts. This calls for a long-term approach punctuated with short-term results, and a consistent long-term commitment to capacity building coupled with project implementation in the short term.

[5] The ability to restart generation without external energy or electricity source.

Figure 3 Projected Percent Change in Runoff for 2030 and 2050 at the Catchment Level



Source: Adapted from World Bank. 2009. "Water and Climate Change: Understanding the risks and making climate-smart investment decisions", Washington, DC. (forthcoming).

Hydropower infrastructure plays a dual role in meeting the climate change challenge. It is the largest source of affordable renewable energy, and as a low-carbon fuel, plays a critical role in mitigating greenhouse gas emissions.[6] For example, increasing the share of hydro in the Indian energy mix from 24 to 35 percent, as proposed by the Indian government, will avoid 138 mt CO_2 per year from alternative coal generation, equal to 8.5 percent of emissions in India in 2015. Indirectly, hydropower can leverage other renewables such as wind and solar by providing reserve capacity to meet peak demands and enhancing reliability of power grids. At present, hydropower accounts for more than half of the World Bank Group's renewable energy portfolio.

Hydropower infrastructure also plays a role in climate adaptation. Climate change will exacerbate hydrologic variability, the consequences changes in the long term water balance and intensification of extreme weather events, and the challenge of managing a scarce resource subject to multiple demands (Figure 3). Infrastructure management and operations will need to adapt to more variable hydrology while also taking on the role of water management, especially where multiyear storage is economically, environmentally, and socially feasible. Among a variety of adaptation tools, hydro infrastructure can help meet increasingly demanding levels of infrastructure for water security.

[6] The World Bank Group considers hydropower of all sizes and configurations to be renewable.

Focus on Sustainable Infrastructure

There has been a fundamental shift in the definition of quality in hydropower projects, driven by the varied imperatives of sustainable development. Poorly identified and managed environmental risks and a narrow approach to resettlement issues, based on compensation for land, contributed significantly to the move away from hydropower investments in the 1990s. It is now broadly recognized that hydropower must be developed in the context of broader development goals, including:

i. Internalizing the impacts on affected populations

ii. Responsible environmental management (for example, ecosystem services and social impacts, both upstream and downstream of facilities, and linkages, with a focus on ecosystem services)

iii. Leveraging of regional development opportunities for social inclusion, poverty alleviation, and social development (for example, social infrastructure, benefit sharing with poor and local communities—beyond compensation)

iv. Integrated water and energy management (for example, more informed and transparent tradeoffs across economic, social, and environmental values)

v. Institutional development (for example, compliance and sustainability of operations.)

The shift is the result of a decade of increased understanding of and engagement with environmental and social risks once considered overwhelming. The World Commission on Dams produced a useful reference document that identifies core values and outlines important strategic priorities for dams. The United Nations Environment Programme's (UNEP) followup to the commission, the Dams and Development Project,[7] issued its final report in July 2007. *Dams and Development: Relevant Practices for Improved Decision-Making* is a positive and constructive compendium addressing environmental and social concerns. These efforts complement the industry's own efforts to raise awareness and improve practices through the International Hydropower Association's *Sustainability Assessment Protocol*[8] and website for good practices. Consistent with these efforts, World Bank Group projects are themselves subject to the "most sophisticated set of policies, operational procedures, and guidelines amongst the international donor community."[9] These are prompting innovative approaches to sustainability.

The challenge now is to systematically and effectively apply these enhanced environmental and social standards. Many countries understand the benefits of good practice, but considerable work is needed to embed appropriate regulatory and policy frameworks and capacity into project design, construction, and operations, and to ensure developers understand and employ such practices.

Views from Stakeholders

The unanimous endorsement of the *Water Resources Sector Strategy (2003)*[10] by the World Bank Group Board reflects a strong view that infrastructure investment is central to the Bank's mission of poverty reduction. Several countries' response went further to call on management to immediately support two high-risk, high-reward projects in each region. At both country and regional levels, hydropower is emerging as a critical tool for renewable energy and water management. At a 2006 Africa Inter-Ministerial Conference on Hydropower and Sustainable Development, ministers committed to "working together to unlock the hydropower potential of Africa as a major renewable energy option to promote sustainable development, regional integration, water and energy security and poverty alleviation."

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[7] http://www.unep.org/dams
[8] http://www.hydropower.org
[9] World Commission on Dams (2000), *Dams and Development: A New Framework for Decision-Making.* Earthscan.
[10] The World Bank. 2003. "Water Resources Sector Strategy." Washington, D.C. 2003.

The Government of India has set the target for India's optimum power system mix at 40 percent from hydropower and 60 percent from other sources.

The hydropower industry is operating at capacity. Up to 2008, consultants and equipment manufacturers experienced a sharp upswing in business and there is cautious optimism about the industry's growth prospects. However, fears persist about the risks of such projects, especially in low-capacity countries. Governance and corruption are considered the "most problematic issues."[11]

Some non-governmental organizations (NGOs) remain critical of dams and hydropower, although partnerships are emerging. NGOs focus on the key concerns of environmental impacts, resettlement and attendant social and livelihood consequences. Some groups maintain a strong and vocal single-objective philosophy and many follow the World Commission on Dams framework, variously supporting only the strategic priorities or the full set of 26 guidelines. At the same time, there is a growing recognition among NGOs of hydropower's potential contribution to meeting energy demands as a low-carbon, renewable energy resource.[12] Adopting a development perspective, they emphasize the risks and difficulties of "doing dams right" and advocate careful environmental management and benefits-sharing. While this debate continues, there is a healthy recognition of the need to balance the discussion by keeping the principles of water management and by implementing them pragmatically. For example, several major NGOs are currently collaborating with the World Bank Group on hydropower initiatives and are active members of the Hydropower Sustainability Assessment Forum.[13]

Risks Remain

Notwithstanding the expanding value of hydropower, and the progress made in understanding key elements of sustainability, risks remain. These risks are inherent in the complexities and uncertainties of hydropower projects: high capital costs; uncertain geology, construction scheduling, and contract management; climate change and variable hydrology; evolving and uncertain market rules; multidisciplinary and cross-sectoral project design; and corruption. Of particular concern are the risks associated with environmental management, social inclusion, and appropriate sharing of benefits and rents. These are becoming more complex and less predictable in the face of changing hydrology and increasing social pressures. In Lake Victoria, for example, the combination of natural and human interventions—including hydropower projects—has resulted in serious declines in lake levels and disruption of livelihoods. On the social side, some countries are introducing new policies to share benefits, but the mechanisms to implement them are poorly defined.

