Increasing Global Renewable Energy Market Share:
Recent Trends and Perspectives

Final Report

Prepared for:
Beijing International Renewable Energy Conference 2005

Prepared by:
The Expert Group on Renewable Energy Convened by
The United Nations Department of Economic and Social Affairs

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List of Acronyms

AC	Alternating Current
ACORE	American Council on Renewable Energy
ADB	Asian Development Bank
ADEME	French Agency for the Environment and Energy Management
AfDB	African Development Bank
AMKN	African Microhydro Knowledge Network
APEC	Asia Pacific Economic Cooperation
AREED	African Rural Energy Enterprise Development
APPCDC	Asia-Pacific Partnership on Clean Development and Climate
APRM	African Peer Review Mechanism
ASTAE	Asia Alternative Energy Unit
BAU	Business as Usual
BIREC 2005	Beijing International Renewable Energy Conference 2005
BMF	Blue Moon Fund
BMU	Federal German Ministry for Environment, Natural Conservation and Nuclear Safety
CDM	Clean Development Mechanism
CERs	Certificates of Emission Reductions
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
CPV	Concentrating Photovoltaics
CRED	Chinese Center for Renewable Energy Development
CREIA	Chinese Renewable Energy Industries Association
CRESP	China Renewable Energy Scale-Up Program
CSD	Commission on Sustainable Development
CSP	Concentrating Solar Power Plants
CTI	Climate Technology Initiative
CYTED	Science and Technology Development Program
DC	Direct Current
DFCC	Development Finance Corporation of Ceylon
DFID	UK Department for International Development
DGIS	Netherlands Directorate General of International Cooperation
DME	Dimethylether
E+Co	Energy through Enterprise
EAP	Environmental Action Program
EBRD	European Bank for Reconstruction and Development
ECAs	Export Credit Agencies
EEA	European Environment Agency
EGNRET	Expert Group on New and Renewable Energy Technologies
EGS	Enhanced Geothermal Systems
EJEDSA	Empresa Jujeña de Sistemas Energeticos Dispersos
EPA	Environmental Protection Agency
ESMAP	Energy Sector Management Assistance Program
EU	European Union
EUEI	European Union Energy Initiative
EWEA	European Wind Energy Association
EWG	Energy Working Group
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
GIS	Geographic Information Systems
GMI	Global Market Initiative
GNESD	Global Network on Energy for Sustainable Development

GREFF	Global Renewable Energy Fund of Funds
GTZ	Deutsche Gesellschaft für Technische Zuammenarbeit
GVEP	Global Village Energy Partnership
GW	Gigawatts
HDI	Human Development Index
IAP	International Action Program
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IDB	Inter-American Development Bank
IEA	International Energy Agency
IIA	International Investment Agreements
IPO	Initial Public Offering
IPP	Independent Power Purchase
IREDA	Indian Renewable Energy Development Authority
IRR	Internal Rates of Return
JI	Joint Implementation
JPoI	Johannesburg Plan of Implementation
JREC	Johannesburg Renewable Energy Coalition
KaR	Knowledge and Research
KfW	Kreditanstant Für Wiederaufbau
kW	Kilowatt
kWh	Kilowatt hours
LDC	Less Developed Countries
LPG	Liquefied Petroleum Gas
MDGs	Millennium Development Goals
MFI	Micro Finance Institution
MFP	Multi Function Platform
MIGA	Multilateral Investment Guarantee Agency
MNES	Indian Ministry of Non-Conventional Sources
Mtoe	Million tons of oil equivalent
MW	Megawatt
NDRC	China National Development and Reform Commission
NEPAD	New Partnership for Africa's Development
NGO	Non Government Organization
NREL	National Renewable Energy Laboratory
OAS	Organization of American States
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
O&M	Operation and Maintenance
PPA	Power Purchase Agreements
PTC	Production Tax Credit
PV	Photovoltaics
RBF	Rockefeller Brothers Fund
R&D	Research and Development
RD&D	Research, Development and Demonstration
REEEP	Renewable Energy and Energy Efficiency Partnership
REIA	Renewable Energy in the Americas
REILP	Renewable Energy and International Law Project
REN21	Renewable Energy Network 21
Renewables 2004	Bonn International Renewable Energies Conference 2004
REPIN	Regulatory Environmental Program Implementation Network
RETs	Renewable Energy Technologies
REPSOs	Renewable Energy Program Support Offices
RPS	Renewable Portfolio Standard
SEEDs	Sarvodaya Economic Enterprises Development Services
SHS	Solar Home Systems

SMMEs	Small, Medium, and Micro-Enterprises
SWERA	Solar Wind Energy Resource Assessment
SWH	Solar Water Heating
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNF	United Nations Foundation
UNFCCC	United Nations Framework Convention on Climate Change
UNSO	United Nations Statistical Office
UNIDO	United Nations Industrial Development Organization
USAID	US Agency for International Development
USDOE	United States Department of Energy
VAT	Value Added Tax
WBG	World Bank Group
WEO	World Energy Outlook
Wp	Watts-peak
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization

Letter from the President of the People's Republic of China

On the Beijing Renewable Energy Conference 2005

On this occasion of opening of the Beijing International Renewable Energy Conference 2005, on behalf of the government and the people of China, I would like to extend my sincere congratulations! I also express my warmest welcome to all the participants!

It is a global wish and common responsibility to take right action to cope with challenges posed by environment and energy as well as to achieve sustainable development through strengthening international co-operation. Along with the global economic growth, energy shortage and environmental pollution have become an increasingly big problem. If it is not solved in a good and efficient manner, not only will human society not achieve the goal of sustainable development, but it will also make a serious impact on the living environment and quality of human society. In this regard, renewable energy resource is rich, clean and sustainable. Therefore, it is an indispensable measure to deal with the increasingly serious issues of energy and environment as well as ensure sustainable development of human society by accelerating the use and development of renewable energy.

China attaches great importance to the utilization and development of renewable energy and considers it as one of the most important instruments to promote socio-economic development. China's Renewable Energy Law will take effect on January 1, 2006. We will continue to pursue economic and social development under the concept of scientific development, accelerate economic restructuring and the transformation of the mode of economic growth, take further steps to enhance innovative ability, develop recycling economy, protect the environment, expand renewable energy development, promote the co-ordinated development of economy with population, resources and environment, and build a resources-conservation and environmental friendly society.

It is very important to seek international co-operation in order to accelerate the development and use of renewable energy. The international community should enhance co-operation in areas such as research & development (R&D), technology transfer, and financial assistance, etc. which will increase the contribution of renewable energy to the socio-economic development of man, and benefit people all around the world. I sincerely hope that the conference can play an important role in promoting the development and use of renewable energy worldwide as well as strengthening international co-operation in this field.

Finally, I wish the conference a great success!

President of the People's Republic of China

Hu Jintao, November 6, 2005

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THE SECRETARY-GENERAL

Message to the Beijing International Renewable Energy Conference from the Secretary General

Beijing, 7-8 November 2005

Delivered by Ms. JoAnne DiSano, Director of the Division for Sustainable Development, UN Department of Economic and Social Affairs

I am pleased to send my greetings to the Beijing International Renewable Energy Conference. This event, attracting thousands of stakeholders from around the world, is an important contribution to implementing the renewable energy commitments made at the World Summit on Sustainable Development. I congratulate the Chinese Government on this initiative.

Three years ago in Johannesburg, Governments agreed to substantially increase the global share of renewable energy. At the 2005 World Summit this past September, world leaders reaffirmed that commitment. Despite this political momentum, this is also a time of growing volatility and uncertainty in world energy markets. Oil price increases, which hit oil-importing developing countries especially hard, highlight the need for alternative energy supplies.

Thanks to its multiple benefits and advantages, renewable energy has an important role to play. It can help combat climate change by contributing to reductions in greenhouse gas emissions. It can reduce indoor pollution, a significant source of morbidity and mortality in many developing countries. It can also empower the many millions of poor and vulnerable people who lack access to reliable, affordable and clean modern energy services. This "energy divide" entrenches poverty. Renewable energy can instead buttress livelihoods and provide opportunities for healthier lives and more productive activities.

Some forms of renewable energy require large up-front capital costs, which could pose a financial barrier for many developing countries. Innovative financing schemes involving public-private partnerships, South-South cooperation and assistance from developed countries can help overcome this obstacle.

Yet even these measures will not be enough. We need to step up research and development, and broadly disseminate technological breakthroughs. For that to happen, Governments must create supportive policy and regulatory frameworks, and strengthen institutional and human capacity.

In May 2006, the United Nations Commission on Sustainable Development will address energy and related issues. Your conference is well placed to contribute to those proceedings. Working in partnership -- public-private, North-South, South-South -- we can make a difference. In that spirit, please accept my best wishes for a successful conference.

Executive Summary

Background

Globally, energy consumption is growing at a rapid rate. The World Energy Outlook predicts that in the next 25 years, energy consumption will increase by 60 percent with the bulk of this growth to occur in developing countries. Under a business as usual scenario, fossil fuels will continue to dominate the energy mix, with enormous environmental, health, economic, and energy security consequences. The share of renewable energy, though growing in absolute terms, will remain largely unchanged (14 percent, of which the bulk today is traditional biomass and hydropower). Further, despite these growth rates, 1.4 billion people will be without electricity in 2030 and a comparable amount will continue to rely on traditional biomass for heating and cooking needs. Clearly, this is an unsustainable path for the world to follow, particularly given rising fossil fuels prices that are projected to remain high into this decade and beyond.

On November 7-8, 2005, the National Development and Reform Commission (NDRC) of the People's Republic of China organized the Beijing International Renewable Energy Conference 2005 (BIREC 2005). This meeting brought together the international community around the shared goal of global renewable energy development, with a particular emphasis on developing countries. BIREC 2005 reviewed the status of renewable energy and its contribution to economic development and poverty reduction; shared success stories and lessons learned from renewable energy deployment; and explored approaches and trends in renewable energy policy, finance, and capacity building.

BIREC 2005 was supported by the Federal Ministry for Environment, Natural Conservation and Nuclear Safety (BMU), Germany; the Federal Ministry for Economic Cooperation and Development, Germany; the United Nations Department of Economic and Social Affairs (UNDESA); and the European Commission. The Conference builds upon the groundwork of renewable energy for development begun at the World Summit on Sustainable Development (WSSD) in the Johannesburg Plan of Implementation (JPoI). This plan calls for an increase in the global market share for renewable energy–*with a sense of urgency*. This work was furthered at the landmark Bonn International Renewable Energies Conference in June 2004 (*Renewables 2004*) that brought together participants from across the world to focus on renewable energy scale up, with an emphasis on the industrialized world. Outcomes of the Bonn Conference included a Political Declaration, a set of Policy Recommendations, and an International Action Program (IAP) that included 200 voluntary commitments on renewable energy from a range of stakeholders. BIREC 2005 also reviewed progress on commitments made at WSSD and in Bonn.

BIREC 2005 provided a unique and timely platform for building consensus on issues, actions, and accomplishments for increasing the global market for renewable energy. Conclusions of the meeting will provide important inputs to the upcoming 14th session of the Commission on Sustainable Development (CSD) to be held in New York City, May 1-12, 2006. CSD 14 will have energy as one of its principle themes.

Why Renewable Energy?

Renewable energy—including biomass, geothermal, hydropower, solar, wind, tidal, and wave—offers tremendous benefits for meeting global energy needs. Building on a foundation of hydropower, biomass combustion, and geothermal power pioneered during the industrial revolution in the late 1800s, new forms of renewable energy began to be developed and commercialized, including solar, wind, and several forms of advanced bioenergy. Today, these renewable energy technologies are the fastest growing energy technologies (particularly wind and solar) and are cost competitive in a variety of grid, off-grid, and remote applications worldwide. They utilize locally available resources, off setting the need for costly fuel imports; are environmentally beneficial, without the harmful emissions of conventional energies; provide diversification to a country's energy mix; and create local job and income opportunities.

Nonetheless despite their advantages, the bulk of renewable energy development to date has occurred in industrialized countries (with the limited exception of a few emerging economies like China). The countries most in need of the positive attributes of these technologies are not yet beneficiaries. This is due in large part to a number of barriers that hinder renewable energy advancement. Most notably, renewable energy continues to be comparatively expensive for a variety of developing country needs. Further, many of these countries have not yet put in place the policy and regulatory frameworks needed to induce investment in renewable energy, or eliminated subsidies for conventional fuels that make it difficult for the technologies to compete. Moreover, many developing countries have imperfect capital markets and insufficient access to affordable financing for developers and consumers, as well as inadequate institutional capacity to support the technologies.

Rapid scale up of renewable energy, as envisioned at WSSD and in Bonn, will require addressing these barriers. It will also necessitate expanding the base of countries committed to enhancing the global market share of these technologies.

BIREC 2005 Report

This report addresses issues and approaches for tackling the barriers and increasing market penetration of renewable energy. It has been prepared by a group of experts in the renewable energy field representing developing and developed countries across the globe. The report has been organized and convened under the guidance of UNDESA, with technical inputs and financial support provided by the United Nations Foundation (UNF) and BMU.

This report outlines a number of priorities for the international community in accelerating the scale-up of renewable energy, particularly in the developing world. It also identifies the potential role that BIREC 2005 can play in moving these priorities forward. Proposed actions include:

- *Technology Research, Development and Demonstration*. Continue and accelerate investments in technology research, development, and demonstration in order to drive down costs for the technologies; enhance product and system performance, reliability, and efficiency; and expand the base of cost competitive end use applications. This includes renewable energy research and development for electricity, thermal, mechanical, and refined fuel needs. It also involves further research and development on "low tech" applications in the field (water pumping, water purification, etc.), and productive use applications, in order to expand the benefits of renewable energy, including to the rural poor.

- *Improve Policy and Regulatory Frameworks*. Securing political commitment and putting in place effective policy and regulatory frameworks are crucial elements to improve the investment climate for renewable energy. Governments have a role to play at all levels—national, state, and local—and there are a range of policy options that have been applied and from which lessons are being learned.
- *Financing Facilitation*. Finance and investment are essential ingredients in the growth and development of renewable energy for industrialized and developing countries alike. As the industry matures it will be increasingly important to expand the scope and breadth of financing sources and instruments, both locally and internationally. More creative leveraging of public and private sector resources will be needed to meet the financing requirements of the renewable energy industry, including official development assistance, the Global Environment Facility, and carbon financing.
- *Capacity Strengthening*. For renewable energy markets to grow, capacity strengthening is needed in all aspects of project and program design, development, implementation, and operation. Capacity development is a prerequisite for governments, private firms and entrepreneurs, financiers, developers, and academia, for both industrialized and developing countries. Areas where capacity strengthening is most needed include technology research, development, deployment, marketing, financing, operation, and maintenance; policy formulation, implementation, and regulation; business planning and development; and consumer outreach and awareness
- *International Collaboration*. Though each country has the main responsibility for developing its own domestic renewable energy market and fulfilling commitments made at WSSD towards increasing the global market share for these technologies, international collaboration can enhance a country's capabilities to succeed in building markets, and accelerating cost and technology improvements. Support in the areas of technical assistance, joint research and development, technology transfer, reduction of trade barriers, investment and partnership, and opportunities for North-South, South-South, and South-North exchange, can all contribute towards these distinct goals.
- *Mechanisms for Reviewing Progress on Increased Use of Renewable Energy*. There exist a range of options for reviewing and reporting progress on renewable energy, including achievements towards the WSSD JPoI and the Bonn *Renewables 2004* IAP. These options are outlined in the report and provided the basis for discussion at BIREC 2005, where participants invited CSD 14 to consider an effective arrangement for reviewing and assessing progress towards increase the global share of renewable energy. The review would also be useful in addressing the link between energy and the Commission's biannual thematic cluster, and voluntary reporting could be enhanced through inputs from relevant organizations, partnerships, and networks.

In summary, opportunities for renewable energies are limitless and countries around the world have committed to work together on increasing their global market share. BIREC 2005 provided a unique and timely forum to exchange experiences on renewable energy development, share views on policies and approaches, explore financing mechanisms, promote international cooperation, and determine how to measure success. BIREC 2005 provided a platform to build consensus and secure commitments on moving forward towards a cleaner energy future, from which all can benefit. This report served as a background report for BIREC 2005, provided input to the dialogue and discussion, and contributed to the primary outcome of the meeting – the Beijing Declaration.

1 Introduction

1.1 Purpose and Objectives

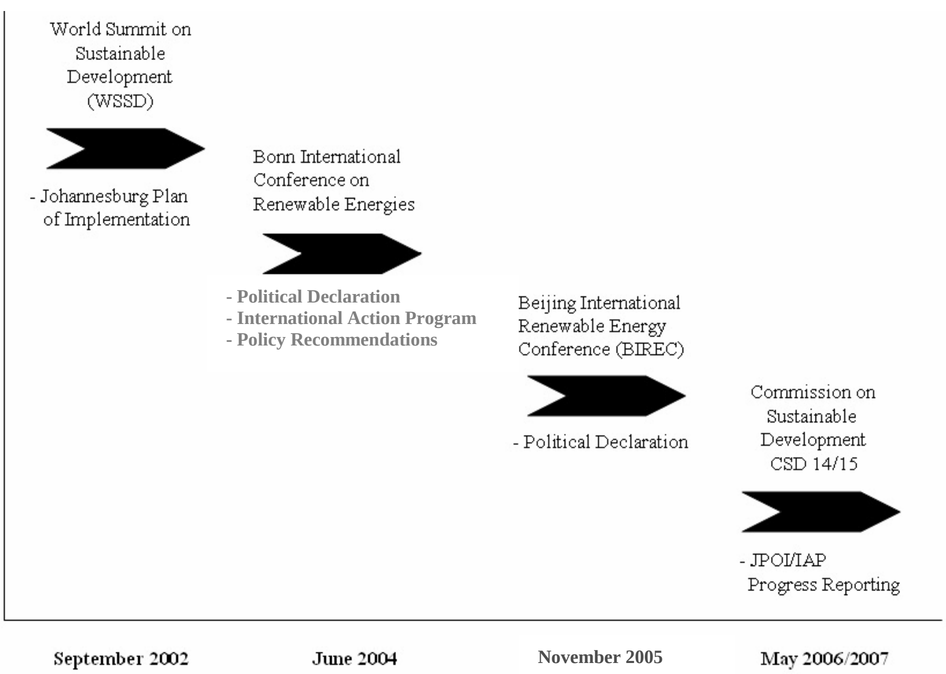
This document was prepared as a background report for the Beijing International Renewable Energy Conference held November 7-8, 2005, in Beijing, China. The Beijing Conference provided a unique forum for continuing the momentum for advancing renewable energy at the global level (see Exhibit 1.1).

This was begun at the World Summit on Sustainable Development, with the launching of the *Johannesburg Plan of Implementation* by member states, international organizations, and other stakeholders. The JPoI called for a substantial increase in the contribution of renewable energy to total energy supply "with a sense of urgency."

It continued with the landmark Bonn International Conference on Renewable Energies that brought together over 3,600 participants from across the world to chart the global expansion of renewable energy. Bonn Conference outcomes included a *Political Declaration* outlining shared goals for increasing the role of renewable energies and a joint vision of a sustainable energy future; an *International Action Program* including 200 actions and commitments to accelerate the use of renewable energy; and *Policy Recommendations* for renewable energies to support the development of new approaches, strategies, and partnerships in scaling up these technologies.

Looking forward, BIREC 2005 offered a unique platform for the international community to advance consensus on issues, actions, and accomplishments for increasing the global market share for renewable energy, to be reported at the upcoming Commission on Sustainable Development Meetings 14 and 15. CSD 14, which will be held May 1-12, 2006 in New York City, will have a focus on energy.

Exhibit 1.1 Renewable Energy Scale-Up: The Road from WSSD to CSD



BIREC 2005 assembled the international community around the shared goal of global renewable energy development, with a particular focus on developing countries. The objectives were to:

- Review and assess the status of renewable energy technologies and their contribution to development, including jobs, income generation, and energy security;
- Determine the role of renewable energy for poverty eradication and the prospects of North-South, South-South, and South-North collaboration;
- Share success stories on renewable energy deployment worldwide;
- Explore policy and financing mechanisms for mainstreaming renewable energy in developing and industrialized country markets;
- Examine opportunities for domestic and international collaboration in renewable energy; and
- Review progress on renewable energy commitments made at WSSD and the *Renewables 2004* Conference, and to plan for the upcoming CSD Meetings 14 and 15.

In preparation for BIREC 2005, this report provided a forward looking perspective on renewable energy technology development, policy needs, capacity building, and financing conditions necessary for developing countries to take greater advantage of renewable energy. Report objectives include: (1) review trends in renewable energy development worldwide; (2) assess the challenges and barriers to further development and expansion; and (3) develop recommendations on how to move forward in accelerating the use of renewable energy, including a mechanism to monitor and appraise future progress for renewable energy development.

This document is particularly timely as there are a number of initiatives, activities, and players that have emerged or gotten traction since *Renewables 2004* and it is important that they be made aware of the latest perspectives on renewable energy. Among these are the:

- G8 Gleneagles Commitment that focused on climate change, clean energy, and sustainable development;
- The commitment of the World Bank to the energy sector after a five year retrenchment, including a pledge to achieve 20 percent average annual growth in renewable energy and energy efficiency in the next five years;
- Similar support for renewable energy, including for poverty reduction, by regional development banks and organizations including the Inter-American Development Bank (IDB), the Asian Development Bank (ADB), the African Development Bank (AfDB), the European Bank for Reconstruction and Development (EBRD), the Organization of American States (OAS), the Asia Pacific Economic Cooperation (APEC), etc;
- Implementation of partnerships launched at the WSSD that include emphasis on renewable energy, such as the Renewable Energy and Energy Efficiency Partnership (REEEP), the Global Village Energy Partnership (GVEP), the Global Network on Energy for Sustainable Development (GNESD), and the European Union Energy Initiative (EUEI); and
- Emergence of a range of new players to the sector including Fortune 500 firms, large international banks, investment houses, venture capital firms, public banking institutions, development banks, and foundations investing in renewable energy projects and programs.

This document builds upon the extensive base of materials prepared for the Bonn Conference (available at http://www.renewables2004.de/en/cd/default.asp). It also serves to complement reports by the Chinese and German Governments, the Renewable Energy Network 21 (REN21), the World Bank, the United Nations (UN), participating countries, and others developed for BIREC 2005.

1.2 Background[1]

Globally, demand for energy services is strong, and growing. The World Energy Outlook 2004 predicts that under a business as usual (BAU) scenario, energy needs through the year 2030 will increase by 60 percent. Developing countries, led by China and India, will account for two thirds of the growth in energy demand. By the year 2030, developing countries will equal and begin to exceed the demand levels of the industrialized world. Fossil fuels will continue to dominate energy use—accounting for 85 percent of world primary demand—with renewable energy as a percentage of total energy consumption remaining largely unchanged at approximately 14 percent.

Yet the composition of renewable energy consumption is expected to shift in this timeframe. In 2002, renewable energy use consisted primarily of traditional biomass (7 percent), including dung, fuel wood, and crop wastes, and hydropower (6 percent). Other renewables—modern biomass, solar, geothermal, wind, tidal, and wave—accounted for 1 percent of total energy consumption. Through the year 2030, renewable energy consumption is expected to increase from about 1,400 Mtoe in 2002 to 2,200 Mtoe in 2030 (a rise of 60 percent). Traditional biomass is expected to decline as it is used more efficiently or displaced with modern energy sources and large hydropower will remain relatively constant. The growth will occur in other renewables, which are expanding rapidly, primarily in developed countries and a few developing countries.

The pursuit of this BAU path brings with it enormous consequences. Environmentally, carbon dioxide (CO_2) emissions are expected to grow by 60 percent, primarily from coal-fired power stations and the projected boom in car and truck use in developing countries. From an energy security perspective, the bulk of the petroleum to be consumed is sourced from only a handful of countries. Regarding energy poverty, despite growth in energy use, developing countries will consume only one-quarter of that of the industrialized world, with 1.4 billion people projected to lack electricity access in 2030 and the associated social and economic benefits it can provide. From a stability perspective, countries are expected to experience even greater energy supply uncertainties and price increases from fossil fuels. Recent trends in the world energy industry, especially a doubling of oil prices in less than two years, has increased the economic risk of relying primarily on imported energy and the volatile world energy market.

The challenge is how to meet these growing energy needs in a more sustainable and environmentally sound manner, as the business as usual model is clearly unsustainable.

[1] Unless otherwise noted, statistics and supporting explanation are drawn from the International Energy Agency (IEA), World Energy Outlook (WEO) 2004, Organization for Economic Cooperation and Development (OECD), Paris, France.

Textbox 1.1 No Energy, No MDGs

The Millennium Development Goals (MDGs) commit the international community to an expanded vision of development, one that vigorously promotes human development as the key to sustaining social and economic progress in all countries, and highlights the importance of creating a global partnership for development. The goals have been commonly accepted as a framework for measuring development progress.

Although energy does not have a dedicated MDG, it was widely recognized and officially endorsed at WSSD, that the MDGs could not be achieved without adequate and affordable energy services. The MDGs include:

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria, other diseases
7. Ensure environmental sustainability
8. Establish global partnership for development

1.3 Why Renewable Energy? Why Now?

Renewable energy technologies have made tremendous advances in 25 years. Today, they offer significant advantages over conventional fuels for meeting energy needs worldwide. Benefits of renewable energy technologies include:

- Utilize locally available resources—the sun, wind, biomass, geothermal, and hydropower.
- Reduce the need for fossil imports and their attendant foreign trade impacts.
- Enhance energy security by diversifying the energy portfolio, improving price stability in times of rising fossil fuel costs, and reducing risks associated with future energy cost uncertainties.
- Create local job, revenue, and income opportunities.
- Are modular in nature which means that systems can be sited close to the load requirement—offsetting the need for costly grid extension, complementing consumers' ability to pay, and expanding as demand warrants.
- Match well to a variety of grid, off-grid, remote, and distributed applications; in many instances, renewable energy will be the least cost energy solution.
- Conserve a country's natural resource base.
- Provide health benefits, particularly to women and children through the transition to improved cookstoves and cleaner combustion of cooking fuels. Additionally, electric lighting, as an alternative to kerosene, provides better quality light while avoiding fumes, carbon monoxide emissions, and the serious fire hazards of kerosene use.
- Contribute to rural and peri-urban social and economic development through the provision of modern energy services, including lighting, heating, cooking, cooling, water pumping, transportation, and communications that enhance people's lives and livelihoods. Renewable energy can also contribute to achievement of the Millennium Development Goals (see Textbox 1.1).
- Are environmentally beneficial, lacking the nitrogen and sulfur oxides that are harmful to humans, animals, and plants, and carbon dioxide and methane emissions which contribute to climate change (see Textbox 1.2).

Textbox 1.2 Renewable Energy and Climate Change

Over the last few decades, climate change has evolved into an issue of global concern. The link between anthropogenic emissions, concentrations of greenhouse gases (GHG) in the atmosphere, and climatic changes is well documented. There is broad consensus in both the scientific and political communities that significant reductions in carbon emissions are going to be necessary to limit the changes to manageable levels.

It is clear that the major contribution to GHG emissions comes from fossil fuel based energy related activities. Industrialised countries are responsible for the majority of current and historic emissions, but developing countries are significantly increasing their share of emissions, especially driven by rapid growth in some of the major emerging economies like China and India.

Renewable energy can make a major contribution to reducing GHG emissions, and this has already begun on a modest scale. Large global companies have entered the markets for wind, solar, and biomass technologies, and the traditional finance community is gradually mainstreaming renewable energy into its' lending portfolios. The REN21 "Global Status Report" notes that about US$30 billion was invested in renewable energy in 2004, contributing 160 gigawatts (GW) of global power capacity. Most long-term projections predict that these technologies will play a major role in the global energy supply in the second half of the century, but in the first decades the increase in renewable energy will be more modest.

In the last few years, renewable energy technologies have experienced substantial improvements in cost, performance, and reliability, making them competitive today in a range of applications. Led by wind and photovoltaic (PV) technologies, they represent the fastest growing of all energy industries (though starting from a relatively low base). The momentum for renewable energy worldwide is strong, and the prospects for these technologies virtually untapped.

A number of drivers are spurring market growth in renewable energy. Most notably, investments in technology research, development, and demonstration (RD&D), primarily by industrialized nations; supportive policy and regulatory frameworks; energy security issues; environmental and climate change concerns; and local and regional development opportunities that these technologies offer. Price spikes and supply concerns over fossil based technologies are further increasing interest in and demand for the technologies. As Exhibit 1.2 shows, market drivers will vary across countries. For example, in Europe, environment, climate change, and energy security are the key market drivers. In the US and Japan, energy security is the greatest driver for renewable energy followed by environmental, climate change, and consumer demand considerations. In developing countries, the prospects for energy access and economic development are the prime market movers.

Nonetheless, despite their advancements, the key markets for renewable energy today are in the industrialized countries (with limited exception of emerging economies such as China and India). For example in 2003, a clear geographical imbalance was evident, with industrialized countries accounting for 92 percent of the wind power installed capacity, and 88 percent of the PV cell production.

Exhibit 1.2 Key Market Drivers for Renewable Energy

	Factors Affecting Demand for Renewable Energy					
	Climate Change[1]	Environ-mental Issues	Energy Security	Consumer Demand	Increased Reliability	Local Economic Development
Europe	●	●	●	◑	○	◑
Japan	◑	●	●	◑	○	○
United States	◑	◑	●	◑	◑[2]	◑
Developing Countries	○	○	◑	●	◑	●

1. Government vs. individuals
2. Region specific

(Source: Navigant)

● High ◑ Medium ○ Low

Developing countries, where energy services are critically lacking, have not meaningfully benefited from renewable energy services. Clearly, if we are to increase current rates of growth, have a significant impact on the environment, displace/supplement fossil fuel resources, and reduce the energy-poverty gap, renewable energy technologies must play a much larger role in meeting the growing energy needs of developing country markets.[2]

1.4 Addressing the Barriers

That renewable energy potential is far from maximized is due in large part to a number of outstanding barriers which put renewable energy at an economic, regulatory, or institutional disadvantage relative to other forms of energy[3]. Barriers include:

- The higher relative costs of the technologies (despite cost reductions) in a number of applications; renewable energy systems have higher upfront capital costs than conventional alternatives, though lower operation and maintenance (O&M) costs.
- Lack of mature markets and favorable policy, regulatory, and legal frameworks to encourage the development of and investment in renewable energy.

[2] Use of renewable energy should be done in conjunction with energy efficiency as the two are highly complementary. Renewables increase the "supply" of energy services, and efficiency reduces the "demand". Working in tandem they can enhance sustainability for a country. This was the finding of a paper prepared by GTZ for the Bonn Conference entitled "Towards Sustainable Energy Systems: Integrating Renewable Energy and Energy Efficiency is Key".
[3] E. Martinot, *Renewable Energy Policies and Barriers, Encyclopedia of Energy*, Academic Press/Elsevier Science, 2004.

- Subsidies for fossil-based fuels, which make it difficult for renewable energy to compete; and lack of fuel-price risk assessment.
- Inadequate institutional capacity for all aspects of renewable energy project/program design, development, and implementation, including lack of skills and knowledge.
- Imperfect capital markets; insufficient access to affordable financing for project developers, entrepreneurs, and consumers; and financing risks and uncertainties.
- Lack of awareness and understanding of the benefits, costs, and applications of renewable energy among policymakers, the local private sector, finance institutions, and prospective customers.
- Inadequate information on the renewable energy resource potential.
- Restrictions on siting and construction, transmission access, and utility interconnection.
- The small scale nature of the technologies, often coupled with the geographic dispersion and low population densities of rural customers, contributes to high transaction costs for renewable energy projects and insufficient cost recovery.
- Inadequate demonstrated models for scale-up.
- Insufficient mechanisms for international cooperation, including technology transfer, trade, and financial flows.

Rapid increase of renewable energy in developing countries will require addressing these barriers, including development of supportive policy and regulatory frameworks, securing public sector commitment, strengthening local capacities and entrepreneurship, transferring technologies, and increasing access to affordable financing and consumer credit. It will require transitioning from traditional biomass to modern use of biomass, cleaner fuels, and improved cook stoves; maximizing use of hydro resources (large, small, and micro) in an environmentally sustainable manner; more efficient use of biomass residues for power generation and transport, including growth of dedicated crops; and increasing deployment and reducing costs of solar, wind, geothermal, wave, tidal, and other renewable energy sources.[4] The good news is that these issues have been tackled successfully in several countries around the world and models exist for replication elsewhere.

With the increasing costs and risks associated with the International Energy Agency (IEA) BAU scenario, the question is no longer can we afford renewables, but can we afford fossil energy. Portfolio theory has shown that adding renewable energy to a fossil-dominated energy portfolio will reduce generating cost and enhance energy security.[5] The challenge then becomes how to provide renewable energy services in an affordable and accessible manner.

1.5 Organization of Report

This report addresses activities that can be undertaken and/or enhanced to address many of the barriers outlined above. In particular:

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[4] J. Saghir, The Global Investment Climate: Financing the Growth of Renewable Energy in Developing Countries, Renewable Energy World, July-August 2005

[5] S. Awerbuch, *Portfolio-Based Electricity Generation Planning: Policy Implications for Renewables and Energy Security*.

- Chapter 2 provides an overview of the current status and future prospects of renewable energy, including cost and performance trends.
- Chapter 3 outlines policy approaches for scaling up renewable energy worldwide and documents the impact that effective policies can play in driving renewable energy markets.
- Chapter 4 describes financing options and sources for renewable energy.
- Chapter 5 presents opportunities for capacity building and strengthening in various aspects of renewable energy deployment and use, including specific requirements of developed country, newly industrialized country, economies-in-transition, and developing country markets.
- Chapter 6 describes the role of and potential for international cooperation in promoting renewable energy.
- Chapter 7 provides perspectives and options for monitoring progress on the WSSD JPoI, the *Renewables 2004* Conference IAP, and other commitments to renewable energy made by various stakeholders.
- Chapter 8 provides conclusions and next steps.

This report served as background information for BIREC 2005. It also contributed to the primary outcome of the meeting, the Beijing Declaration, in which Ministers and government representatives participating from 78 countries reaffirmed their commitment to implementing the outcomes of the Earth Summit, WSSD, and the UN 2005 Millennium Review Summit, and to substantially increasing – with a sense of urgency – the global share of renewable energy in the total energy supply as called for in the Johannesburg Plan of Action. The full Declaration is provided in the Appendix.

2 Renewable Energy Technology Status & Prospects

2.1 Overview

2.1.1 Global Status and Prospects

Renewable energy has a vital role to play in meeting the world's energy needs and supporting sustainable development objectives. As noted in Chapter 1, renewable energy met 14 percent of global primary demand in 2002 and this share is projected to remain relatively constant through 2030 (Exhibit 2.1), as global energy demand increases by 60 percent. However, there will be significant changes in the renewable energy mix as the use of wind, solar, and geothermal energy, and biofuels for transportation continue to see rapid increases and traditional use of biomass for cooking and heating is stable or declines. It is important to note that traditional forms of biomass use are often not sustainable.

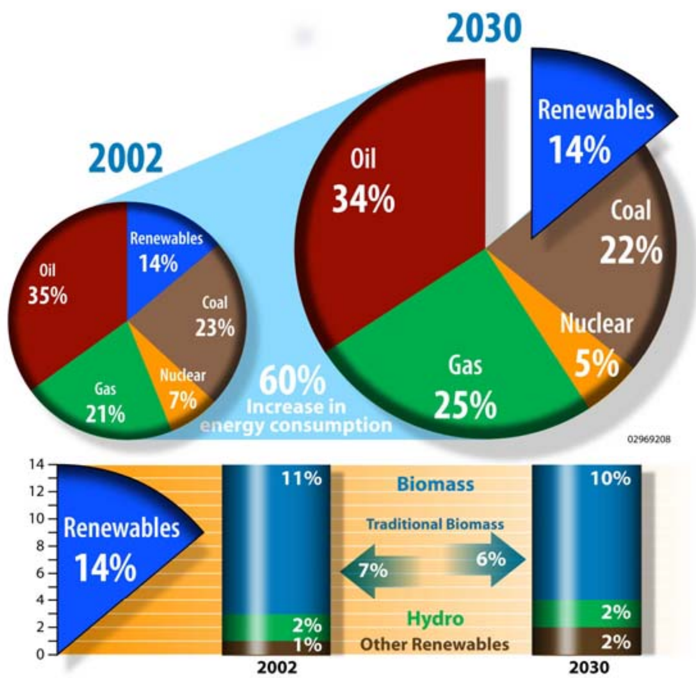


Exhibit 2.1 World Energy Consumption
Million tons of oil equivalent (Mtoe)

Recent growth rates for renewable energy have outpaced all other fuels. Exhibit 2.2 illustrates that the fastest growing energy technology in the world has been grid-connected solar PV, followed by wind power, biodiesel, solar hot water/heating, off-grid solar PV, geothermal heat capacity, and ethanol. Other renewable energy power generation technologies, including biomass, geothermal, and small hydro, are more mature and growing more slowly at rates similar to those of fossil fuels.