These risks can vary considerably across projects. All hydropower projects are, and will remain, risky and sometimes controversial. While small run-of-river projects and rehabilitation projects are considered less risky because there are fewer environmental and social impacts, they can be particularly subject to hydrological risks and, in the case of rehabilitation, unforeseen equipment and civil works complications.

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[11] Casartelli, Gian (2007) "The Role of the World Bank in Hydropower and Water Resources Optimization: The Views of the Industry." Prepared for the World Bank.

[12] For example, WWF includes 200 GW of hydropower in its recent energy scenario for climate change, mainly from new large investments (WWF (2007) *Climate Solutions: WWF's Vision for 2050.)*

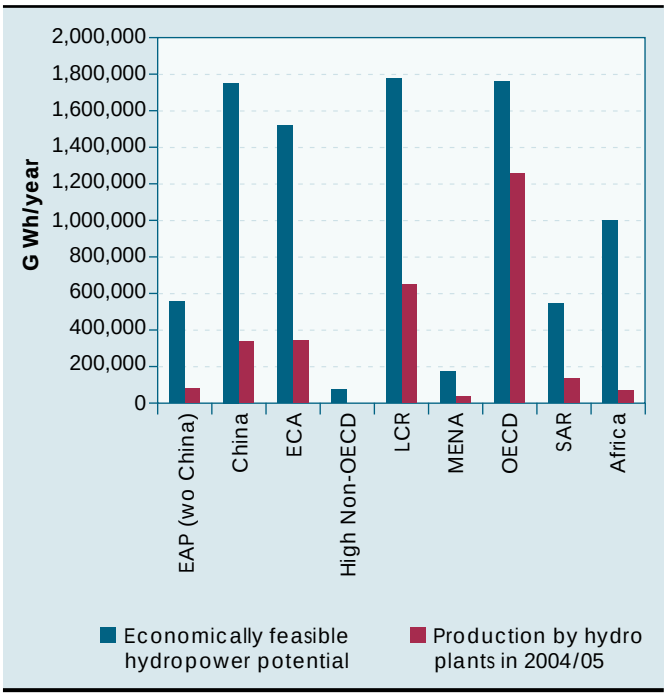
[13] The Hydropower Sustainability Assessment Forum (HSAF) is a collaboration of representatives from different sectors who aim to establish a broadly endorsed sustainability assessment tool to measure and guide performance in the hydropower sector. They are jointly reviewing and recommending improvements to the IHA Sustainability Assessment Protocol (2006). The IHA Sustainability Assessment Protocol was developed as a measuring tool to assess social, environmental and economic performance of hydropower projects and operating facilities against criteria described in the IHA Sustainability Guidelines (2004). Both the IHA Sustainability Guidelines (the "Guidelines") and the IHA Sustainability Assessment Protocol (the "Protocol") can be viewed at *www.hydropower.org.*

Hydropower projects, therefore, emphasize the need for transparent and effective risk management in project identification, preparation, construction, and operations. Good risk management, a core function of the developer, is also the purview of financiers (in ensuring good project preparation), governments (in delineating and regulating public good aspects and offtake provisions), and stakeholders (in ensuring good project preparation and monitoring post-construction implications).

Opportunities

In developing countries, economically feasible potential hydropower capacity exceeds 1,900 GW, 70% of which (1330 GW) is not yet exploited. This compares with current installed capacity of 315 GW in Europe and North America, and 730 GW worldwide. On a regional basis, only 7 percent of economically feasible hydropower potential has been exploited in Africa, 18 percent in East Asia and the Pacific, 21 percent in the Middle East and North Africa, 22 percent in Europe and Central Asia, 25 percent in South Asia and 38 percent in Latin America and the Caribbean (Figure 4).

Figure 4 Economically Feasible Hydro Potential & Production (by World Bank Region)



Source: Based on International Journal on Hydropower and Dams, World Atlas 2006 and various national statistics.

These measures cover only potential new (greenfield) site developments. Additional energy and capacity are available from rehabilitation of existing energy and water infrastructure portfolios, whether by restoring original capability by repairing or replacing infrastructure components; upgrading capability through new technology, equipment, or design; redesigning infrastructure functions and services to meet emerging demands and market or system opportunities; or modifying allocations and management of water resources (reoperation) for a different set of outcomes, including ecosystem services. Another key consideration is that rehabilitation offers advantages such as shorter project preparation and development time, lower risk profile, greater cost-effectiveness, and the potential to improve environmental and social conditions. Rehabilitation will not fully meet the demand for energy services and should be seen as part of a package with new investments; however, it can increase value by improving the old, with benefits across a range of criteria, including new sources of revenue and ecosystem services.

Industry statistics indicate a sharp rise in investment in the recent past. This increase reflects volatile energy prices, efforts to reduce carbon emissions, and a tentative but growing confidence in the sector. Hydropower is a major contributor to the growth of renewable energy, outpacing capacity growth in wind, biomass, geothermal and solar (Figure 5). Much of this growth has come in developed and emerging economies. Approximately 7 percent of total potential is currently under construction (Figure 6), of which the WBG's share falls below 10%.