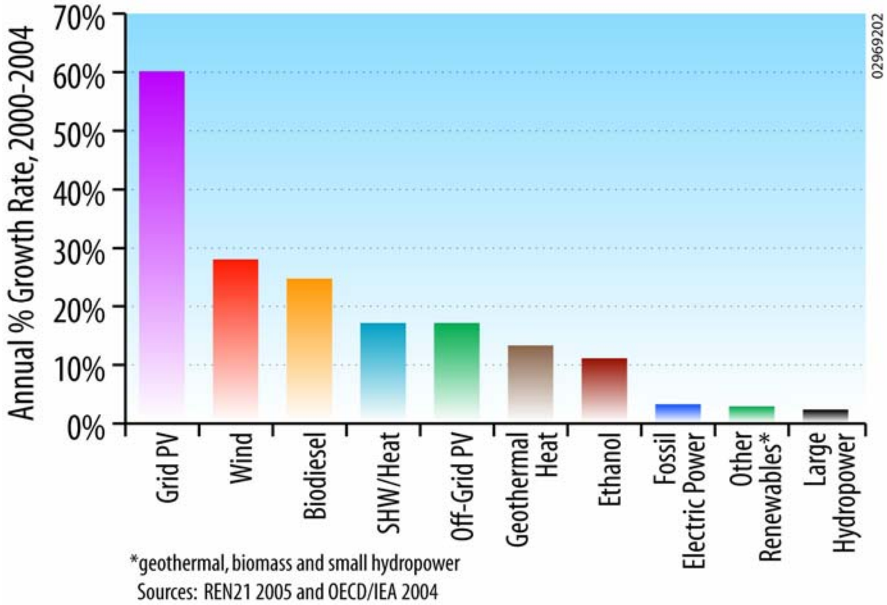


Exhibit 2.2 Renewable Energy Growth Rates

Renewable energy costs have declined at rapid rates across the board over the past several decades and are all projected to continue to decrease (see Exhibit 2.3). These cost reductions are resulting from improvements in technology performance and increasing scales of production and use. Coupled with increasing prices for conventional energy sources and other market and policy drivers, these cost reductions have allowed mature renewable energy technologies, such as wind power, bioenergy, solar hot water and PV systems, geothermal energy, and hydropower to achieve significant market penetration around the world. Also, since 1975, ethanol from sugarcane in Brazil has presented strong reductions in production costs (see Exhibit 2.4). Projected future declines in renewable energy costs will accelerate this growth in renewable energy use.

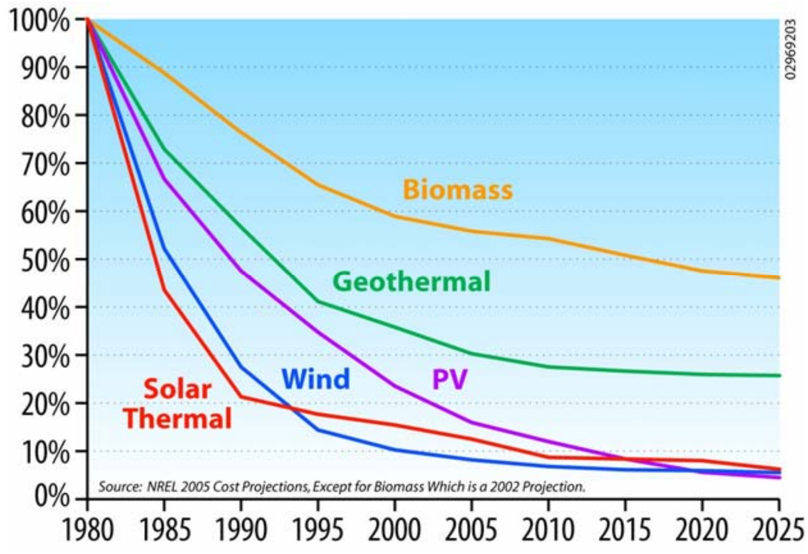


Exhibit 2.3 Renewable Energy Electricity Generation Costs as Percentage of 1980 Levels: Historical and Projected (NREL 2005)

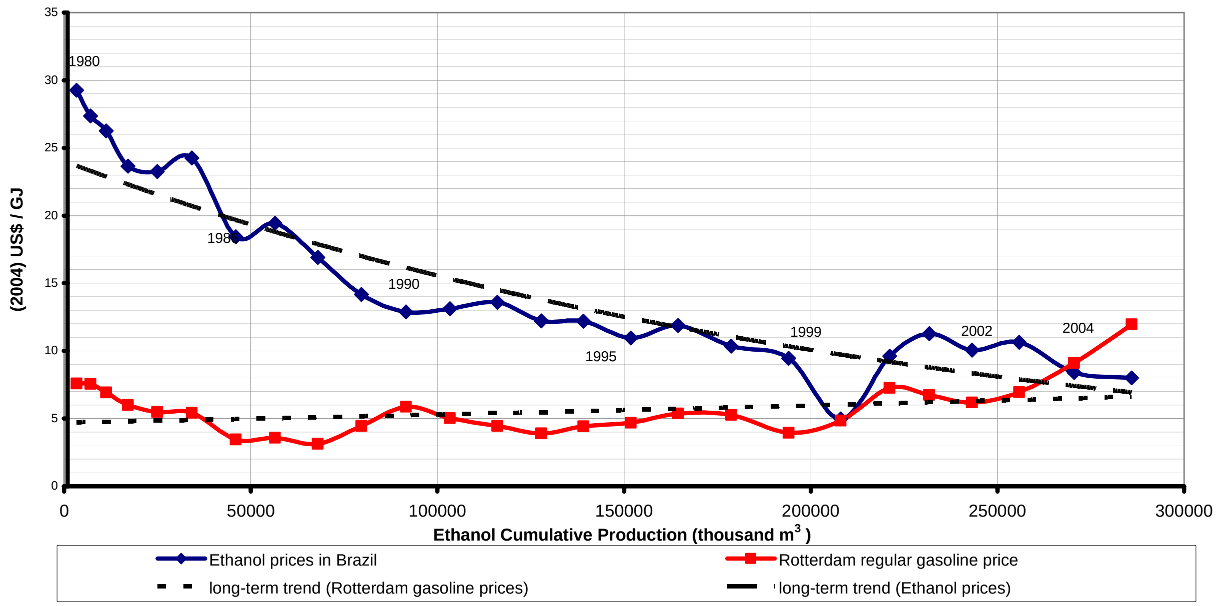
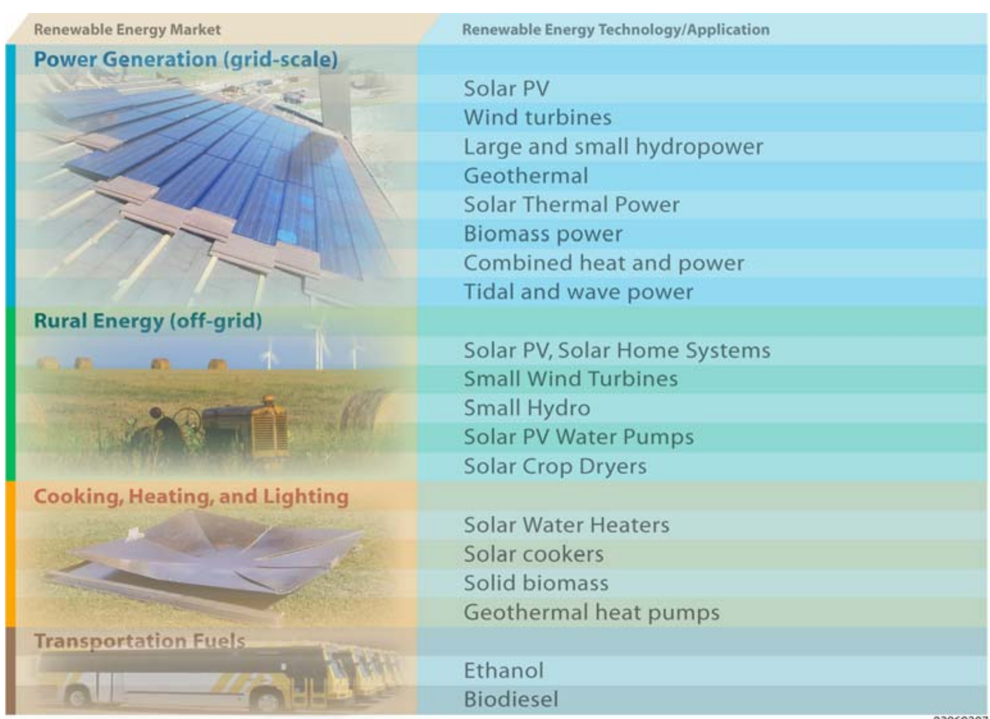


Exhibit 2.4 Brazilian Ethanol Learning Curve (Brazil)

2.1.2 Renewable Energy Markets

The primary markets for renewable energy technology are: 1) Power generation (grid-scale); 2) Rural energy (off-grid); 3) Hot water and space heating; and 4) Transportation fuels. Exhibit 2.5 summarizes the major renewable energy applications for each of these markets.

Exhibit 2.5 Global Renewable Energy Applications



Power Generation (grid-scale)
World electricity demand is projected to double between 2000 and 2030, with electricity demand growth tripling in developing countries by 2030. Renewable energy (excluding large hydro) accounted for 4 percent of total global electricity capacity, or 160 GW, in 2004 and is projected to increase rapidly over the next several decades. Developing countries accounted for 44 percent of the 160 GW in 2004, with 2/3 of this capacity from small hydropower and wind energy (REN21 2005).

There are large opportunities for increased use of all major sources of renewable energy electricity generation in the future (see Exhibit 2.6). Onshore and offshore wind energy is expected to make the largest contribution across the renewable energy technologies, expanding both in developed countries and in developing countries that have made major commitments to wind development. PV markets are currently booming in Germany, Japan, and some US states, with expectations that growth will continue in these markets and in other countries. Biomass electricity and heat production is slowly expanding in Europe, while small-scale power and heat production from agricultural waste should see ongoing growth in developing countries with large agricultural industries. Starting with the Brazilian experience on ethanol from sugarcane, liquid fuels are now being seen as providing good opportunities for developed countries aiming to reduce GHG emissions and their external dependence on fossil fuels, and for developing countries seeking to increase job creation, particularly in rural areas and to reduce fossil fuel import dependency. Also, there are at least 24 countries with geothermal electricity and significant increases in geothermal capacity are expected in both developed and developing countries. Finally, the concentrating solar thermal power market is seeing a resurgence of investment, with new projects under development.

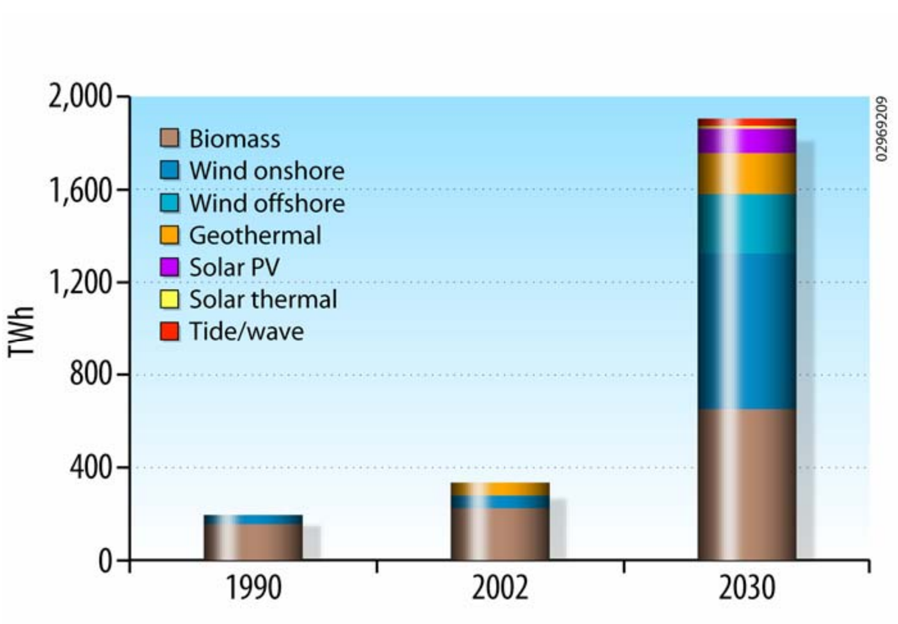


Exhibit 2.6 World Electricity Generation from Non-Hydro Renewable Energy Sources (IEA 2004)

Rural Energy (Off-Grid)
According to the IEA 2004 World Energy Outlook, there are currently 1.6 billion people without access to electricity and there will be 1.4 billion people without electricity access in 2030. As depicted in Exhibit 2.7 from the World Bank, most of these people live in developing countries, with especially poor electricity access in South Asia and Sub-Saharan Africa.

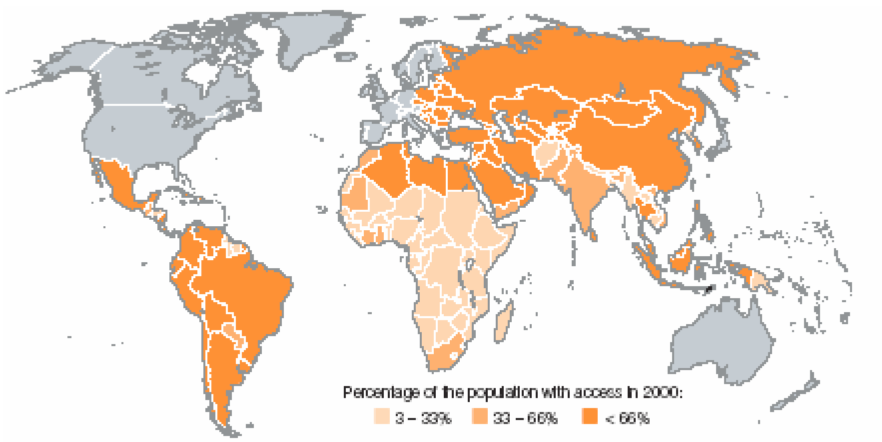


Exhibit 2.7 Populations without Electricity Access (World Bank 2001)

More than 2 million households in developing countries receive electricity from solar home systems (SHS). Most of these systems, as well as the recent growth in solar home use, are occurring in a few specific Asian countries (India, Sri Lanka, Nepal, Bangladesh, Thailand, and China), where the affordability problem has been overcome either with micro-credit or by selling small systems for cash, and where government and international donor programs have supported markets and capacity building for local technicians. Small-scale biomass gasification is also a growing commercial technology in some developing countries, most notably China and India. More than half of the world's small hydropower capacity exists in China, where an ongoing boom in small hydro construction added nearly 4 GW of capacity in 2004. Other countries with active efforts include Australia, Canada, India, Nepal, and New Zealand.

Village-scale mini-grids serving tens or hundreds of households have traditionally been powered by diesel generators or small hydro. Generation from solar PV, wind, or biomass, often in hybrid combinations including batteries and diesel generators, is providing an alternative model. For example, tens of thousands of mini-grids exist in China, primarily based on small hydro, while hundreds or thousands exist in India, Nepal, Viet Nam, and Sri Lanka. Biomass residues are also useful for village-scale applications.

There are several other important renewable energy off-grid applications including PV and wind-powered water pumping, solar crop drying, and solar water purification. Productive uses of electricity and mechanical energy produced from renewable energy are especially important in promoting community-based economic development. Such productive uses can support small-scale industry, agriculture, telecommunications, health, education, and water services in rural areas.

Cooking, Heating, and Lighting
The number of people relying on traditional biomass for cooking and heating is projected to grow from 2.4 billion in 2002 to 2.6 billion in 2030, with especially large reliance on traditional biomass in developing countries in Africa and Asia (IEA 2004). There are a variety of renewable

energy-based cooking and lighting technologies that are used primarily in developing countries, especially in rural or semi-rural areas. These include biogas (from rural residues) produced in biodigestors in countries such as China, India, and Nepal. Heating technologies such as geothermal heat pumps and direct heat utilization and solar water and heating technologies are used across the world.

There are significant opportunities for increased use of efficient biomass stoves, which can save 10–50 percent of biomass consumption and can dramatically improve indoor air quality. Improved stoves have been produced and commercialized to the largest extent in China and India, where governments have promoted their use, and in Kenya, where a large commercial market has developed. There are 220 million improved stoves now in use around the world. Another promising option is use of biogas for lighting and cooking. An estimated 16 million households worldwide, including 12 million in China, receive energy for lighting and cooking from biogas produced in household-scale plants (anaerobic digesters).

Solar hot water/heating technologies contribute significantly to the hot water/heating markets in China, Europe, Israel, Turkey, and Japan. Dozens of other countries have smaller markets. There is significant potential for expanded use of solar hot water/heating technologies in both developed and developing countries, especially for residential applications. There also are significant opportunities for expanded use of geothermal direct heat utilization.

Transportation Fuels

Demand for renewable biofuels is increasing rapidly around the world in response to high oil prices, desire to reduce reliance on imported petroleum, and concern about the environmental impacts of oil production and consumption. There is much room for growth in biofuels use; biofuels only accounted for around 3 percent (or 33 billion liters) of worldwide gasoline consumption in 2004 (REN21 2005) and demand for transportation fuels is expected to continue to grow. The total vehicle stock in developing and transition countries is expected to triple between 2002 and 2030, to 550 million vehicles, reaching 75 percent of the vehicle stock in developed countries, although per capita oil use in developing countries is expected to stay well below that of developed countries (IEA 2004).

These market forces are projected to stimulate rapid growth in production of biofuels for transportation use, especially ethanol and biodiesel. Ethanol is used both as a low-level blend with gasoline and as pure ethanol or high-level ethanol blends (for flexible fuel vehicles or pure-ethanol vehicles). Over 15 countries currently produce fuel ethanol, with the largest of these in Brazil and the United States. Biodiesel is also used both as a blend with diesel oil and as a pure fuel for both light and heavy duty vehicles that have been adapted. Germany, France, and Italy are the largest biodiesel producers, with several developing countries starting to invest in biodiesel plants. Many developing countries have the potential for significant biodiesel development and are starting to invest in this sector, including Argentina, Brazil, and India among others.