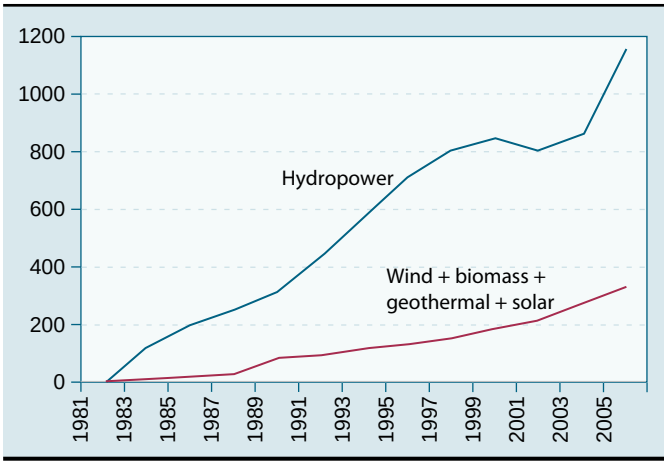
Hydropower as a renewable energy plays a key role in the response to climate change. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change confirmed that the warming of the climate system is unequivocal, and will be accompanied by changes in hydrological pat-

terns.[14] Potential impacts will be felt disproportionately in poor countries, requiring attention to both mitigation and adaptation. There are numerous unique opportunities for hydropower infrastructure to contribute to both agendas as both a low-cost, mature, renewable energy source and a tool for water management and regulation.

Some important issues related to hydropower's role in climate change need further consideration. First, where present, methane emissions from reservoirs must be investigated and embedded in project assessments and environmental management plans. While it is thought that emissions are likely associated with anoxic, shallow, tropical reservoirs (versus temperate or deep reservoirs), the science is still emerging and predicting and measuring emissions pose technical challenges. Second, climate change will alter the hydrological resources on which hydropower depends. These alterations need to be better understood and incorporated into the design and operation of new and existing hydropower facilities. Specific impacts will vary by location; some could affect economic and environmental feasibility as well as the long-term roles of dams and reservoirs.

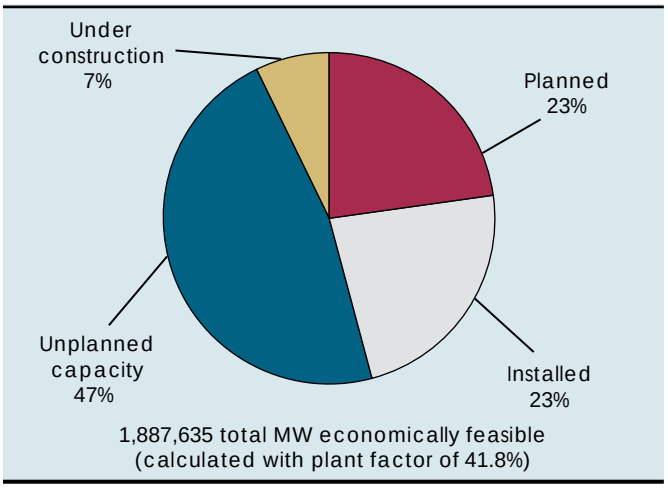
Specific actions to take advantage of opportunities, while managing risks, are described in Box 3.

Figure 5 Growth in renewable energy (TWh)



Source: Energy Information Administration.

Figure 6 Hydropower in Developing Countries in MW (as of 2006)



Source: World Bank: Business Warehouse; Project Staff Appraisal Reports; Project Appraisal Documents; Implementation Completion Reports; World Bank Carbon Finance Unit; and IFC.

Constraints

Notwithstanding a strong development rationale, enormous technical potential, and a robust body of knowledge on good practices, scaling up hydropower will face some important constraints and barriers.

Financing: Based on International Energy Agency (IEA) forecasts and adjusting for universal access to electricity, there is a gap of some 50 percent between financing needs and sources (including retained profits, increased efficiencies, private sector investment, and multilateral development bank [MDB] involvement).[15] The financing gap is most severe in the poorest countries, where constraints on

[14] *IPCC, 2007: Climate Change 2007*. Contributions of Working Groups I, II, and III to the Fourth Assessment, Cambridge University Press, Cambridge, UK.
[15] Stuggins, G. and V. Krishnaswamy (2007). *Closing the Electricity Supply-Demand Gap*. Energy and Mining Sector Board Discussion paper No. 20. The World Bank

Box 3: Realizing opportunities, managing risks of climate change

- Access to carbon funds
- Improve water allocation and sharing of benefits of water management (including flood and drought management) through storage and multipurpose investments
- Increase flexibility and opportunities for adaptive management through project design and water regulation
- Expand the range of insurance products for hydrological variability and natural disasters
- Improve understanding of potential for emissions from reservoirs, and improve techniques for monitoring
- Embed hydropower in low-carbon growth and climate change strategies
- Identify priority storage sites as global public goods
- Enhance hydrological assessments of climate-induced variations and changes in both new and existing facilities
- Accentuate synergies between hydropower and other technologies whose supply source is less reliable (for example, wind/solar)
- Strengthen research on linkages between water management and the economic impacts of climate change

IDA lending can limit Bank involvement. Closing this gap is complicated by the inherent complexities of hydropower infrastructure, including the need for financial instruments best suited to the revenue profile and life of investments; the proportion of local versus foreign currency components; and the project's risks (for example, risk guarantees, insurance against hydrological variability, and funds to support improved project preparation). Particularly needed are instruments and approaches to increase private sector participation, a critical factor in closing the financing gap. Improvements in the enabling environment include sound policies and institutions, effective regulatory oversight, attention to governance and corruption, and reliable offtakers. Finally, innovative business models are needed to (i) facilitate multipurpose ventures with both public and market benefits and address the associated gap between economic and financial viability; and (ii) capture synergies with environmental protection efforts, such as payment for environmental services or green bonds for carbon credits.

Pipeline: While the potential for power is known, planning and project prioritization are inadequate, leading to increased costs and risks in project preparation.[16] In particular, outdated engineering studies need to be updated with new knowledge (particularly of hydrology) and with more detailed consideration of environmental and social values including regional impacts and cumulative effects. As a public good, governments need to undertake strategic assessments and prefeasibility studies to develop a pipeline of projects and to identify priority storage sites.