2.2 Bioenergy

2.2.1 Technology Applications

Biomass (organic matter such as vegetable oils; wood; and agro-industrial, urban, or rural residues) is the most widely used renewable energy source, as well as the largest renewable contributor to global primary energy supply. Most biomass today is directly combusted to produce: (1) heat, such as cooking over a wood stove; (2) electricity, such as combustion or co-firing with coal in utility-scale thermal power plants; or (3) a combination of both through combined heat and power (CHP) for industrial use. Biomass can also be gasified and the gas can either be used in gas turbines to generate electricity or reformed to produce hydrogen that can be used in fuel cells. Straight vegetable oils can be used in adapted engines to replace diesel in remote areas, like in Malaysia, India, and Brazil. Biomass, typically in the form of animal dung or other organic residues, is also commonly used in anaerobic digesters to produce methane, which can be used for heating, lighting, or electricity generation. Finally, biomass can be fermented, thermally converted, or hydrolyzed with heat and pressure to produce biofuels such as ethanol, biodiesel, or hydrogen.

Photo courtesy of NREL

Biomass is stored energy that can be used when needed, which is beneficial for utility dispatchers or remote applications where storage (or local access) may be limited. Many of the biomass resources used for fuel and bioenergy are either the products of farming and forestry or by-products in the production of farm and forestry derived products. At times this leads to synergies such as the use of bagasse for CHP in sugar and ethanol mills, while at other times, there may be a market competition between the production of foodstuffs such as sugar or ethanol from the same mills. In other circumstances, the beneficial use of biomass for energy and fuels offsets and mitigates environmental problems such as the use of landfill gas in power generation instead of its emissions as methane, a potent greenhouse gas, or the use of forest thinning to improve forest health and avoid large scale forest fires. Finally, use of biomass can help alleviate environmental problems such as the waste effluent from animal farms or clearing underbrush to mitigate against forest fires.

2.2.2 Status and Trends

The IEA estimates the current bioenergy supply to be about 11 percent of the total primary energy demand of 50 EJ/year (IEA 2004) of which 7–10 EJ/year is used in industrial countries and 40–45 EJ/year is used in developing countries. Around two-thirds of current biomass use is for traditional cooking and heating and much of this biomass use is considered to be unsustainable. China and India are the largest biomass energy producers worldwide. While most biomass electricity production occurs in OECD countries, several developing countries, especially India, Brazil, other Latin American/Caribbean, and African countries (e.g., Mauritius Islands), generate large amounts of electricity from combustion of bagasse from sugar alcohol production. Global installed biomass electricity capacity is expected to reach 60 GW in 2013 (Navigant 2003) and to triple from current levels by 2030 (IEA 2004).

Liquid biofuels have tremendous potential to displace petroleum fuels around the world and many countries are in the process of establishing policies to promote biofuel use. The two primary biofuels are ethanol and biodiesel, both of which can be used either as a blend or as a pure fuel. The largest production of biofuels is from corn in the United States and from sugarcane in Brazil, where nearly 2 percent of the United States and 30 percent of the Brazil transport fuel demand is met by ethanol (IEA 2004). Brazil's ethanol production was around 15 billion liters and the United States's around 14 billion liters in 2004 (REN21 2005). Since 1975, Brazil has invested around US$12 billion in production of ethanol, but has saved over US$29 billion in oil imports (GNESD 2005) and now ethanol represents almost half of the automotive fuel sales in Brazil. Ethanol production and use is expected to see dramatic increases around the world.

Biodiesel production is currently around 2 billion liters a year, with most of this production concentrated in Germany, France, and Italy. In 2004, biodiesel production in the United States was approximately 0.1 billion liters. Several developing countries are making investments in biodiesel. For example, Malaysia is building its first biodiesel plant to convert palm oil to biodiesel (REN21 2005). In Brazil, the first plants are being built to produce biodiesel from palm and castor oils. Biodiesel can be produced from methanol (methyl alcohol), as in European Union (EU) countries, or from ethanol (ethyl alcohol) as in Brazil and other developing countries. In Brazil, ethanol production costs are *lower* than the cost of petroleum fuel production (IEA 2004), while in the United States, ethanol is commercially produced from corn at a cost of US$.90-$1.10/gallon (US$1.46-$1.80/gge). Exhibit 2.8 shows the projected decreases in costs from ethanol production from all sources, including corn, straw, and woody biomass in gallons of gasoline equivalents (gges). This accounts for the fact that ethanol has two-thirds of the gasoline energy equivalents in use. The cost of ethanol from these biomass sources is expected to go as low as US$1.20 in gges by 2025. The production cost of biodiesel from soybean oil is in the range of US$2.50 to $2.75/gallon.

Direct biomass combustion is a mature technology but plants are small with low efficiencies (20 percent). Costs of biopower generally range from US$0.08 to US$0.12/ kilowatt hour (kWh) and are predicted to drop to US$0.06-0.07/kWh by 2020. The most promising near-term option for large-scale biopower generation is co-firing. Co-firing biomass with coal in large power plants is more efficient (33 percent) and less costly (currently US$0.02-$0.04/kWh, and predicted to drop to US$0.01-0.02/kWh by 2020) than existing biomass power plants.

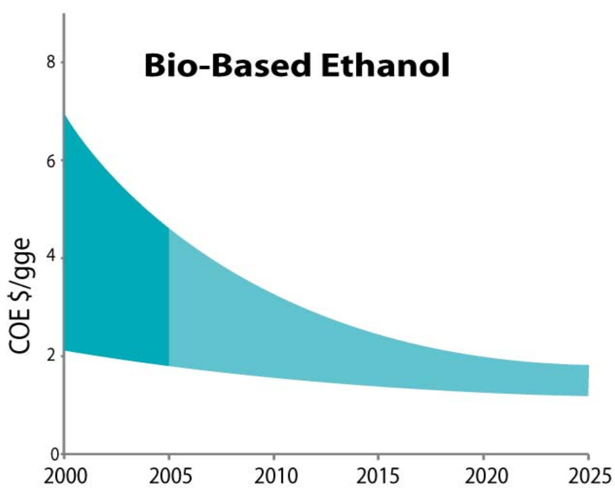
Combined heat and power (CHP) applications using a waste fuel are generally the most cost effective of the biomass technologies with investment costs of US$1,400-2,100 per kilowatt (kW) and electricity generation costs of US$0.04-0.08/kWh. CHP can have total efficiencies nearing 90 percent.

Biomass gasification combined cycle plants can reach efficiencies of greater than 40 percent, but this technology is only starting to be commercialized. Costs are currently estimated to be in the US$0.06-0.07/kWh range, decreasing to US$0.04-0.06/kWh by 2020 (Biopower Technical Assessment: State of the Industry and Technology 2003).

2.2.3 Technical Issues

While combustion and co-firing technologies are mature, a wide array of gasifiers are being tested and optimized to produce power from biomass. Further

Exhibit 2.8 Projected Decreases in Costs from Ethanol Production (NREL 2005)



commercialization and demonstration of these systems is needed to prove the technology and decrease costs. Small biopower systems have been used extensively in developing countries but gas cleanup and reliability have stifled further dissemination of these technologies. Research is underway to address these issues and demonstrate the technology for use in rural and off-grid applications. Extensive research and development (R&D) into improved cook stoves has gained, at best, a factor of 2 in efficiency (Kammen 1995) resulting in a reduction of fuel input, but progress in reducing toxic air pollutant emissions has been very limited (Ludwig, Marufu et al. 2003). These emissions have been linked to acute respiratory infections, which are a leading cause of childhood illness and death.

Anaerobic digestion is widely used in both developing and developed countries. A growing trend is the installation of anaerobic digesters to manage the effluents from animal farms. While these systems can be capital intensive, there are several small, easy-to-operate, simple systems in India and Nepal. The benefits in terms of the environment, as well as the energy income, combine to make them viable solutions.

The relative share of biofuels in the transportation sector is low, except for Brazil, due to the higher costs of ethanol and biodiesel production with respect to petroleum fuels. Research is underway to use inexpensive lignocellulosic feedstocks such as waste materials or fast-growing energy crops instead of the high-value sugar and starch parts of plants. Research on gasification and thermo-chemical pathways is also being undertaken to produce other fuels including hydrogen for fuel cells and synthetic diesel.

With increasing biomass use, it is necessary to ensure the sustainability of this resource by paying attention to the life cycle balance of carbon, water, key nutrients, and biodiversity.

2.2.4 Opportunities

There is a significant growth potential for biomass use in the transportation sector. About a tenth of world gasoline use could be displaced with Brazilian style ethanol production by 2020. Even more could be displaced as lignocellulosic conversion costs decline (IEA/2004). Biodiesel could potentially displace 5-10 percent of diesel use worldwide. Existing biofuels use is driven by government policies and subsidies which in turn, are generally agriculture-driven.

The commercialization of gasification technologies is very promising for generation of fuels and power at a relatively low cost, even at smaller scales. The production of dimethylether (DME) from biomass could be used to manufacture a substitute for liquefied petroleum gas (LPG) and modernize the use of renewable biomass in cook stoves instead of fuel wood and charcoal. Gasification can also be used as a platform for biorefineries, which co-produce energy as well as higher value products (US Department of Energy, USDOE, 2003).

2.3 Geothermal Energy

2.3.1 Technology Applications

Photo courtesy of NREL

Geothermal energy is a major contributor to electricity production in at least 24 countries. There is also an increasing widespread use of direct application of geothermal heat, for example, for space heat and domestic water heating. Geothermal energy recovered as heat takes two general forms: steam or hot water is piped into facilities where it provides ambient heating for comfort. Alternatively, heat pump technology is used to recover earth heat by pumping a confined heat-transfer fluid through a heat exchanger embedded in a warm body of soil. Geothermal heat is used to generate electrical power primarily through direct steam production or by flashing produced hot brine to release steam, which drives a turbine/generator set to make electrical power. An evolving technology expected to see major application in the future is "binary" electrical generation, in which a produced geothermal fluid heats a drive fluid (e.g., volatile organic fluid or ammonia) in a closed-loop power generation unit.

2.3.2 Status and Trends

Worldwide geothermal energy recovery currently contributes around 13,000 megawatts (MW) of electrical power (a little over 8 percent of total electricity capacity). There is significant potential for expanded geothermal electricity generation, up to 73 GW with current technology, and up to 138 GW with enhanced geothermal systems (EGS) technology (Gawell 2004).

There also are opportunities for expanded use of geothermal direct heat utilization, with capacity nearly doubling from 2000 to 2005, and with at least 13 new countries using geothermal heat for the first time. About half of the existing geothermal heat capacity exists as geothermal heat pumps for building heating and cooling, with 2 million pumps used in over 30 countries. Exhibit 2.9 displays past and projected future trends in the cost of geothermal power.

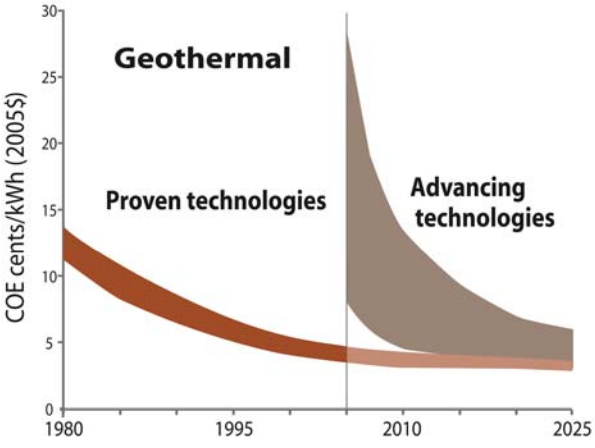


Exhibit 2.9 Geothermal Power Cost Curve (NREL 2005)

2.3.3 Technical Issues

Technical issues for increasing the production of geothermal power hinge mainly on the temperature and location of resources. Most importantly, the depth of a geothermal reservoir below the earth's surface, the reservoir temperature and productivity, and the nature of rock strata that geothermal wells must penetrate are controlling determinants in the net cost of producing geothermal power. Research in the field of geothermal energy is aimed at several key goals, in order of priority: expanding the volume and hydraulic productivity of geothermal resources, and improving technologies for exploration, drilling, and energy conversion. These goals fall under EGS development.

2.3.4 Opportunities

There are significant opportunities for increased geothermal development in many countries around the world, especially France, Iceland, Indonesia, Kenya, Mexico, the Philippines, Russia, and the United States. Worldwide, there are resources that are under-utilized or undeveloped, which could provide cost-effective energy in the near to mid-term using existing technology. In the longer term, it is projected that very large bodies of warm and hot geologic formations could develop into competitive commercial power markets via permeability enhancements.

2.4 Hydropower

2.4.1 Technology Applications

Hydropower schemes can be developed over a range of scales and type, according to various conditions, including: hydrological and topographical conditions, local and regional needs, and electricity markets. Both continuous 'base' load operation and peaking (following demand fluctuations) output can be provided. The volume of water stored, relative to the schemes generating capacity, will determine the flexibility of operation. Hydropower with significant storage can compliment other less flexible, intermittent technologies like wind power.

Photo courtesy of NREL

2.4.2 Status and Trends

Hydropower currently produces some 3,000 TWh per year from an installed capacity of 800 GW. Europe has developed some 75 percent of its technical and economic potential, while Africa uses only 7 percent now. The greatest undeveloped potential remains in Asia, Latin America and Africa: China alone plans to commission 190 GW of new hydro capacity by 2020 (NDRC 2005).

The costs of developing hydropower vary according to the remoteness of the site, the demand at the site, the domestic component (materials, equipment and labor), and the financing conditions. Costs of installation range from US $500/kW to US$4,500/kW. In most cases, economies of scale result in larger schemes having lower unit costs. In terms of efficiency, hydro generating equipment has seen a 5 percent improvement over the last three decades. Turbine efficiencies of more than 95 percent are now achievable. Generating plants have also become more compact and can operate at higher speeds than previously. This can also bring about savings in the costs of civil works. Furthermore, turbines have been designed to work under a broader range of flow conditions, which enables greater flexibility in the management of headwaters for other purposes such as flood control.

2.4.3 Technical Issues

Significant R&D has been conducted in the pursuit of turbine designs that minimize fish mortality and promote water quality. Increasing efforts are being applied to recover energy economically from smaller flow volumes and lower heads (differential between upstream and downstream water levels). Retrofitting hydropower units at existing water infrastructure built for other purposes carries significant potential; for example, only 25 percent of the world's reservoirs have any associated hydropower applications. Similar potential exists at many thousands of ship locks and weirs. Such applications are typically marginal economic projects; to attract investment, they would need to benefit from secure (long-term) premium prices of renewables incentive programs. A hydro plant is quite flexible; it can stop, start, and vary output in short periods of time, moving from standstill to full output in tens of seconds. In more developed markets, much higher prices are paid for the short periods of peak electricity demand. Hydro schemes that are equipped with units that can be available for peaking operation capitalize on this. Also, hydro schemes are often used to provide quality enhancement roles through ancillary services such as voltage regulation and frequency control. Hydropower and pumped storage schemes are increasingly used in this way, but further returns from electricity markets will be required for these ancillary services to foster continued R&D. Much work has been conducted on benchmarking and identification of good practice. Voluntary sustainability guidelines for planning, implementation, and operation have been developed and indicators of compliance are being researched (see www.hydropower.org).

2.4.4 Opportunities

Hydropower offers significant potential for increasing the global market share from renewable energy sources. This was a key finding of global leaders that met in Beijing in October 2004 at the UN Symposium on Hydropower for Sustainable Development.

Hydropower, combined with enhanced energy efficiency, can contribute to sustainable development, to providing access to energy, especially for the poor, and to mitigating greenhouse gas emissions. Hydropower represents an important source of energy, accounting for some 20% of world electricity supply.

To date, hydropower has made a contribution to development, as shown in the experience of developed countries where the majority of technically and economically feasible hydropower potential has been exploited, and in some developing countries, where hydropower has contributed to poverty reduction and economic growth through regional development and expansion of industry. However, two thirds of economically viable hydropower potential is yet to be tapped, and 90% of this potential is in developing countries. In Africa, less than 5% has been developed. Significant potential exists in developing countries, as well as in countries with economies in transition, for harnessing hydropower potential, and bringing benefits to these countries. Opportunities exist for greenfield projects, as well as for rehabilitation of existing facilities and the addition of hydropower to present and future water management systems.

Development of hydropower resources should be sustainable from a range of social, economic, and environmental perspectives. This includes taking an integrated approach to dam construction, bearing in mind that other than generating electricity, dams often perform multiple functions, including supplying water for irrigation, industrial production, and residential use, as well as flood prevention and habitat maintenance.

Small-scale, robust hydro equipment offers rural communities an opportunity to enjoy reliable power supplies (wherever the relevant hydro resources are available). Community assisted development ensures that a strong stimulus for economic development is created at the least social and environmental cost. As development continues, larger schemes can be interconnected to enhance security of supply and greater economic returns, increasingly through public-private partnerships. Linkages that improve the reliability of supply of other renewable technologies and optimize the performance of thermal schemes remain major opportunities for hydropower.

Continued dialogue is required with environmental experts on minimizing negative impacts and optimizing positive outcomes of hydro development. Greater community involvement in the implementation of new schemes needs to be nurtured. Financing models must be promoted that minimize foreign-currency debt and maximize the local component of development projects. The term of lending needs to be extended as far as possible into the operating period, to fit better with the typically high up-front construction costs (but low operating costs) of renewable technologies such as hydropower.

2.5 Solar–Concentrating Solar Power

2.5.1 Technology Applications

Concentrating solar power (CSP) plants produce power by first converting the sun's energy into heat, next into mechanical power, and, to electricity in a conventional generator. The three types of technology involved are 1) parabolic trough-electric, 2) dish-Stirling, and 3) power tower systems. The market for parabolic trough systems and power tower systems is dispatchable, intermediate-load, wholesale generation. The markets for dish-Stirling systems are non-dispatchable, intermediate-load, wholesale power generation and, due to their modularity, niche markets such as utility grid support, remote, and village power.