Availability of quality service firms: Over the past decade of low activity, the hydropower service industry (consultants, construction firms, equipment manufacturers) has contracted.[17] Current strong demand from developed countries has absorbed much of the industry's already reduced capacity at each point in the value chain, resulting in a shortage of capable professionals, especially in regions where safety is a concern. In many developing countries, unclear regulatory and contractual

[16] For example, bid preparation costs, which can exceed $1 million for each developer, are affected by lack of detail or lack of assurances on project fundamentals.

[17] "Most industry players agree that the MDBs' weak appetite for hydropower projects had a domino effect on bilateral trade; eventually manufacturers, contractors, and consultants were affected, and the entire sector slowed dramatically, with the exception of a few individual countries (e.g., China)." (Casartelli, G. (2007), "The Role of the World Bank in Hydropower and Water Resources Utilization: The Views of the Industry." Prepared for the World Bank.

frameworks, unreliable procurement processes, and corruption further compromise access to high-quality firms.

Institutions and capacity in client countries: Capacity requirements for hydropower projects are diverse. Considerable knowledge is now available, but implementation remains a challenge. Proper implementation requires more attention to project budgets, additional appropriate expertise, and capacity building at all levels of the industry (government, services, and developers). Clear government policies that are responsive to local communities are lacking, as are institutional capacity in design and implementation of livelihood programs for affected people. These are challenges with few easy, prescriptive solutions. More broadly, regulatory frameworks for water resources management (especially for transboundary resources) and private sector participation are needed,[18] as is capacity to link hydro infrastructure to regional development opportunities.

Limited hydrological data, analysis, and modeling: Inadequate data and analysis pose significant risks to hydropower infrastructure. Planning, design, and operations based on poor hydrologic data can severely compromise performance and threaten the water management benefits the infrastructure is designed to generate. Unreliable infrastructure can impose significant cost on the private sector: about 3% of sales in China & Brazil, about 7% in Algeria and more than 10% in Tanzania.[19] Climate change accentuates these risks for two reasons: (i) extrapolations of historical data are inadequate for infrastructure design as the past becomes an increasingly poor predictor of the future; and (ii) in the future, the lack of adequate understanding of hydrological resources can lead to sub-optimal operating decisions and serious and unexpected impacts on environmental, social, and economic values, as currently manifest at Lake Victoria. Well-conceived hydrologic analysis and strong technical institutions will support a country's ability to maximize the value of its water resources. In the context of hydropower, for example, effective data and modeling enable planners to match hydrology with the right hydropower investment (e.g., diversion vs. run-of-river). Of particular concern is the basis on which to identify high-value storage sites that can support multipurpose benefits and help manage the challenges of climate change.

[18] Education and training are building blocks for capacity in both client countries and the industry. However, only four countries provide complete hydropower programs at the university level (China, Sweden, Norway, and India) and only 12 universitiesó9 of them in Chinaóhave separate hydro departments. Source: Parid, V. and M. Cervantes (2006) Luleå University of Technology, Sweden.

[19] World Bank. (2005.) "World Development Report." Washington D.C. 2005.

3 THE WORLD BANK GROUP'S ROLE IN SCALING-UP HYDROPOWER

The previous section—Hydropower Infrastructure and Development—sets out the development rationale for hydropower investments and key opportunities, risks and constraints. It is a complex sector that demands skills, knowledge, financial resources and a long term perspective. This section places the World Bank Group within this landscape: its current activities, strategic framework and regional outlooks. It outlines the WBG's two-track approach to addressing priorities for effective and sustainable scaling-up of hydropower resources for development.

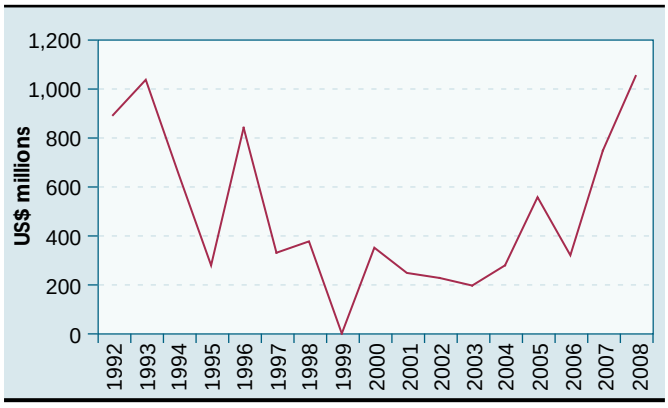
The World Bank Group's Re-Engagement in Hydropower

The WBG's involvement in hydropower development reflects international trends and demands: a significant decline in lending during the 1990s, accompanied by a shift to projects with fewer environmental and social impacts.[20] **By the early 2000s, however, several policies repositioned the World Bank Group in terms of infrastructure and risk, and established a renewed framework for hydropower.** The *Water Resources Sector Strategy*, approved by the Board in 2003, stated that significant levels of investment in water infrastructure are required throughout the developing world. The Bank's 2003 *Infrastructure Action Plan* concluded that "the Bank needs to increase its engagement in infrastructure in light of growing needs, withdrawal of private investors, and a growing recognition that the MDGs can only be met in a multisectoral way." This theme is repeated in the World Bank Group's 2008 *Sustainable Infrastructure Action Plan*.

Lending increased significantly over the last five years. Average new lending between 2002 and 2004 amounted to less than $250 million per year; between 2005 and 2007, that total increased to $500 million per year. In FY08, new lending exceeded $1 billion, with an increase in larger, stand-alone projects (Figure 7). Sixty-seven hydropower projects have been approved since FY2003, amounting to US$3.7 billion in WBG contributions (US$3.2 billion for hydropower components) to support a total of US$8.5 billion and almost 9700 MW[21] in project investments.

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 are under discussion in India, Vietnam, Rwanda/Nile Equatorial Lakes, Ethiopia, Guinea, Brazil, Romania, Turkey, Georgia, and Tajikistan, as are carbon finance projects in Russia, Sri Lanka, and Madagascar. The new

Figure 7 World Bank Group: Hydropower Components by Approval Year (FY) (Value of WBG Contribution to Multipurpose Hydropower Components)



Source: World Bank: Business Warehouse; Project Staff Appraisal Reports; Project Appraisal Documents; Implementation Completion Reports; World Bank Carbon Finance Unit; and IFC.

[20] The exception to this trend was a continuing involvement in projects in China.

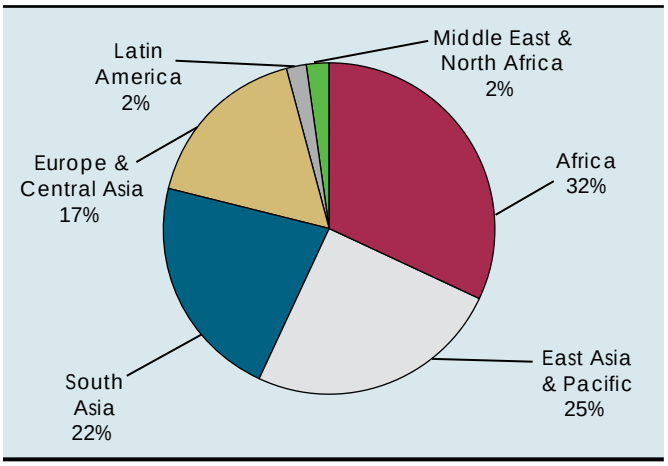
[21] Includes rehabilitation that ensures availability of existing capability at Inga (1300 MW) and plants in the Niger (1338 MW).

projects are larger and include a larger proportion of new generation (Table 1).

In aggregate, the World Bank Group exceeds other multilateral development banks in lending to the hydropower sector. However, on a regional basis, both the Asian Development Bank and the Inter-American Development Bank are dominant lenders, in absolute terms and in proportion to total lending.

The World Bank Group has adapted product lines and financial instruments over time to meet changing needs and opportunities. Over the period 1992–2002, the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA) accounted for 99 percent of the lending portfolio, and International Financial Corporation (IFC) the remaining 1 percent. During 2003–08, IBRD/IDA's share fell significantly, to 58 percent—mainly because of an absolute decrease in IBRD lending. Over the same period, IFC increased support (to 20 percent), as did carbon finance (to 5 percent), and guarantees (to 17 percent), reflecting increased private sector involve-

Figure 8 World Bank Group: Hydropower Components by Region for FY 2003–2008



Source: World Bank: Business Warehouse; Project Staff Appraisal Reports; Project Appraisal Documents; Implementation Completion Reports; World Bank Carbon Finance Unit; and IFC.

Table 1: Approvals of Major Hydropower-Related Infrastructure in US$ (2003–08)

Year	Region (Country)	Project	WBG
2003	EAP (China)	Yixing Pumped Storage	$145m
2004	ECA (Turkey)	Turkey Renewable Energy Project	$202m
	EAP (China)	Fourth Inland Waterways	$91m
2005	EAP (Laos PDR)	Nam Theun 2	$270m
	ECA (Ukraine)	Hydropower Rehabilitation	$106m
2006	AFR (Regional)	Felou	$75m
	EAP (China)	Fifth Inland Waterways	$100m
2007	AFR (Uganda)	Bujagali	$360m
	AFR (DRC)	Inga Rehabilitation	$297m
2008	SAR (India)	Rampur	$400m
	AFR (Regional)	Niger	$186m
	EAP (Philippines)	Magat Privatization	$105m

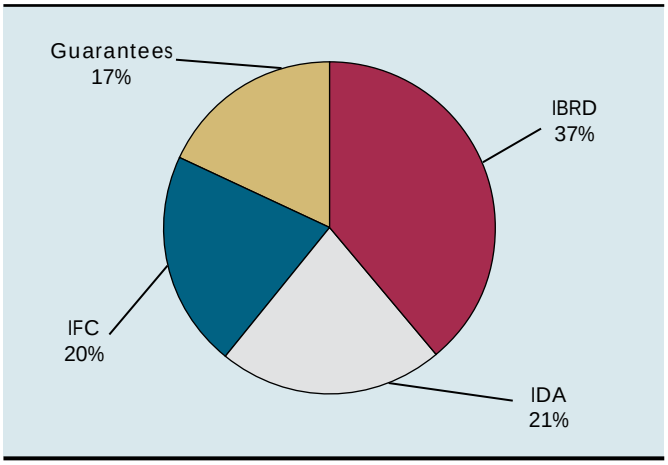
Source: World Bank: Business Warehouse

ment and the momentum of carbon trading (Figure 9). 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 US$315 million since 2005.

The WBG now supports a range of hydropower investments, from small run-of-river to rehabilitation to multipurpose projects (Figure 10). Run-of-river projects currently account for the largest portion of the portfolio in both value and number of projects. Storage and rehabilitation combined account for about half the portfolio. Two significant rehabilitation projects, totaling US$480 million, have been approved recently, bringing the total since 2004 to US$865 million over 14 projects, mainly in Africa and Eastern and Central Asia.

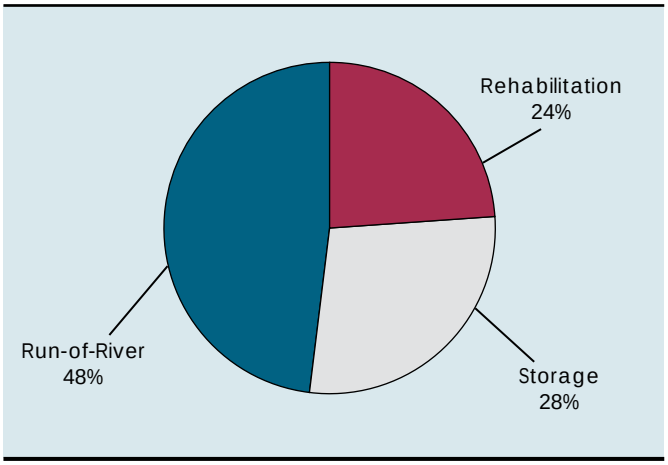
The WBG's assistance extends well beyond lending—to technical support, knowledge sharing, policy dialogue, economic and sector work, and support during project preparation and implementation. In these roles, the WBG draws on a range of products and services. Many of these were developed during the downturn in hydropower lending in the 1990s, when the Bank remained actively involved in the power sector, assisted market reforms and initiated important policy and regulatory benchmarks for environmental, social and water resources management. The resulting operational directives and safeguards, coupled with the ongoing development of tools such as Strategic Environmental Assessment and payments for environmental services, offer the Bank an important opportunity to add impetus to hydropower efforts.