Photo courtesy of NREL

2.5.2 Status and Trends–Current Use and Projections

All of the fully operational CSP plants are currently located in the United States, however several CSP projects are in development throughout the world. Recently, the announcement of commercial plants in Spain and the United States has led to a resurgence of interest, technology evolution, and potential investment. Some developing countries, including Algeria, Morocco, India, Egypt, and Mexico have planned projects with multilateral assistance, although the status of some of these projects remains uncertain.

2.5.3 Cost and Performance trends

Combined cost projections for parabolic trough and dish Stirling systems are provided in Exhibit 2.10. The projected cost reductions are based on a combination of deployment (cost reductions due to learning), R&D, and plant scale-up. A 100 MW parabolic trough reference system with six hours of thermal storage, projected annual solar-to-electric efficiency of 11.9 percent, and an indirect, two-tank, molten-salt storage system has a levelized cost of energy of approximately US$0.12/kWh in solar resource regions of 7.65 kWh/m^2-day. A 1MW field of prototype 25-kW dish/Stirling units, with a projected net annual solar-to-electric generation efficiency of 22 percent has high O&M costs (US$0.10/kWh), current annual availability of about 80 percent, and current installed system costs of about US$8600/kW, yielding a levelized cost of energy of US$0.49/kWh.

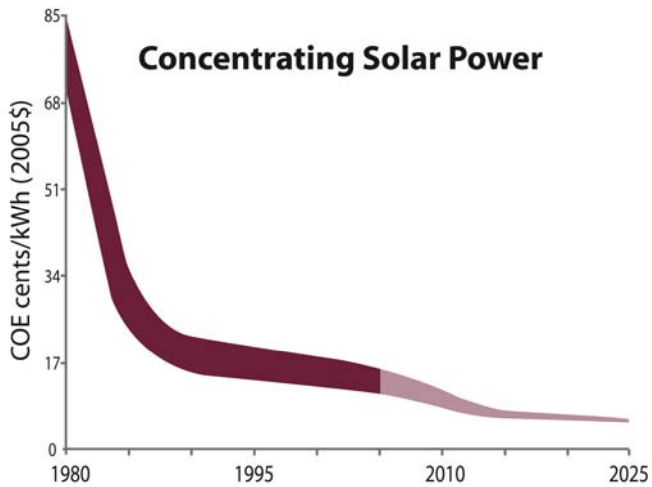


Exhibit 2.10 Concentrating Solar Power Cost Curve (NREL 2005)

2.5.4 Technical Issues

The key technical challenges for parabolic trough technology relate to improving the efficiency and reducing the installed capital cost of the solar field, including the concentrator and solar receiver. An additional technical challenge is to develop a low-cost and thermally efficient energy storage system that can dispatch power to meet system peak load. Because dish-Stirling systems and tower systems are still prototype in nature, the key technical challenges are to improve and demonstrate system reliability and reduce the system cost in order to attract investment necessary for large-scale deployment.

2.5.5 Opportunities

At an international level, the Royal Decree in Spain is providing incentives for 500 MW of CSP trough and tower technologies. Israel is supporting the development of 500 MW of trough plants. The United States has state-led policies and initiatives and a new 30 percent solar investment tax credit which will help drive CSP markets. Success in these markets could generate future interest in the technology. In addition, international activities such as the Global Market Initiative (GMI) for the market introduction of CSP systems could help to break barriers for the deployment of solar thermal electricity generating technologies worldwide.

2.6 Solar–Photovoltaics

2.6.1 Technology Applications

Photo courtesy of NREL

Photovoltaic panels produce direct-current (DC) electricity from absorbed photons from sunlight. Power PV panels typically come in one of two forms: 1) flat-plate PV panels, which use sunlight directly to produce electricity, and 2) concentrating PV (CPV) panels, which use concentrated sunlight to produce electricity. Flat-plate PV panels are typically manufactured in units (modules) that range from 5 to 300 watts-peak (Wp) of output. Concentrating PV modules are larger and range from 500 Wp to 40 kWp. Although a number of applications use direct current (DC) from the modules, the fastest-growing markets for PV use panels that are integrated into systems with power-conditioning equipment that converts the DC electricity from the panels to alternating current (AC). These systems are then interconnected to the utility grid and are referred to as grid-tied systems. The modularity of PV has opened a wide variety of markets worldwide for this technology, with residential grid-tied, commercial grid-tied, and central power generation being the main markets in the industrialized countries. The primary applications in developing countries are small, off-grid systems, usually with battery storage.

2.6.2 Status and Trends

The worldwide PV industry has been expanding very rapidly over the past decade. Global PV production increased from about 60 megawatts (MW) in 1994 to just over 1 GW in 2004, with a growth rate of nearly 60 percent from 2003 to 2004. The PV industry is expected to continue its rapid expansion over the next decade, with a continuing shift toward grid-connected markets, driven by PV-targeted subsidies in Germany, Japan, and a number of US states (e.g., California, Arizona, New Jersey).

The trend in PV module prices has generally reflected an "80 percent learning curve" through 2003, that is, the module price decreased by 20 percent for every doubling of cumulative production. In 2003, the module price was approximately US$3.00/Wp at a cumulative production of 3,000 MW. A shortage of silicon feedstock, coupled with continuing strong market demand, has resulted in module price increases in 2004 and 2005. One of the key questions, in terms of future projections, is what will it take in terms of R&D effort and market stimulation to maintain or accelerate the price-reduction trend in the future and how long can such price-reductions be continued? Exhibit 2.11 provides estimates from NREL of projected future cost reductions for the cost of energy from photovoltaics.[6]

[6] For many developing countries PV systems are still expensive technology solutions, only affordable when no other solutions are available, such as in remote villages in the Brazilian Amazon, or to increase energy access for basic needs.

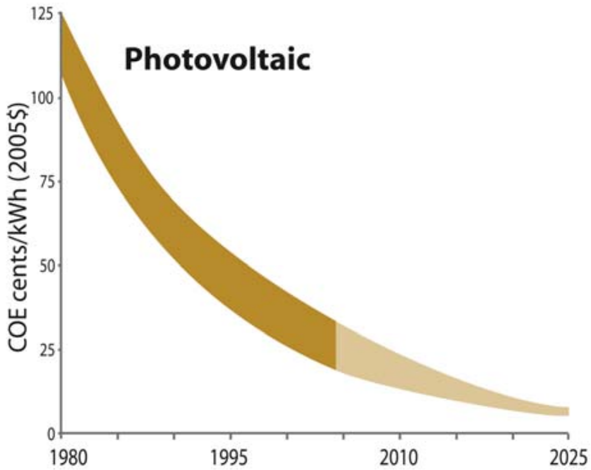


Exhibit 2.11 Solar Photovoltaic Cost Curve (NREL 2005)

2.6.3 Technical Issues

The major metrics for accelerating the market-acceptance of PV systems relate to improving the performance, cost, and reliability of all system components. One of the most significant trends over the past 30 years—one that is undeniably one of the best measures of the success of PV research—is the continuous improvement of solar cell efficiencies for all technologies over the years. Laboratory cell efficiencies for concentrator cells and thin films have more than doubled during the past 25 years, to more than 39 percent and 19 percent, respectively. Crystalline silicon cells are nearly 25 percent efficient now compared to around 15 percent efficiency 25 years ago. However, the efficiencies of commercial (or even the best prototype) modules are only 50–65 percent of these "champion" solar cells. Closing these gaps is the focus and challenge of ongoing and future research efforts worldwide.

2.6.4 Opportunities

Until the cost of PV is competitive with other forms of generation in urban areas, the largest markets will continue to be created by subsidies. However, in many places, PV electricity is already competing with the peaking, day-time electricity prices. PV use for rural electrification, where it can be more economical than extending the grid, will also continue, but may constitute a smaller share of world PV use because of the smaller scale. Also, as balance of system equipment improves and workforce development for installation and O&M technicians continues, the PV market will become even more robust.

Which of the many technology paths is likely to emerge as the *winner*? The most likely scenario is that crystalline silicon technologies will continue to dominate the market place for the next decade (and possibly longer), with module prices probably leveling off in the US$1.10–$1.40/Wp range. This would result in very large, sustainable markets for PV. The second most likely scenario is that through continued research and development successes in next-generation PV technologies, namely thin-films (and concentrators), these technologies will move rapidly into the market place. Finally, it is possible that third generation PV technologies (e.g., dye cells, organic cells, and some yet to be discovered) could have an even greater potential impact on the learning curve, however, this is not expected to occur until 2020 or later.

2.7 Solar–Hot Water

2.7.1 Technology Applications

Photo courtesy of NREL

Solar hot water systems use thermal energy from the sun to heat water for use in homes, commercial buildings, swimming pools, and other applications. Solar water heating can provide energy supply in most climate regions, but with current technology, the cost of solar water heating in freezing climates is high.

2.7.2 Status and Trends

Solar hot water/heating technologies contribute significantly to the hot water/heating markets in China, Europe, Israel, Turkey, and Japan. Dozens of other countries have smaller markets. China accounts for 60 percent of total installed capacity worldwide. Total sales volume in 2004 in China was 13.5 million square meters, a 26 percent increase in existing capacity. The 110 million square meters of installed collector area worldwide translates into almost 40 million households worldwide now using solar hot water.

Currently in freezing climates, solar water heating costs US$0.11–0.12/kWh, while in mild or "sunbelt" climates, solar water heating costs about US$0.08–0.10/kWh. In some countries such as China, solar water heating systems are already competitive with conventional systems in certain climates. Future technology goals will be to reduce material costs while maintaining energy performance. In addition, innovations in lower cost materials may allow passive solar water heaters to be used in wider geographic ranges, including areas that experience regular freezes. It is anticipated that by 2011, the cost of solar water heating systems in freezing climates will be in the range of US$0.05-0.06/kWh. In the long term, the cost of solar water heating systems in mild climates will be cost-competitive with conventional technologies, at approximately US$0.04–0.06/kWh.

2.7.3 Technical Issues

Solar water heaters are a mature technology, but focused R&D can continue to contribute significant advances in materials, design, and manufacturability. These innovations can lower the cost of solar water heaters, enhance performance, and simplify installation. The main R&D issues that remain are the shortcomings in freeze protection and the high cost compared to conventional water heating systems. Polymer solar water heaters offer the promise to eventually bring down manufacturing and installation costs further. Other market barriers not related to technology include building codes, covenants, or restrictions that may limit use of solar systems; lack of qualified and licensed installers and maintainers; and limited information about performance, cost, and benefits of solar water heaters.

2.7.4 Opportunities

Solar water heaters are a proven reliable and relatively low-cost technology with steady growth and great market potential in "sunbelt" climate zones, especially if the market barriers mentioned above are addressed. Increased deployment in other areas will depend on reducing cost of technologies that tolerate freezing temperatures. The passive thermosiphon system is the most common type of solar water heating system worldwide. Simple flat plate collectors made of copper absorbers, aluminum enclosures, and glass cover plates were the predominant technology for this system for the last few decades. However, evacuated tube collectors have recently dominated the world market because of the development of water-in-glass evacuated tube systems in China.

2.8 Wind

2.8.1 Technology Applications

Photo courtesy of NREL

The power of the wind can be captured by turbine blades which convert the kinetic energy in the wind to mechanical energy that can be used to do mechanical work, such as pumping or grinding, or can be used to drive a generator to produce electricity. Utility-scale wind turbine technology has developed rapidly over the last 20 years, from a few hundred kilowatts to multimegawatt machines capable of producing enough electricity to power hundreds of homes. These turbines are used singly for distributed generation or in wind farms that may be hundreds of megawatts in size. Small-scale wind turbines of 100 kW or less can be used to displace diesel fuel in villages and as stand-alone, hybrid, and grid-connected systems to power homes, businesses, and farms/ranches. Smaller wind applications include water pumping, ice making, powering boats, and telecommunications.

2.8.2 Status and Trends

In the past 10 years, utility-scale global wind energy capacity has increased tenfold—from 3.5 GW in 1994 to more than 47 GW by the end of 2004. In some countries, wind generation has reached 20 percent of domestic generation. In 2004, new wind installations totaled more than 8,000 MW, half of which was installed by Spain and Germany. Other fast-growing markets include India, the United States, Italy, Portugal, the United Kingdom, Japan, the Netherlands, and China. By 2013, it has been estimated that installed capacity will top 150 GW, with 14 GW/year installed (Navigant 2003), mostly in Europe, North America and Asia/Pacific. The small wind industry has also experienced remarkable growth over the last 15 years. For example, the United States had 30 MW of capacity by the end of 2004, with 14 MW predicted to be sold worldwide in 2005.

The cost of wind power continues to fall steadily, driven by technology development, increased production levels, and larger machines. According to the IEA, installed wind farm costs average US$1,250/kW and range from US$1,000 to 1,400/kW, depending on location, project size, and other factors. The cost of energy has decreased dramatically over the past two decades—from US$0.8 per kWh to about US$0.04 to 0.06/kWh or utility-scale turbines located in excellent wind resource areas. United States researchers believe that further improvements to the technology will reduce the cost of electricity from wind an additional 30 percent. Exhibit 2.12 provides estimates from NREL of projected future cost reductions.

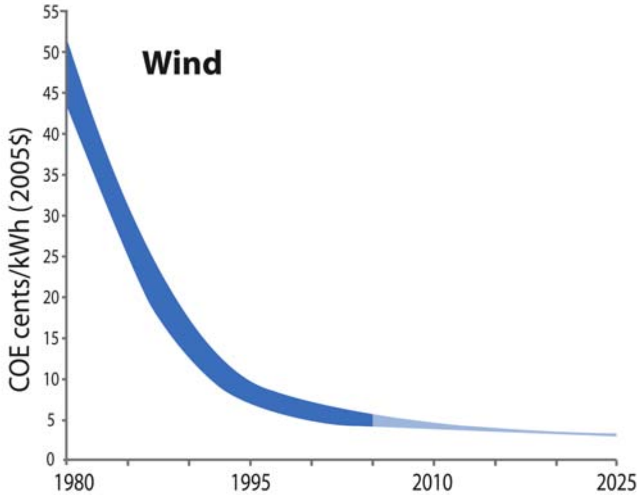


Exhibit 2.12 Wind Technology Cost Curve (NREL 2005)

2.8.3 Technical Issues

As the wind power industry grows, the number of premium wind sites with easy access to transmission lines and demand centers will dwindle. To ensure the industry's future growth, researchers are designing turbines for lower wind speed areas with taller towers, lighter-weight materials, larger rotors, more efficient airfoils and generators, and improved control strategies. They are also exploring innovative applications such as offshore wind farm development. Over 600 MW of offshore capacity is operating in Europe, and some are planning for major expansion of offshore wind power. In addition to solving the technical issues involved with designing low wind speed turbines and developing innovative applications to increase wind energy deployment, industry researchers are working to remove technology barriers that include transmission constraints, operational policies, and a lack of understanding of the impacts of wind energy on utility grids.

2.8.4 Opportunities

Utility-scale wind power has tremendous potential to meet some of the rapidly increasing global demand. Costs are competitive with conventional power generation, the industry has matured, and the technology is reliable. For Spain, Germany, parts of the United States, and other areas that are rapidly developing their best sites, new turbine technologies for low wind speeds and increased development of offshore wind will provide additional opportunities. For many other countries, including China, India, Brazil, and Argentina, many excellent sites remain to be developed and a great deal of experience is available for their policymakers, utilities, and industry. There also is significant potential for increased use of small wind turbines to meet rural energy needs around the world. The establishment of policies that level the playing field and allow wind to compete with conventional power is a critical factor that could dramatically increase the future prospects of this technology.

2.9 Implications for BIREC 2005

BIREC 2005 provided an excellent avenue to focus attention on the need for and importance of continued and accelerated investment in all aspects of renewable energy research, development, and demonstration. RD&D is necessary to drive down costs, increase performance and reliability, and improve efficiencies in all aspects of renewable energy manufacturing and production. RD&D is needed in the development of new and/or improved materials, processes, components, subsystems, and systems and these individual aspects need to be integrated in order to meet market and end user needs. Further, RD&D is required not only for renewable energy electricity end uses (grid and off grid) but also for thermal, mechanical, and refined fuel applications (including charcoal and pellets used in improved cook stoves). BIREC 2005 helped to raise visibility on the need for more effective leveraging of public and private sector RD&D funds; the importance of expanding product and service offerings to match the needs and income streams of developing country customers (particularly rural poor); the need for ongoing dissemination of information on technology performance, costs, and market potential; and joint opportunities for RD&D between and among industrialized and developing countries.

3 Policy

The evolution of renewable energy policies shows a discernable pattern over the past three decades. Starting with RD&D in the early 1970s, government investments moved toward market deployment support. In the late 1970s, governments began to employ guaranteed prices, investment incentives, voluntary programs, and tax measures. By the mid 1980s, most developed countries had RD&D policies. By the early 1990s, new market-based policies were being introduced, and by the late 1990s and early 2000s, a clear acceleration in renewable energy policy making was taking place at national, state/provincial, and municipal levels. Some policies set targets for future shares or amounts of renewable energy. Other policies promote power generation, solar hot water, biofuels, and/or purchases of green power.

The IEA[7] (2004) has offered a number of preliminary lessons from the policy history of developed countries, although it notes that it is too soon to fully assess the impacts of the most recent policies. Years of implementation experience will provide better clarity about the newer policies, particularly renewable energy portfolio standards and other obligation systems, and tradable renewable energy certificate systems. Nevertheless, the IEA says that "experience with investment incentives, tax measures and incentive tariffs suggest that all these policies can be made effective. It is the design of the support mechanism rather than the type that determines the success of policies. Over time, the array of policy choices has become broader and the market learning experience richer. Strong market growth in the late 1990s indicates that the support schemes in place may have been effective. On the other hand, it also must be stated that without government support, new renewables would show low or no increase in market growth rates."

Analysts may argue about the details and relative effectiveness of different renewable energy policies, but nonetheless many policies have clearly produced significant results. Examples include feed-in tariffs in Germany, Spain, and Denmark; subsidies for grid-connected solar PV in Japan and the United States; the production tax credit in the United States; vehicle ethanol policies in Brazil; and programs for biogas, biomass, and small hydro in developing countries such as China, India, and many others. Solar hot water promotion policies at municipal and national levels have been very effective in supporting the integration of solar hot water and heating into buildings. Electricity restructuring allowing retail power competition has clearly fostered voluntary green power purchasing, which along with utility green power pricing and/or renewables certificates systems, has fostered the growth of green power markets in Europe, the United States, Australia, and Japan.