Figure 9 Bank Support of Hydro Components (Approvals 2003–2008)



Source: World Bank: Business Warehouse; Project Staff Appraisal Reports; Project Appraisal Documents; Implementation Completion Reports; World Bank Carbon Finance Unit; and IFC.

Figure 10 Active Project Breakdown by Value



Source: World Bank: Business Warehouse; Project Staff Appraisal Reports; Project Appraisal Documents; Implementation Completion Reports; World Bank Carbon Finance Unit; and IFC.

Strategic Framework

The WBG's ultimate objective is scaling up its engagement in hydropower to help countries maximize the value of hydropower investments in economic development and poverty alleviation in an environmentally and socially sustainable manner. This will be accomplished by expanding the pipeline of high-value investments in each country or basin, and by mobilizing societal support and adequate resources, knowledge, and skills to meet clients' needs while managing the risks inherent in the sector. At this stage of hydropower re-engagement, it is also necessary to reduce project development costs—but only if the principles of sustainable development remain fully embedded through sound environmental management and social inclusion. The private sector plays a critical role in providing the

required financial management and technical skills. However, private sector participation depends on the right balance of public and private responsibilities and allocation of risks and benefits. In many cases, the public sector needs to play a leadership role in reducing risks in hydropower development, maximizing an array of potential benefits, and ensuring balanced access and use of natural resources.

The WBG's approach to hydropower development is supported by other WBG strategies, including the *Sustainable Infrastructure Action Plan* (2008), the *Clean Energy Investment Framework* (2007), and the *Development and Climate Change Strategic Framework*, as well as strategies for energy (2006), water resources (2003), and environment (2001). The *Clean Energy Investment Framework* (CEIF), for example, articulates three pillars: access to energy; accelerating the transition to a low-carbon economy; and adaptation to climate variability and change. Hydropower has a role in each of these.

The *Sustainable Infrastructure Action Plan* (SIAP) recognizes the same influences and trends shaping the WBG's role in hydropower, such as:

- Global trends: climate change, volatile energy prices, globalization of production of goods and services, growing disparities between urban and rural areas, the role of private investment, and the proliferation of aid channels
- The focus on core infrastructure sectors, including water and energy
- The central role of cross-sectoral themes (climate change, public/private partnerships, rural-urban integration,[22] regional and multi-country approaches)
- The sustainability framework, with a focus on integrating environmental and social values in a triple bottom line.

Core elements of the SIAP echo the priorities in scaling up hydropower, including: leveraging finance; recognizing the need for more agile WBG responses to client and stakeholder demands; and addressing the perverse impacts of poor governance on the investment climate.

The *Development and Climate Change Strategic Framework* recognizes the role of water management in climate change response, including scale-up of hydropower infrastructure as both a mitigation measure, as a low-carbon renewable energy, and the role infrastructure can play in managing hydrologic variability. Its six action areas[23] will support hydropower in delivery co-benefits of adaptation and mitigation.

World Bank Group's Value-Added

The WBG's convening power is central to scaling up hydro infrastructure. Supported by the formation of the Sustainable Development Network, the Bank can help countries work across sectoral lines, mainstreaming environmental management, leveraging local development, and integrating water and energy needs. The WBG's ability to convene across national borders has been demonstrated in regional coordination in both energy and water, and its ability to catalyze financial packages will be instrumental in addressing financial constraints in the sector. The WBG can bring world-class expertise to clients at the policy and project levels through access to consultants and, importantly, convening of independent panels on environmental and social safeguards. Finally, coordinated World Bank-IFC

[22] In hydropower, rural/urban linkages are characterized by large infrastructure projects that have local and regional impacts but benefit distant urban communities. In these cases, careful attention to benefits sharing and local community impacts are at the core of spatial integration.

[23] Support climate actions in country-led development processes; mobilize additional concessional and innovative finance; facilitate the development of market-based financing mechanisms; leverage private sector resources; support accelerated development and deployment of new technologies; and step up policy research, knowledge, and capacity building.

actions can support the many countries that are evolving from vertically integrated electricity monopolies to contracts-based public-private initiatives.

The WBG is in a strong position to provide support for hydropower across the full value chain (Box 4). Direct lending to investment projects will remain a key WBG function, complemented by providing access to multiple financing sources (donors, carbon financing, the private sector). The WBG can also support the sector more broadly, by building capacity in areas such as environmental management and social analysis and by strengthening sector-level planning. Further upstream, the WBG is in a position to help governments create the policies, regulations, and institutions that will guide responsible actions at the project level.

Box 4 Hydro Value Chain

Operations, Compliance

↓

Procurement, Construction

↓

Engineering, Feasibility Studies, Financial Architecture, Licensing

↓

Environmental and Social Management, Benefit-Sharing, Revenue Management Baseline Studies

↓

National Strategies, Sector Plans, Strategic Environmental Assessment

↓

Laws, Regulation, Market structure

The WBG's comprehensive, long-term involvement in country programs provides multiple entry points to engage with and/or support hydropower development. The WBG is uniquely positioned to address the complexity of hydropower projects. It can identify and take advantage of cross-sectoral linkages, for example, between transportation and health care. It can coordinate with other donors and other program participants to maintain effective and efficient project structures; and it can tailor support to meet the unique needs, opportunities, and constraints of each region or country, including:

- Leveraging hydropower investments for broader regional development benefits;
- Providing full-service support on the range of natural resource management issues that arise in hydropower projects (for example, water management, catchment area treatment, fisheries, and the like);
- Strengthening sustainability practices through the application of safeguards and operational policies; and
- Identifying and realizing opportunities for multipurpose hydropower infrastructure, consistent with development plans and priorities.