Lessons from developed countries drawn by the IEA show that:

- Significant market growth has always resulted from combinations of policies, rather than single policies. Those countries that have experienced strong growth have done so through a combination of financial incentives and guaranteed prices, underpinned by strong RD&D.

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[7] IEA 2004, *Renewable Energy: Market and Policy Trends in IEA Countries*. Organization for Economic Cooperation and Development, Paris, France.

- Longevity and predictability of policy support are important to overall market success. In most cases, feed-in tariffs typically span 8-20 years. Conversely, “stop and go” incentives, such as the US production tax credits, can undermine investment.

- National policies are strengthened when local, state, or provincial governments have authority to act independently of the national government. For example, in Spain, the bulk of wind power growth is occurring in areas where regional government has supported development via administrative change and funding.

- Policies for rural electrification in developing countries have begun to incorporate renewables into a least-cost strategy for reaching areas too expensive to serve via power line extension. In addition to development assistance programs, national policies for supporting rural village-and household-scale renewable energy have been effective in many developing countries, such as Argentina, Brazil, China, India, Philippines, Sri Lanka, and Thailand. Lessons related to rural electrification policy[8] are: (a) historically, affordability of rural energy has been addressed through government subsidies, donor programs, and private cash sales of small systems; (b) new approaches to affordability are emerging, including vendor-supplied credit, micro credit, and rental models, but are still untested; (c) credit risk is a serious concern of financiers and dealers and makes credit sales challenging; (d) lower income rural households need long-term credit or rental options; and (e) even with credit/rentals, lower income groups will only benefit with targeted policies, including subsidies, justified by development goals. Also, energy access must be linked to income generating activities in these regions.

- Policies to promote renewable power generation have been proven effective in several developing countries. Examples include India for wind power, Thailand for small power producers using biomass and small hydro, Sri Lanka for small hydro and other renewables, and Brazil for wind, biomass, and small hydro. Lessons suggested by Martinot et al (2002) are that: (a) policies that promote production-based incentives rather than investment-based incentives are more likely to spur the best industry performance and sustainability; (b) power-sector regulatory policies for renewable energy should support Independent Power Producers and Power Purchase Agreements (IPP/PPA) frameworks that provide incentives and long-term stable tariffs for private power producers; (c) regulators need skills to understand the complex array of policy, regulatory, technical, financing, and organizational factors that influence whether renewable energy producers are viable; and (d) financing is crucial but elusive.

This remainder of this chapter outlines existing policies for increasing renewable energy use worldwide. This material is summarized, for the most part, from the REN21 “Renewables 2005 Global Status Report, “ which contains further information and references.

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[8] Martinot, E., Chaurey, A., Lew, D., Moreira, J., and Wamukonya, N., 2002. *Renewable Energy Markets in Developing Countries*. Annual Review of Energy and the Environment 27: 309-48.

Textbox 3.1 Impacts of Rising Fossil Fuel Prices in Developing Countries

Subsidies of fossil fuel prices in countries around the world have lead to market distortions and sent market signals that have perpetuated the use of these options. As fossil fuel prices rise, this has resulted in sharp and negative impacts, particularly for developing countries. For example, many countries have had to reduce funding for other sector activities (health, education, development, etc) to pay for higher fuel prices. Governments, in some cases, have also rapidly reduced or eliminated the fossil subsidies with little lead time, requiring households, commercial players, and businesses to pay a higher portion of their budgets on energy and to make critical trade-offs regarding how they will spend their money. In Indonesia, for example, the government raised fossil fuel prices by 125 percent overnight, which has lead to business closures, unemployment, decreased economic growth, reduced purchasing power, and reduced quality of life. Inclusion of renewable energy in a country's energy portfolio can help to reduce fossil fuel volatility and enhance economic development

3.1 Removal of Market Distorting Policies

Removal of market distortion policies can be the most effective policy instrument to promote investment in economically viable renewable energy technologies. These are not promotional policies for renewables, rather they are removing market barriers.

Examples include:

- Thailand and Sri Lanka have put in place regulations and rules to adopt avoided cost principles for the purchase of renewable electricity as a means of leveling the playing field for renewables as compared to fossil based solutions. These countries also put in place other mechanisms to advance the use of renewables such as regulatory frameworks for independent power producers to operate, standardized power purchase agreements, and tariffs and incentives for developers (e.g., import duty waivers, income tax concessions, etc.)
- Several countries have begun to reduce/eliminate fossil fuel subsidies, estimated at $200 billion per year. These subsidies lead to artificially low prices for fossil fuels, encourage their use and dependency, and make it difficult for renewable energy options to compete. Removal of energy price supports makes renewable energy more financially attractive. The recent surge in petroleum prices is accelerating reductions in fossil fuel subsidies as countries are forced to make tough decisions as to whether to pay fuel bills or cut social and other programs (see Textbox 3.1).
- Energy sector reform can serve to reduce market distortions and increase deployment of renewables, as has been experienced in China (Textbox 3.2) and South Africa. In these cases, power sector reform is opening up competition in rural markets and expanding opportunities for rural energy-service providers and entrepreneurs that had not existed under prior government-owned and -operated utilities.

Textbox 3.2 The Aggregate Renewable Energy Supply Curve for China

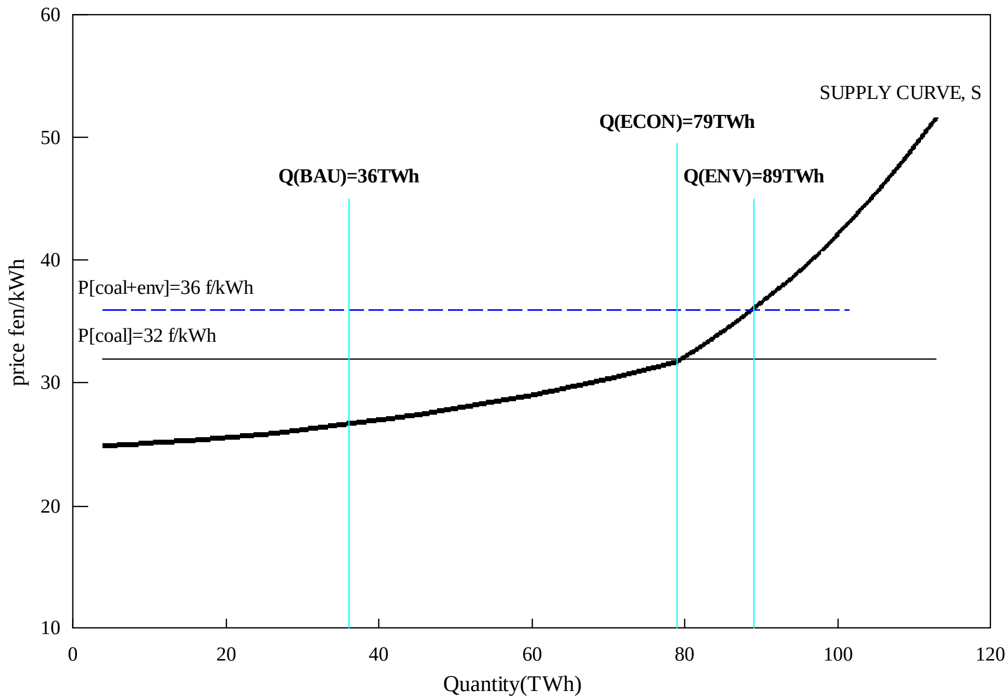

Figure 1 depicts the renewable energy supply curve, ***S***, which shows the amount of renewable energy that can be generated at a given price, compared to the production cost of electricity generation from coal, in *economic* prices (P_{COAL}, assumed here for illustrative purposes to be 32 fen/kWh).

Not all renewable energy is more expensive than coal; there are many projects (e.g., small hydro), whose costs are *less* than coal and which would be built even in the absence of a RE policy–as evidenced by the 22GW of small hydro already in place. The quantity of renewables that has a price less than or equal to that of coal is shown in Figure 1 as Q_{ECON}—about 79TWh, corresponding to 15,300MW of added installed capacity. The projects to the left of Q_{ECON} are often called "win-win"–as they cost less than coal *and* have no (or only very small) environmental impacts.

However, not all of the renewable energy projects with costs lower than that of coal would in fact be built in the absence of an express RE promotion policy due to institutional, technical, and market barriers. Therefore what actually gets built in the absence of a renewable energy policy is not QECON, but QBAU, which is estimated at about 36TWh (about 7,000MW).

If local externalities are taken into consideration, then the true (social) cost of coal rises from 32 to 36 fen/kWh; as shown, the optimum quantity of RE increases from 79 to 89TWh (17,400MW)*.

Source: P. Meier, "Economic & Financial Analysis of the China RE Scale up Program (CRESP)," Volume I: The Economically Optimal Quantity of Grid-connected Renewable Energy, World Bank, 2003.

*As discussed in detail in the body of the report above, the cost of coal, and the damage costs, varies from province to province. The quantities shown in Figure 1 represent the sum of the results for all of the provinces of China (and 32 fen/kWh and 4 fen/kWh are approximate all-China averages for the economic costs of coal, and the externality values) for the World Bank, February 2003.

3.2 Targets and Timetables for Renewable Energy

By mid-2005, at least 43 countries had set a national target for renewable energy supply, including all 25 EU countries. The EU has Europe-wide targets as well—21 percent of electricity and 12 percent of total energy by 2010. In addition to these 43 countries, 18 US states (and the District of Columbia), and three Canadian provinces have targets based on renewables portfolio standards. An additional seven Canadian provinces have planning targets. Most national targets are for shares of electricity production, typically 5–30 percent. EU country targets (by 2010) range from 3.6 percent in Hungary to 78 percent in Austria, with most of these targets providing a 5–10 percent increase in the share from renewables compared to 1997. Other targets around the world are for shares of total primary energy supply, specific installed capacity, or total amounts of energy from renewables. Most targets aim for the 2010–2012 timeframe.

Among the 43 countries with national targets 10 are developing countries: Brazil, China, the Dominican Republic, Egypt, India, Malaysia, Mali, the Philippines, South Africa, and Thailand. Latin America and Caribbean countries have established a renewable energy target during the Ministerial Level Meeting in Sao Paulo in 2002.[9] A few other developing countries are likely to announce targets in the near future. China's target of 10 percent of total power capacity by 2010 (excluding large hydropower) implies 60 GW of renewables capacity given projected electric-power growth, a large increase from today's 37 GW. India is expecting 10 percent of added electric power capacity, or at least 10 GW of renewables, by 2012.

3.3 Grid-Connected Policies

At least 48 countries—34 developed and transition countries and 14 developing countries—have some type of policy to promote renewable power generation. The most common existing policy is the feed-in law. By 2005, at least 32 countries and 5 states/provinces had adopted such policies, more than half enacted just since 2002. Among developing countries, India was the first to establish feed-in tariffs, followed by Sri Lanka, Thailand (for small power producers), Brazil, Indonesia, and Nicaragua. Three states in India adopted new feed-in policies in 2004, driven by a 2003 national law requiring new state-level policies. In 2005, new feed-in policies were enacted in China, Ireland, Turkey, and the US state of Washington. China's feed-in policy was part of a comprehensive renewable energy promotion law enacted in February 2005.

Renewables portfolio standard (RPS) policies are expanding at the state/provincial level in the United States, Canada, and India. At least 32 states or provinces in these countries have enacted RPS policies, half of these since 2003. Most RPS policies require renewable power shares in the range of 5–20 percent, typically by 2010 or 2012. There are also six countries with national RPS policies, all enacted since 2001—Australia, United Kingdom, Japan, Sweden, Poland, and Thailand.

Energy production payments or tax credits exist in several countries. The United States federal production tax credit (PTC) has applied to more than 5400 MW of wind power installed between 1995 and 2004. Starting at 1.5 cents/kWh in 1994, the credit increased through several expirations and renewals to 1.9 cents/kWh by 2005, with expiration now extended until 2007. Other countries with production incentives include Finland, the Netherlands, and Sweden.

[9] http://www.pnuma.org/foroalc/esp/index.htm

Textbox 3.3 Improving Energy Access in Rural Argentina with Renewable Energy

Jujuy is one of 24 provinces of Argentina, located in the northwest part of the country with many rural, poor communities. Prior to 1996, all electric services in the area were provided by the Provincial Energy Direction, an arm of the provincial government, and either were not reliable, or did not reach many rural areas. With the passage by Parliament of two laws in 1995/6, the electricity sector was reformed; privatizing the distribution of electricity. However, the government then mandated that small or remote villages and sparsely populated areas that could not be feasibly connected to the national grid must be given electricity access (which the Argentinean Government would subsidize). If the company failed to provide the rural market with the quantity and quality of services specified, it could be penalized by losing the concession for the grid-connected market—clearly the more lucrative investment. To accomplish the rural access challenge, the newly privatized company, Empresa Jujeña de Sistemas Energeticos Dispersos (EJEDSA), provided small-hydro systems, diesel-powered systems (gensets), hybrid PV-wind mini-grid systems, and small solar home systems (SHS) to the area. After almost nine years of continuous work including progressing through an economic crisis, EJEDSA increased the number of rural customers served in Jujuy Province by 3,400—benefiting close to 14,000 inhabitants in the region. The majority of these were provided access with renewable energy (mainly SHS), and the electricity supplied was of sufficient quantity and quality to provide basic illumination and social communications. The results obtained to date indicate that the privatization of public utilities can, under some circumstances, serve as the most efficient model for development of a renewable energy-based electricity supply in remote areas.

Policies to promote rooftop grid-connected solar PV utilize either capital subsidies or feed-in tariffs, or both (along with net metering). Japan's rooftop solar PV policies that are set to end in 2005 provided capital subsidies that started at 50 percent in 1994, but had declined to around 10 percent by 2003. Germany provides a guaranteed feed-in tariff, and until 2003 also provided low-interest consumer loans. Recent and continuing policies in France, Greece, Hungary, Italy, Republic of Korea, Luxembourg, the Netherlands, Portugal, Spain, and Thailand typically provide capital subsidies of 30–50 percent and/or favorable power purchase tariffs.

Net metering laws exist in at least seven countries, 39 US states, and several Canadian provinces, and are being enacted regularly, with six new US states passing such laws in 2004. Most recently, a 2005 US federal law requires all US electric utilities to provide net metering within three years.

Policies for competitive bidding of specified quantities of renewable generation, originally used in the United Kingdom in the 1990s, now exist in at least seven other countries—Canada, China, France, India, Ireland, Poland, and the United States. China bid and awarded 850 MW of wind power in 2003–2004 and plans another 450 MW of bidding in 2005. The PROINFA Program in Brazil (Brazil Renewable Energy Incentive Program) called recently for 3,300 MW of renewable energy generation capacity for dispatch to the national grid (1,100 MW each of wind, biomass, and small hydropower).

Many other policies in dozens of countries support renewable power generation, including direct capital investment subsidies or rebates, tax incentives and credits, sales tax and value added tax (VAT) exemptions, and direct public investment or financing.

3.4 Technology-Specific Policies

3.4.1 Solar Hot-water or Heating Promotion Policies

The Chinese market for solar hot water has been driven by unmet demand for hot water along with favorable economics and systems that sell for a fraction of prices found in developed countries. Although there are no explicit policies for promoting solar hot water in multi-story urban buildings, building design and construction by developers has begun to incorporate solar hot water, and there are government programs for technology standards, building codes, and testing and certification centers.

Beyond China, at least 17 countries, and probably several more, provide capital grants, rebates, or investment tax credits for solar hot water/heating investments, including Australia, Austria, Belgium, some Canadian provinces, Cyprus, Finland, France, Germany, Greece, Hungary, Japan, the Netherlands, New Zealand, Portugal, Spain, Sweden, the United Kingdom, many US states, and the US federal government. Capital grants are typically for 20–40 percent of system cost.

Dozens of municipal governments in Spain and some cities in other countries are introducing local mandates for solar hot water in new construction, led by Barcelona's 2000 Solar Thermal Ordinance, which applies to buildings above a specific size. Israel appears to be the only country with a national-level policy mandating solar hot water in new construction; since 1980, most buildings have been required to have solar hot water collectors.

3.4.2 Biofuels Promotion Policies

Brazil has been the world leader in promoting biofuels for 25 years (see Textbox 3.4). Since 1975, Brazil has mandated that ethanol be blended with gasoline, typically in the range of 20–25 percent. All filling stations are required to sell gasohol (E25) and pure ethanol (E100). Ethanol production was subsidized in the past but today these subsidies have been eliminated as ethanol is competitive with gasoline. Tax preferences have been given to vehicles that run on pure ethanol and most recently to "flexible-fuel" vehicles as well. Brazil has more recently begun to target increased use of biodiesel with a January 2005 law allowing blending of 2 percent biodiesel.

In addition to Brazil, mandates for blending biofuels into vehicle fuels have been appearing in several other countries in recent years. At least 18 states/provinces in Canada, China, India, and the United States now have mandates for blending ethanol and/or biodiesel with all vehicle fuels sold. In India, the government mandated 10 percent ethanol blending (E10) in nine states starting in 2003. In China, four provinces mandate E10 blending, and five additional provinces were slated for a similar mandate in 2005. In the United States, three states mandate E10 blending and one state mandates 2 percent blending of biodiesel (B2). In Canada, one province mandates E5 (average) blending by 2007. National blending mandates have appeared in Colombia and the Dominican Republic. Thailand has a target for biofuels as a share of total energy by 2011, for which it is considering E10 and B2 blending mandates.

Textbox 3.4 Increasing Agricultural Productivity and Reducing Oil Imports: The Case of Ethanol in Brazil

Brazil's Alcohol Program (PROALCOOL), the largest commercial biomass-to-energy initiative in the world, was established in 1975 following the oil crisis. Its goal was to displace gasoline imports and enhance the country's foreign trade balance.

In the beginning, the Federal Government required a mandatory blend of anhydrous ethanol (used as a fuel additive) with gasoline, a mix known as gasohol, for all cars in a proportion of 20-25 percent. In addition, "ethanol" cars were introduced into the market, that ran on pure hydrous ethanol (used unmixed as fuel in modified engines). At inception, subsidies were paid to alcohol producers, however these were eliminated in 1999. Today, ethanol is competitive with gasoline without subsidies.

All energy needs are supplied by sugarcane bagasse (by product from sugarcane crushing). Also, existing legislation to incentivize renewable energy production in the country means that industries can generate electricity surplus for sale to the grid. This legislation, combined with increases in agro-industrial productivity, was responsible for significant cost reductions in alcohol production. Ethanol production has gone from .6 to 14.8 million cubic meters from 1975 to 2005 and is expected to increase further, continuing to bring with it positive economic and social aspects, low environmental impacts, and decreased pollutant emissions.