Areas of Focus

Complex, multipurpose projects that cross both national and sub-national borders take full advantage of the WBG's value added, drawing on convening power and cross-sectoral reach. Projects such as hydropower development and water management in the Senegal and Niger Basin, and pre-investment initiatives in the Zambezi and the Eastern Nile, strive to leverage benefits beyond energy through multipurpose activities and synergies with regional development plans. The transformational impact of hydropower infrastructure in these basin-level investments will be felt over the longer term.

WBG participation in the full range of project types, including microhydro, medium run-of-river, and rehabilitation investments, is equally important. Small projects benefit from the WBG's renewable energy program. The WBG's focus on social and environmental safeguards and performance standards has offered important entry points for medium-scale projects (including run-of-river) in South Asia, with

the added benefits of access to independent experts and capacity building at the country level. The Bank's involvement in rehabilitation opportunities, which offer lower risk and deliver faster paybacks, facilitates reoperation for environmental and social objectives, access to carbon markets, and revision of hydrological assessments in the context of climate change.

In most regions, privatization and market restructuring are creating opportunities for the private sector. These opportunities can benefit from the WBG's mix of businesses. The IFC plans to scale up investments in renewable energies in existing projects, including hydropower. Partnership with IBRD/IDA and MIGA during various stages of project preparation will facilitate investments in IDA countries and in public-private partnerships such as the Bujagali project. Focus countries include China, India, Brazil, Chile, Peru, Uganda, and Democratic Republic of the Congo. Of particular importance are opportunities for pairing IFC's US$100m InfraVenture Fund for project feasibility studies with advisory services to improve the environment for and participation of the private sector. Other opportunities lie in joint IFC-World Bank work on safeguards, good practice, and coordinated country strategies.

Two-Track Concept for Scaling Up

The WBG will scale up investment in sustainable hydropower through two complementary tracks:

- **Track 1: Implement investment opportunities.** The WBG will consolidate recent increases in lending to high-quality projects executed in a timely manner. In addition to direct development benefits, these projects will help demonstrate the application of progressive approaches to hydropower and the WBG's role as a partner in developing sustainable water infrastructure projects, whether small, medium or large, complex, transboundary investments.
- **Track 2: Strengthen sectoral foundations.** The WBG can broaden its impact and help maximize the strategic value of hydropower by moving upstream to capacity building, planning, and policy development in client countries. This work is critical to mobilize adequate financing and to provide the foundations for sustainable complex multipurpose transboundary projects. It broadens the contribution hydropower infrastructure can make to managing the implications of climate change. This track takes a central place in helping governments define their roles in planning, resource management, regulation, direct investment, and public/private partnerships.

The two tracks support and reinforce each other. 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 through benefits sharing and multipurpose project design. At the same time, direct financing in hydropower projects helps establish relationships and create opportunities to build capacity and tailor foundations' work to corporate, state, national, or regional needs.

While the major scale-ups will have elements of both Track 1 and Track 2, flexibility in designing the right blend and sequencing is important. In low-capacity countries, policy and regulatory work must precede or accompany large, complex projects—a lesson well demonstrated in the case of Nam Theun 2. In other countries, engagement may be more opportunistic, leading with direct investment and leveraging participation in strengthening sectoral foundations. In India, for example, the entry point has been financing of medium-size projects, from which other policy and water/environmental management opportunities are emerging (for example, river basin assessment, catchment area treatment, and resettlement and rehabilitation policies). Each track is described on the following page.

Track 1: Implement Investment Lending Opportunities

Promising pipeline projects of around US$2 billion over the next several years have been identified in consultation with regional operations and the IFC. This complements approvals in FY08 of over US$1 billion but 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. Partnership and convening of financing sources, such as private financiers and emerging players from China, India and Brazil, will be needed to leverage direct WBG financing. As described in the *Sustainable Infrastructure Action Plan* (SIAP), significant opportunities for leveraging are available through collaborations across WBG businesses, broadening activities through cross-sectoral linkages, and partnering with private and emerging financiers.

Regions vary considerably in projections. Although significant prospects are identified in Africa, the formal pipeline is modest. By contrast, the portfolio is South Asia is stronger in pipeline projects with less identified in the longer term. WBG involvement in Latin America is currently small but gaining momentum while East Asia and Pacific activity concentrates on projects under preparation or implementation (e.g., Nam Theun 2).

Geographically, South Asia and Africa will be the focus areas over the next three years, with continued activity East Asia. However, each region has its own unique hydropower story.

A strong renewable energy program, led by India, is emerging in South Asia. Driven in part by the World Bank's engagement in the power sector, the program complements the Indian government's focus on access to energy. It addresses a significant gap in access to electricity and is realigning the balance between renewable and nonrenewable energy resources. The India scale-up includes investment lending for rehabilitation, new projects, and regulatory reform. To support intensive development plans for hydropower in two northern states, the World Bank is addressing river-basin management concepts for power optimization, economies of scale in infrastructure, and broader benefits-sharing opportunities for local communities. Project development includes specific provisions to build energy companies' capacity to manage for sustainability. Hydropower developments are appearing across the region, with technical assistance and project scoping planned for Pakistan, Nepal, and Afghanistan. The IFC is exploring opportunities in India and Pakistan. With transboundary rivers running through China, India, Pakistan, Nepal, and Bhutan, water resources management and emerging energy trade will shape the longer term hydropower infrastructure agenda in the region.

In Africa, the challenges of multiple demands for water and the predominance of international rivers match the imperatives of energy access. The starting points for many projects are institution building and helping countries develop regionally coordinated river basin organizations to sustainably develop water resources. The regional context is a key driver from the energy side, with expanding power pools and system integration that qualitatively change the role of hydropower in a mixed energy system. The Africa portfolio will host numerous large, complex, multipurpose initiatives over the next decade, spotlighting the WBG's role in convening across donors, countries, and sectors. The WBG is already positioned for this work, with active and comprehensive engagements in the Nile and West African basins (Senegal, Niger) as well as project-specific work at the country level. The key challenges for Africa hydropower are low capacity and financial constraints—in particular IDA limits—and the climate for private sector development, and the complexities of developing transboundary water resources.

Eastern Europe and Central Asia: With strong economic growth over the last few years, and a backlog of needed investments in aging energy infrastructure, a looming energy crisis in parts of Europe and Central Asia is forcing a focus on short-term options and, consequently a preference towards ther-

mal resources. Large untapped hydropower resources (in Russia, Central Asia, Southeast Europe, and Turkey) are attracting the interest of investors but are facing a complex environment and significant market risks in addition to concerns from civil society. Therefore, in the short term, lending will continue to focus on dam safety and rehabilitation projects, with several large (conventional and pumped storage) hydropower projects in the pipeline for possible development in the medium to longer term.

Latin and Central America: The current portfolio in Latin America related to hydropower is dominated by carbon finance, IFC and, in the late 1990s, MIGA guarantees. Recently the World Bank has reengaged in technical assistance for hydropower development, and investigation of possible financing for investment. This includes an assessment of opportunities development, sector planning, feasibility studies and studies of interconnection of large hydro. Studies are ongoing in Peru, Central America and Brazil. The Latin America region will continue to be a focus region for IFC lending, particularly in Brazil, Chile and Peru.

East Asia and Pacific: The East Asia hydropower program is dominated by implementation of the Nam Theun 2 project in Laos PDR and project development in Vietnam. Smaller projects are likely in the South Pacific. China, which was the dominant region for the WBG through the 1990s, will likely seek carbon financing advantages, both within and outside the Bank with less investment lending than previously. Upstream work will be important to strengthen the hydropower sector in Mongolia (energy planning) and Vietnam (evolution from centralized planning to contractual basis for generation and dispatch) and Laos PDR (capacity building). Ongoing work in the Mekong Basin is building toward investments in regional water and energy security.

Middle East and North Africa: Water security issues dominate in the Middle East and North Africa, where nearly 80 percent of total water resources are withdrawn and climate change is expected to reduce runoff by more than 10 percent over 80 percent of the region. Ongoing and adaptive management of multipurpose water infrastructure will remain critical, and current prospects for scaling up investment lending are modest. However, the WBG's strong focus on institutional frameworks for managing scarcity will support effective hydropower management and development.

Track 2: Strengthen Sectoral Foundations

The second track of the WBG's *Directions in Hydropower* focuses on building the foundations of the sector for increased WBG and non-WBG investments, largely through analytical and advisory services to client countries. Track 2 plays a critical role in building capacity and developing institutions to improve the enabling environment for a range of players and types of projects; reducing the cost and time needed for project preparation; maximizing the strategic value of hydropower infrastructure; and securing good-quality, sustainable investments. Track 2 also addresses private sector and government roles and coordination. Support for sectoral foundations has five components:

1. **Scale up financing:** If scaling up is to be achieved, considerable attention needs to be paid to the foundations for financing. Innovations and new combinations of financing instruments are needed to address inherent challenges such as loan tenures and local currency financing, and to improve the environment for private sector development. Looking forward, two new areas emerge: accessing and taking advantage of carbon credits and revenues; and improving financing modalities for blended public/private sector investments, especially for multipurpose projects. The WBG *Directions in Hydropower* also recommends increased resources for project preparation, to meet the demands of international good practice.
2. **Promote good practice:** In sustainable hydropower, value is defined by the combination of environmental, social, and economic benefits—the "triple bottom line" generated by each project. For example, long-term protection of high-value conservation areas or watershed management

can result in win-win-win outcomes. However, in many countries, lack of capacity and the complexities involved in cross-sectoral and multidisciplinary efforts pose challenges to implementation of good practices. The WBG is well positioned to assist in meeting these multifaceted challenges and mainstreaming good practice through application of operational policies, knowledge management, and a range of technical assistance, with a particular focus on governance and environmental and social safeguards.

3. **Strengthen planning***:* This component focuses on supporting governments to realize the strategic value of hydropower through adequate planning, project identification, policy, and institutional development. A long-term, cross-sectoral perspective is required to realize this value across energy, water, climate change, and regional needs. The WBG will help governments clarify hydropower's contribution to development through resource planning, identifying strategic storage sites, improving hydrological data and analysis, and mainstreaming hydropower into climate change programs. The largest component of Track 2, strengthening planning recommends a significant increase in funds and technical assistance for prefeasibility studies to develop pipelines of quality projects.
4. **Leverage regional development**: This component explores synergies among complementary projects and development opportunities that can benefit local communities and broader national and regional development objectives (for example, social infrastructure, institutional development, and environmental entrepreneurship). Hydropower projects have the potential to transform host regions and communities by exploiting complementarities and economies of scale, and by linking direct project investments with broader development objectives. These can be realized through multipurpose projects, ancillary investments, and revenue management. Focusing on local and regional development is a key factor in avoiding the urban-versus-rural inequities that can result from large hydropower projects. Many challenges remain, however. There are few or no robust models for financing of broader development initiatives, for ensuring clear and appropriate roles and responsibilities for private developers, or for building government capacity at the local, regional, or national level.
5. **Build partnerships***:* The WBG is in a strong position to bring parties together to assist planning, financing, and promoting good practice. It can help promote global dialogue and continuous improvement in sustainable hydropower by participating in multi-stakeholder initiatives such as the Hydropower Sustainability Assessment Forum and by facilitating third-party partnerships. Communication also plays key role; the WBG must ensure its messages are appropriately and respectfully shared and invest in working relationships with civil society and industry groups.

4 LOOKING AHEAD

Hydropower can play a strong, multi-dimensional role in sustainable development and poverty alleviation. Moving forward, hydropower development must adopt a 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 layers 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 basic foundations of the sector.

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