Other countries interested in launching a biofuels program can learn from the Brazilian experience. Countries already producing sugarcane, with an interest in producing ethanol for local consumption and reducing imports can launch a program using part of the existing sugarcane base for alcohol production. Utilizing ethanol as an additive appears to be the best option; it costs around 10-20 percent more than ethanol used alone, but requires no change to the vehicle's engine. Small blends of 2-10 percent can be accepted by existing vehicles. With government mandates, an ethanol market can be created virtually overnight and investors will have the confidence to finance.

3.5 Green Power Purchasing and Pricing

There were more than 4.5 million green power consumers in Europe, the United States, Canada, Australia, and Japan in 2004. Green power purchasing and utility green pricing programs are growing, aided by a combination of supporting policies, private initiative, renewables certificates trading systems, and government purchases. In Europe, green power purchasing and utility green pricing have existed in some countries since the late 1990s. By 2004, there were almost 3 million green power consumers in the Netherlands, supported by a tax exemption on green electricity purchases. Other countries in Europe with retail green power markets include Finland, Germany, Switzerland, and the United Kingdom. Germany's green power market has grown steadily since 1998, with more than 600,000 consumers in 2004.

The United States has an estimated half-million green power consumers purchasing 4500 GWh of power annually. Green power purchasing began in earnest around 1999. By 2004, at least 2 GW of additional renewable energy capacity was built in the United States to accommodate this market. By 2004, more than 600 utilities in 34 states had begun to offer green-pricing programs. Most of these offerings were voluntary, but regulations were enacted in five states between 2001 and 2003 that require utilities to offer green power to their customers. Japan has an estimated 60,000 consumers voluntarily contributing to green power through co-operatives, community organizations, and utility programs. Australia has over 100,000 green power consumers.

3.6 Local Government Policies

Many local governments around the world are enacting their own renewable energy policies. For example, many cities are adopting future targets of typically 10–20 percent of electricity from renewables for all consumers in the city. Examples are Adelaide, Australia; Cape Town, South Africa; Freiburg, Germany; and Sacramento (California) in the United States. Some cities have also proposed or adopted CO_2 emissions-reduction goals, typically a 10–20 percent reduction over a baseline level, consistent with the form of Kyoto Protocol targets. Examples are Freiburg, Germany; Gwangju, Republic of Korea; Sapporo, Japan; Toronto, Canada; and Vancouver BC, Canada.

A number of cities have decided to purchase green power for municipal government buildings and operations. Examples are Portland (Oregon) and Santa Monica (California) in the United States, which purchase 100 percent of their power needs as green power. Other US cities purchasing 10–20 percent of municipal government power are Chicago, Los Angeles, Minneapolis, and San Diego. Cities are also enacting policies to support solar hot water and/or rooftop solar PV, modifying their urban planning to incorporate future energy consumption, constructing demonstrations, and enacting other measures.

Additionally, over 185 cities, including more than 40 million United States' citizens, have agreed to carbon dioxide emission reduction targets, which are similar to the Kyoto Protocol (-7 percent until 2012, reference 1990).[10]

3.7 Rural Electrification Policies

Policies to promote renewable energy in rural areas are typically tied to a government's rural electrification program, and should not be considered in isolation. These programs are aimed at reaching rural populations that lack access to the centralized power grid, often because the costs for grid extension to rural areas are prohibitive due to geographic remoteness, access issues, dispersed nature of populations, difficult terrain, etc.

Options for rural electrification include grid extension, diesel generators linked to mini grids, renewable energy connected in mini-grids (solar, wind, and/or biomass, sometimes combined with diesel), and household-scale renewable energy (solar home systems and small wind). Applications of renewable energy for rural electrification have been growing over the last few years as their costs have declined and awareness of local economic, social, and environmental benefits become more apparent. In most cases, renewable energy services are provided by local businesses and entrepreneurs who operate in the rural areas. However, it has been recognized in many countries that private investment alone is not sufficient to meet the rural energy needs and government subsidies and policies are required, justified by development goals (e.g., social equity, poverty alleviation, etc) and public mandate for universal electricity access.

A range of subsidy approaches have been tried including capital subsidies (Ireland), output-based subsidies (Chile), bulk power subsidies (Thailand), and lifeline rates. Each offers strengths, however the cornerstone to effective subsidies is that they be easy to administer, reach the desired population, and access the poor.[11]

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[10] www.ci.seattle.wa.us/mayor/climate

[11] D. Barnes, Transformative Power: Meeting the Challenge of Rural Electrification. No 2., ESMAP Knowledge Exchange Series, The World Bank, Washington, DC, August 2005**.**

Rural electrification programs specifically incorporating large-scale renewable energy components are occurring in the largest of the emerging countries, including China, Brazil, India, Mexico, and South Africa, and targeting millions of people with energy access. Countries such as Bolivia, Chile, Guatemala, Nicaragua, and Peru are mainstreaming renewable energy into their new or revamped rural electrification programs and putting in place associated legal and regulatory frameworks. Similarly in Asia, Bangladesh, Nepal, the Philippines, Sri Lanka, Thailand, and Vietnam have put in place renewable energy mandates for rural electrification.

Textbox 3.5 Integrating Renewable Energy into Broader Electrification and Development Programs: Some Country Examples

A number of countries are integrating renewable energy into their comprehensive rural electrification and development programs. Examples include:

- The Chinese Government has made renewable energy a high priority in its national sustainable development strategy, targeting 10 percent contribution to the total energy mix by 2010. The China Township Electrification Program, which was essentially completed in 2004, supplied electricity to 1 million people in rural areas, using renewable energy technologies.
- The Brazil Luz para Todos Program (Lights for All) is planning to electrify 2.5 million households by the year 2008; 10 percent of these households, 250,000 will be powered by renewable energy.
- India, with 80,000 MW of renewable energy potential, has targeted 10 percent of new power generation by 2012 to come from renewables and put in place a range of credits, incentives, IPPs and tariffs to make this happen. The Government's Remote Village Electrification Program will electrify 18,000 villages and will include renewable energy, such as biomass gasifiers.
- Central America has 160-300 MW in annual renewable energy investments and has regional interconnection planned by 2007. Guatemala has put in place a dedicated renewable energy law, including a fund for project development; Honduras has put in place tax exemptions and incentives for renewable energy as well as a 10 percent price premium; El Salvador is developing a rural electrification program including renewable energy; Nicaragua has a Presidential decree calling for 5 percent renewable energy (hydro and wind); and Costa Rica is one of the world leaders in renewable energy development.
- Mexico has a number of programs in place to promote renewable energy for rural electrification, including linkages to productive uses and distance based education.
- Philippines is committed to electrify all its districts (baranguays) by 2006, and all households by 2017; renewable energy is playing a key role in meeting these needs.
- In the Mediterranean, countries such as Egypt, Morocco and Turkey are putting in place policies and programs for renewable energy.
- In Africa, South Africa has programs in place for solar and biomass development; East Africa is promoting geothermal and solar technologies for electrification.
- Several small island nations, including Dominica, Grenada, St. Lucia, Fiji and others have developed sustainable energy plans and policies to promote the use of clean energy, including renewable energy.

3.8 Cross Sector Policies

In addition to energy specific policy initiatives, it is important to explore opportunities for tying renewable energy into policies and legislation of other key sectors. This could include agriculture, transport, finance, health, water, etc where renewable energy can play a major role in delivering the objectives of these sectors. For example, in the United States, the US Farm Bill directs the Secretary of Agriculture to make loans, loan guarantees, and grants for renewable energy systems and energy efficiency improvements. This allows for farmers to reduce their energy costs and consumption, as well as promotes new streams of income, new job development, and uses for materials otherwise considered waste. Farmers in the United States see these technologies as the "new crop" for the decade.

3.9 Implications for BIREC 2005

Securing political commitment and putting in place effective policy and regulatory frameworks are crucial elements to improve the investment climate for renewable energy. Governments have a role to play at all levels—national, state, and local—and there are a range of policy options that have been applied and from which lessons are being learned. As many of these policies are still relatively new in their application, and field results limited, BIREC 2005 provided an opportunity to share experiences on policy approaches, tools, and techniques; discuss pros and cons of various options; and further the body of knowledge on best practices.

4 Finance

Clearly, finance and investment are critical components in the growth and development of renewable energy markets in all countries. This chapter provides an overview of financing industry trends in industrialized and developing countries, reviews the types and conditions of available financing mechanisms for large- and small-scale projects, and reviews existing and new sources of financing in the global marketplace.

4.1 Finance Industry Overview and Trends

Though finance sector engagement in renewable energy is still nascent, it has been accelerating in many countries and a number of signs indicate that this trend will continue. In OECD member countries, there is currently a large buoyant market for investment in large-scale renewable energy projects. Transactions are becoming larger and more complex, and developers and manufacturers are increasingly gaining access to the capital markets, with some significant initial public offerings (IPOs) carried out over 2004-2005, and the bond markets also starting to engage.

In non-OECD countries the trends are also somewhat positive, although they stem from a much more modest base and overall, the climate for investment in renewable energy is still difficult. In many less developed countries (LDCs), the private sector often faces significant barriers in accessing the credit markets, which due to limited liquidity and market instabilities, very seldom offer the sort of medium- and long-term financing needed for infrastructure investments.

For renewable energy, weak capital markets create not only a problem of access to finance but also a bias toward investment in fossil fuel-based technologies. Because renewable energy projects are more capital cost-intensive, high interest rates, short maturities, and low debt-to-equity gearing requirements shift the price per kWh upward relative to conventional power.

Emerging markets have improved access to foreign direct investment, but face problems of volatility in their own and in international financial markets. Some emerging economies (e.g., Chile, Malaysia, and Mexico) have domestic markets that provide long-term, fixed-rate local currency financing for infrastructure. Others (e.g., India, Peru, and Brazil) have emerging long-term debt markets, where interventions can be made to extend the terms available or to enable infrastructure projects access long-term debt markets from which they may otherwise have been excluded.

A World Bank assessment has shown that the commitments made by developing countries toward the Bonn International Action Plan translate into capacity additions of more than 80 GW of renewables (other than large-scale hydropower) by 2015, requiring US$90-120 billion, or about US$10 billion per year. Due to the capital cost intensity of renewable energies, the incremental investment required compared to fossil fuel generation is likely to be about US$3-5 billion per year, depending on technology choice.

The challenges involved in attracting this needed capital are significant, and will only be met if the appropriate enabling regulatory frameworks are in place, and financial instruments are developed or adapted to respond to the specific needs of renewable energy projects. Since policies are addressed in Chapter 3 of this document, the rest of this chapter will focus instead on the financial instruments that today are needed to enable renewable energy market growth, and what can be done by governments and the donor community to further accelerate this capital formation process.

4.2 Financing Large-Scale Renewable Energy Projects in Developing Countries

Financing sources for large scale renewable energy projects in developing countries are outlined below.

4.2.1 Project Equity

Equity capital for realizing renewable energy projects is normally sourced from corporate treasuries, strategic investors and joint ventures, private equity funds, or the capital markets (i.e. public equities or bonds), and in some cases government funds. For example, joint ventures are one of the main sources of project equity in larger markets such as India and China. Each of these investor types has seen its ups and downs since the late 1990s, influenced by Enron and other corporate scandals, the technology boom/bust and more recently, a stabilization of trends and healthy investor re-engagement in some specific markets. The one major investor type that has not recovered is the major utilities, which continue to divest of their emerging market assets and consolidate efforts on markets closer to home.

The number of new renewable energy private equity funds and investors has been increasing, although many have shifted away from using pure equity and now employ quasi-equity instruments that allow for easier exits, as described below. However, lack of exit options remains a problem for private equity.

On the public equities side, some progress is being made—a number of high profile IPOs were carried out over 2004-5 by renewable energy companies with a focus on developing countries.[12] Another recent development with public equities has been a perceptible 'Kyoto effect,' whereby renewable energy stocks quoted in countries that ratified the Kyoto Protocol are outperforming those quoted in countries that did not sign.[13] The potential for a secondary Kyoto effect also exists, whereby renewable energy stocks quoted in the more active Clean Development Mechanism (CDM) host countries enjoy greater success, but this has yet to be determined.

4.2.2 Project Debt

The bulk of the financing provided to a project is usually in the form of senior debt, which can be structured as on–balance-sheet corporate finance or off–balance-sheet project finance. A significant amount of innovation in debt financing instruments is currently in progress in developing countries to address some of the barriers to financing renewable energy infrastructure projects. For instance, a variety of instruments are being used by the World Bank, Kreditanstant Für Wiederaufbau (KfW), and other development finance institutions to improve access to long-

[12] A few examples in 2004-2005 include: Suzlon, a wind company (US$310 million IPO) listed on the Bombay Stock Exchange; D1 Oils, a biofuel company (US$23 million IPO), and AgCert, a carbon company (US$110 million IPO), both listed on the Alternative Investment Market of the London Stock Exchange (AIM); Ormat, a geothermal company (US$94 million IPO) listed on the Nasdaq.

[13] The 20 constituent companies of the Global Energy Innovation Index (GEIX), which are quoted in countries that signed the Kyoto Protocol, were up by an average of 21.9 percent in the first quarter of 2005. By contrast, the 30 GEIX constituents quoted in the US and Australia were down by an average of 13.3 percent (source: New Energy Finance).

term financing. These include currency swaps to reduce foreign exchange risk,[14] two-step bridging mechanisms to allow project refinancing,[15] lease-financing arrangements to reduce off-take risk, and various other approaches.[16]

New types of mezzanine finance instruments are also now available in various regions. Typically, mezzanine finance comes in the form of quasi-equity, which can combine some form of preferred shares with subordinated debt and the option to later be bought out, either progressively or in one bullet payment (called 'put options'). Quasi-equity is most useful in illiquid markets, where a lack of exit options makes pure-equity investments less attractive. Mezzanine finance is an appealing option for public sector participation. Public funds can buy down the risks for commercial investors and/or lenders and, by helping close the debt-equity gap, buy up returns for project developers. The potential to leverage private capital is also significant.

The Global Renewable Energy Fund of Funds (GREFF), a mezzanine finance instrument, is being developed by the European Commission and will provide subordinated non-commercial capital to a number of investor-financed funds. Each fund would invest some form of patient equity or quasi-equity into renewable energy businesses and/or projects in developing countries and economies in transition. The capitalization target is €75 million of public/donor funding, which could potentially leverage €300 million of investor capital in the individual funds.

4.2.3 Risk Management

An integral element of a project's financial structuring is risk management. This entails assessing the risks, mitigating them where possible through contracts and warranties, and shifting those remaining risks to insurers and other parties better able to underwrite or manage risk exposure. There are many barriers to the development of new insurance and alternative risk transfer instruments, which create gaps that either prevent projects from going forward or increase the costs of those that do proceed. Many risks are non-traditional and hence uninsurable. Like bankers, insurance underwriters have a limited understanding of renewable energy and its associated risks, and therefore encounter difficulty in aligning strategies for dealing with the risks. In this regard, public/private partnerships could play an important role. Some innovation has been seen in this area in developing countries,[17] but much remains to be done.

One important area of risk management for renewables projects is addressing cross-border risks that can be covered by Export Credit Agencies (ECAs). Although the level of export credit support to mainly non-OECD countries in 2001 was US$455 billion, only a very small share of this financing went toward renewable energy projects. However, it is expected that this share will increase. In April 2005, a special Sector Understanding was negotiated for the renewable energy sector within the OECD Arrangement on Officially Supported Export Credits. Approved initially

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[14] For example, DEG, the private sector arm of KfW, has put in place a cross-currency swap to finance a wind farm in China.

[15] The World Bank has offered a liquidity stand-by guarantee to banks providing term loans to mini-hydro plants in Uganda. Although banking regulations limit loan maturities to eight, this form of 'put option' (the banks can sell the loan to the World Bank after eight years) allows banks to stitch together two loans into a 15-year financing package, a term more appropriate for renewables infrastructure financing.

[16] An in-depth review of these mechanisms can be found in Lindlein P and Mostert W, *Financing Instruments for Renewable Energy*, KfW (2005).

[17] For example, S&S General Insurance Professionals Ltd. of India has developed some new wind farm insurance products including "Minimum Generation Guarantee Insurance" and "Extended Warranty Insurance." A new risk instrument called CarbonRe has recently been launched to provide specialty insurance and reinsurance and structured finance risk solutions to the carbon market.

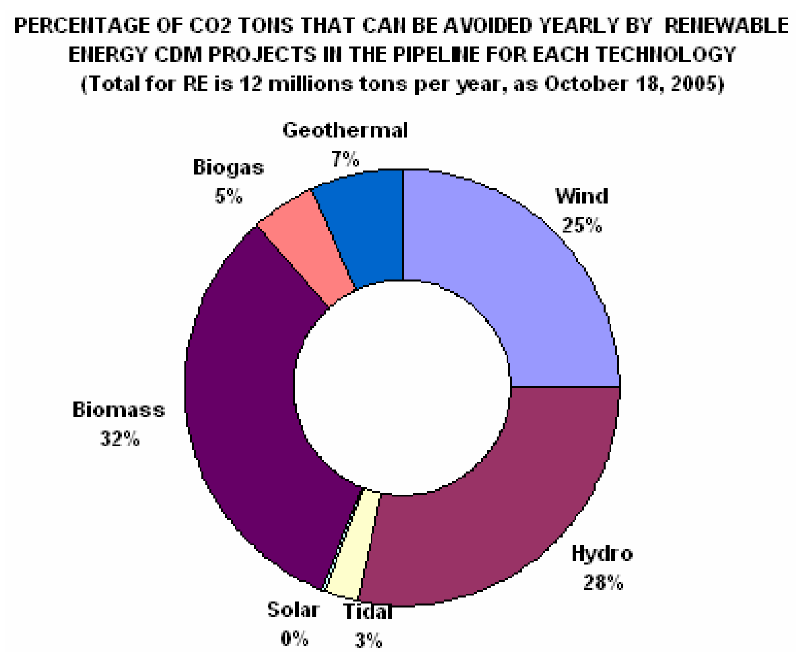
for a two-year period, this agreement principally involves extending the minimum allowable repayment terms to 15 years (from currently 10 or 12 years, depending on project type). This change will allow export credit financing to be more closely aligned with the duration of power off-take agreements and can thus lower a project's overall capital cost.[18]

4.2.4 Carbon Finance

The CDM and the emerging carbon market in general offer the potential for a new revenue stream to boost the financial viability of renewable energy projects. The World Bank has noted that at a price of US$4 per ton of CO_2, "the impact on project financial IRRs (internal rates of return) for a range of CDM projects undertaken by the World Bank is 0.5 to 2.5 percent for hydro, wind and geothermal, 3 to 7 percent for forest and crop residue, and 5 to 15 percent for municipal waste (landfill biogas projects)".[19] Naturally, as the price of carbon goes up—the current trend—the impacts become more significant.

In 2004, the largest share of CDM transactions went to projects that reduced industrial gases, and gases with high global warming potential such as HFC23 (a by-product of the production of HFC22, a hydro fluorocarbon), nitrous oxide, and methane. However, a recent analysis[20] shows that the CDM trend may be shifting gradually toward renewable energy, which as of October 2005 accounted for 60 percent of projects and 20 percent of total carbon reductions in the CDM pipeline. The attached graph (Exhibit 4.1) shows the amount of CO_2 emissions that can be avoided by renewable energy CDM projects in the pipeline for each technology. Considering a value of US$4 per ton of $CO_{2,}$ and that the registered renewable energy projects totaled 12 million tons of avoided emissions per year, the annual potential annual cash flow to the projects from this source should be around US$50 million/year.

Exhibit 4.1



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[18] For a project financial structure with all other terms and conditions held constant, this extended financing can translate into a 5 to 10 percent decrease in the cost of delivered energy.

Veronique Bishop, World Bank, 2005.

[20] See J. Fenhann, UNEP RISOE Centre, May 2005 (www.cd4cdm.org).

CDM projects and related credits can be organized both at the government level and, subject to government approval, at the private enterprise level. Large multinationals may therefore choose to organize their own CDM projects, but much of the carbon investment is expected to flow through so-called carbon funds that are set up with the objective of procuring project-based emissions reductions for Annex-I countries and companies. The World Bank's Carbon Finance Business manages the largest number of carbon funds. However, many national carbon funds have been established to procure carbon for Annex I countries[21] and most recently, a number of 100 percent private funds are approaching financial closure.[22]

An additional source of carbon investment is expected to come from the EU Emissions Trading Scheme, which imposes a cap on emissions of CO_2 being generated by large emitters in the power and heat generation industry and other selected energy-intensive industrial sectors—accounting for more than 12,000 installations in the 25 Member States and about 45 percent of the EU's total CO_2 emissions. In order to achieve compliance, the target installations have various options including reducing on-site emissions, purchasing allowances from the market, and/or purchasing project-based emissions reductions, specifically those generated from CDM and/or joint implementation (JI) projects.

One of the existing barriers for the development of CDM projects (Non-Annex I countries, NAI) is the high risk of the investments associated with the very initial phases of project development (pre-feasibility, feasibility and initial project development). Key barriers are the inexperience of entrepreneurs in CDM financing and the fact that many of the rules and conditions are not completely and clearly fixed at this initial phase. Several issues strongly related with the business cash-flow are a matter of negotiation or approval on a case-by-case basis. The overall result is that many private entrepreneurs are waiting for a more secure investment scenario in order to make the additional investment necessary to add Certificates of Emission Reductions (CERs) to current operations. To overcome this barrier, the Argentina Government recently established (September, 2005) the Argentinean Carbon Fund for the purpose of providing venture capital to finance the first phase of CDM project development.

4.2.5 SMME Finance

Small, medium, and micro-enterprises (SMMEs) play an important role in developing countries by providing technologies and services to niche energy markets that are either poorly served by, or complement, the centralized utility approach. Conventional bank financing is seldom available to renewable energy SMMEs, especially those in the early innovation stages that need seed and risk capital to develop a new product or service offering. In these contexts, new finance intermediaries are needed that can provide appropriate forms of capital and the management support that entrepreneurs need to develop and grow a new business activity.[23] There has been increasing interest in this early stage risk/seed capital sub-sector, with a number of post-Bonn

[21] Examples include the Japan Carbon Fund, the German KfW Carbon Fund, and the Austrian Carbon Fund.
[22] Examples include Natsource, GGCAP, ECF, and ICECAP.
[23] It is this enterprise development area that the African Rural Energy Enterprise Development (AREED) Programme (see the case study at the end of this chapter) has been addressing, along with some other similar initiatives.

Textbox 4.1 Creation of Energy Enterprises through Innovative Finance in Africa

> Many rural communities in Africa lack access to clean energy technologies and services and often rely on low quality biomass fuels such as wood and dung—both of which have negative health and environmental effects. One barrier to increasing access to clean energy has been the ability of the communities to utilize appropriate finance for these technologies and services. Since mid-2000, The African Rural Energy Enterprise Development (AREED) initiative has operated in Ghana, Mali, Tanzania, Senegal, and Zambia focusing on the creation of small- and medium-size energy enterprises using a combination of business development services and seed finance. Initially funded by the United Nations Foundation, AREED is now a US$5 million program of collaboration with seven partner organizations—including UNEP and E+Co (Energy Through Enterprise), which introduced the enterprise development model. To date, AREED has provided business development and seed finance support for 32 enterprises ranging from $24,000–$200,000, for solar crop drying, charcoal briquetting, PV-powered milling, wind-powered pumping, LPG, solar thermal, solar PV, and a range of other clean energy enterprises. The success of the AREED experience has resulted in replication efforts in Brazil and China—titled B-REED and C-REED, respectively.

commitments[24] which, although not significant in absolute terms, are catalytic given the follow-on leverage potential this form of investment has with the mainstream energy investment community. Nevertheless, there exist in many countries, specific funds for technological innovation that can be used to develop or introduce new renewable energy products in the market.

4.2.6 End-User Finance

Since most sustainable energy technologies are highly capital-cost–intensive, their successful scale-up is largely dependent upon the customer or end-user's ability to access financing for the purchase. For smaller household- or community-scale renewable energy technologies, end-user finance comes in various forms, ranging from retailer financing (i.e. the customer pays the vendor in monthly installments), to commercial bank loans, micro-credit, and third-party financing such as leasing or fee-for-service.

For short-term financing, renewable energy retailers often find it most appropriate to offer their own financing options. Managing a credit operation, however, is in no way similar to installing and servicing renewable energy systems, and therefore retailers who want to build a large-scale credit-backed sales operation will usually look to a banking institution to manage credit delivery. Furthermore, financing end-user transactions is generally an inefficient use of a retailer's working capital, given the high cost of this capital. Similarly, the fee-for-service and third-party/leasing models are also costly from a working capital perspective and will only usually work for companies that have access to some form of low-cost financing.

With few exceptions, most large-scale end-user financing programs have occurred through banks and micro-credit institutions. The barriers that hinder bank financing of consumer-oriented renewable energy systems include an increased real and/or perceived risk of customer default, which leads to higher-cost financing; and the small initial demand for renewable energy financing that fails to capture the attention of the banks, and therefore is not mainstreamed in their operations.

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[24] E+Co, the leader in this field, has raised US$40 million since Bonn ($8 million from BMZ; $17 million from IFC/GEF and $15 million from IDB/Cabei/BIO for the CAREC fund) and a new company GroFin has recently raised $22 million for SME investment in east Africa.

Textbox 4.2 GVEP Microfinance and Energy

Over the past two years, GVEP has been active in capacity building activities to strengthen the linkages between microfinance and provision of modern energy services for poverty reduction. These efforts began with a workshop on microfinance and consumer lending to improve access to energy services, held in May 2004 in Manila, Philippines. As a result of the momentum gained by the event, GVEP initiated a number of substantive activities on the subject, including forging strategic partnerships with prominent members of the microfinance community, (e.g., Women's World Banking), creating training materials, and supporting capacity development initiatives in energy and microfinance.

More specifically, with funding from the US Agency for International Development (USAID), GVEP is working with the Small Enterprise Education and Promotion Network to conduct a Practitioner Learning program entitled "Microfinance and Consumer Lending to Improve Access to Energy Services in Eastern and Southern Africa." The training program is working with local financial and energy entrepreneurs in Zimbabwe, Tanzania and Uganda to examine how microfinance institutions can better incorporate loans for energy services into their standard lending portfolios. The Partnership has also facilitated work between the Self Employed Women's Association, an India-based MFI, and the Solar Electric Light Company in India, to design lending products that increase the purchasing power of energy consumers. Moreover, several prominent publications have provided impetus in the area of energy and microfinance, and raised awareness on the role of energy's linkages with development strategy and microfinance among financial practitioners. Finally, USAID, with Citigroup Foundation, is funding research on microfinance institutions that have existing energy lending portfolios to identify gaps and opportunities for future work in this arena. The research will profile six to nine micro finance institutions (MFIs) engaged in lending for energy in Africa, Asia and Latin America, and will inform future microfinance and energy entrepreneurs who are interested in pursuing similar goals.

For renewable energy sectors that are already commercialized on a cash-sales basis, but where growth is constrained by a lack of end-user finance, credit enhancement programs can help local banks build new consumer loan portfolios, either by reducing risk for the lending institution or by facilitating increased demand for their loans. Extending loan durations, guarantees, and collateral support can all be useful support mechanisms, depending on the context.

Both Sri Lanka and Bangladesh provide good examples of local financial institutions being used effectively to develop the renewable energy market. Two successful institutions offering renewable energy micro-credit schemes are Grameen Shakti in Bangladesh and Sarvodaya Economic Enterprises Development Services (SEEDS) in Sri Lanka. The Development Finance Corporation of Ceylon (DFCC) in Sri Lanka has been active in financing solar, hydro, and biomass systems under World Bank credit programs.[25] SEEDS has now offered financial support to over 30,000 households to buy SHS's as a financial intermediary of the DFCC Bank. Similarly, the Infrastructure Development Company (IDCOL) in Bangladesh is active in financing renewable energy, primarily SHS, supported by a credit line of US$20 million from the World Bank. IDCOL operates through intermediaries to deliver financing to end-users of the

[25] DFCC plans to finance rural energy projects worth over US$130 million, primarily supported by World Bank credits.

systems. Grameen Shakti, working with its parent company Grameen Bank, offers a finance-product package for SHS.[26]

4.3 Existing and New Sources of Financing for Renewable Energy

Presented below are existing sources of financing for renewable energy, as well as emerging financing sources entering the marketplace.

4.3.1 National Governments

Several developing country governments, especially among emerging market economies, have instituted large renewable energy programs. Some of the largest such programs are located in Brazil, China, and India. Other countries such as Egypt, Malaysia, Mexico, Philippines, South Africa, and Thailand also have government funding for renewable energy programs and projects.

The Brazilian renewable energy programs have made significant progress in the areas of biofuels and decentralized renewable energy systems. For instance, PROINFA has a public resource allocation of 3,300 MW of capacity additions from wind, small hydro, and biomass, and envisions a public investment of US$1.3 billion over 2002-2007, as well as leveraging $2.9 billion of private investment. Other broader energy programs are expected to provide a significant share of resources to the renewable energy sector. The Luz no Campo (Light in the Countryside) Program aims to electrify one million households by 2007 and has a resource allocation of $650 million. The Luz Para Todos (Light for All) Program aims to electrify 12 million people in the rural areas of Brazil with a resource allocation of $843 million over 2003-2008. It is expected that a significant share of resources from the latter two programs will also be directed toward financing decentralized renewable energy systems.

China’s renewable energy program has made significant achievements in small hydro power, biogas plants, solar hot water systems, and of late, PV and wind systems. During the first stage of China’s Brightness Program, the Township Electrification Program electrified one million people during 2002-2004 using hydro, hybrid, and PV systems with government support of US$340 million. The Chinese government also provides about $125 million annually in subsidies for household-scale biogas systems. The second phase of the Brightness Program, the Village Electrification Program, aims to provide access to electricity for about 27 million people by 2010 with a government budgetary provision of $2.5 billion.

The Indian government-supported renewable energy programs have resulted in significant capacity achievements in wind energy, biomass power, solar energy, small hydro development, and deployment of several rural energy systems. The Indian Renewable Energy Program, coordinated by the Ministry of Non-Conventional Energy Sources (MNES), has an annual budget of US$137 million for the year 2005, of which over 35 percent is earmarked for renewable energy-based electrification of rural villages. MNES has been providing similar levels of resources for renewable energy development in India since its establishment as a department in 1982.

[26] To date, Grameen Shakti has installed over 42,000 SHS, acting as an intermediary of IDCOL.

4.3.2 International and Local Financial Institutions

Some international and many domestic financial institutions have been active in supporting renewable energy advancement in developing countries. Fortis, Rabobank, Australia and New Zealand Banking Group, American International Group, and others offer large scale renewable energy finance in various emerging markets, particularly Asia. However, their involvement in developing countries has been limited. The small Dutch "ethical" bank Triodos has been a notable exception, and has invested in renewable energy companies throughout Africa and Asia.

Domestic financial institutions have been more active in financing renewable energy projects and services in developing countries, often operating multilateral or bilateral credit lines. For example, South Asian financial institutions have shown high levels of activity in renewable energy financing, with the Indian Renewable Energy Development Agency (IREDA) at the forefront[27] and many others such as the China Development Bank, the Development Bank of the Philippines, and the Thai TMP bank also very involved in renewable energy financing.

4.3.3 Multilateral Development Banks

The World Bank Group represents the largest source of renewable energy finance among the development banks. Between 1990 and 2004, the WBG has committed nearly $8.3 billion for renewable energy and energy efficiency investment projects. About half ($3.9 billion) was for hydropower with capacity greater than 10 MW, while $2.3 billion went toward "new" renewables (defined as energy from wind, solar, geothermal, biomass, and hydropower with a capacity less than 10 MW per facility). About $1.3 billion in financing was from the International Bank for Reconstruction and Development (IBRD) and International Development Association (IDA) with $204 million for new renewables. Renewable energy and energy efficiency represents nearly 13 percent of the Bank's cumulative power sector portfolio from 1990 to 2004. WBG's lending leverages three to six times as much investment resources from other sources through its direct investments and through Multilateral Investment Guarantee Agency (MIGA) and the Carbon Finance business. In particular, MIGA support leverages much-needed foreign direct investment. MIGA provided guarantees of $428 million to RE and EE projects in the period 1995 to 2004. This helped leverage Foreign Direct Investment (FDI) of $2.4 billion. The Bank Group has supported the development of the carbon market and currently has approximately $950 million in funds under management since operation began in 2000. In Bonn, the World Bank announced a 20 percent annual increase in support of renewable energy from current levels. The Asia Alternative Energy Unit (ASTAE), established in 1992, played an important role in influencing the power sector lending policies of the World Bank in Asia toward sustainable energy alternatives. ASTAE developed an alternative energy lending portfolio (including energy efficiency) of over $1.3 billion during 1992-2004.

The Inter American Development Bank works with Latin American countries such as Brazil, Ecuador, and Guatemala, and is involved in promotion of renewable energy projects. For example, a geothermal energy project of US$55 million is currently under development in Guatemala. In addition, a family of trust funds—Hemispheric Sustainable Energy and Transportation Funds, established by IDB—finances renewable energy projects in Latin America and the Caribbean, as well as energy efficiency and cleaner transportation initiatives.

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[27] IREDA, which began operations in 1987, has supported over 1700 renewable energy projects as of 2003, disbursing about US$850 million and establishing 2400 MW of renewable energy capacity. IREDA's operations were supported by the World Bank, Asian Development Bank (ADB), KfW, Danish International Development Agency (DANIDA), Swiss Development Cooperation (SDC), and the Government of the Netherlands.

The African Development Bank has been active in renewable energy programs as well, with a current portfolio estimated at over €250 million. Project activities include hydropower, solar thermal power, and wind energy technologies.

The Asian Development Bank has been active in renewable energy since 1998 with the Indian Renewable Energy Development Project of US$100 million. The current ADB portfolio consists of renewable energy projects in China, Indonesia, and the Philippines, and renewable energy projects are under development in the Pacific Islands, Afghanistan, Pakistan, and Nepal.

Finally, a number of European banks are active in renewable energy, including the European Investment Bank and the EBRD.

4.3.4 Bilateral Development Agencies and Banks

KfW has been one of the most active development banks in financing renewable energy. KfW committed over €470 million during 2000-2004, and has set up a special facility for renewable energy and energy efficiency that will make available €500 million over 2005-2009 for up to 50 investment projects, as low-interest loans. Deutsche Gesellschaft für Technische Zuammenarbeit (GTZ), the German development agency, has also been active in renewable energy promotion, and has provided in-kind support in capacity building and technical assistance in several countries worldwide for technologies such as biomass, solar, wind energy, and micro-hydro power.

The US Agency for International Development has also provided significant levels of funding for renewable energy projects and initiatives. Some of the initiatives supported by USAID include the network of Renewable Energy Program Support Offices (REPSOs) in Latin American and Asian countries, and the Renewable Energy in the Americas (REIA) initiative with the Organization of American States, which supports programs throughout Latin America and the Caribbean. USAID energy programs have shifted away from technology specific program to more technology neutral approaches for expanding access to modern energy for enhancing economic and social development. Nonetheless, renewable energy technologies are often the optimal solution and these are employed in many USAID-supported programs worldwide.

The British Government's Department for International Development (DFID) has supported renewable energy projects under its Energy Knowledge and Research (KaR) programs since 1995. A number of projects focused on renewable energy technologies such as hydro, solar, and wind were supported under the KaR Programs by DFID. In addition, the Directorate General of International Cooperation (DGIS) of the Government of the Netherlands has provided considerable support of renewable energy programs globally. Examples of DGIS initiatives include supporting the ASTAE initiative of the World Bank, support of wind and solar energy companies, and support of biomass densification projects in India through IREDA.

The Danish International Development Agency's support of renewable energy has included renewables programs in Nepal, and wind energy programs in India. The French Agence de l'Environnement et de la Maîtrise de l'Energie has implemented renewable energy projects in several developing countries in Africa and Asia, and in French overseas territories. Several other bilateral aid agencies have also been active in supporting renewable energy initiatives, including the Swedish International Development Agency, Swiss Development Cooperation, Austrian Development Agency, Norwegian Agency for Development Cooperation, Canadian International Development Agency, Australian Aid Program, and others.

Finally, the European Union has served as a significant source of financing for energy programs in developing countries. The average annual commitments to the energy sector by the European Union during 1997–2001 were US$795 million. Of this, 14.7 percent or about $117 million annually represents the share of renewable energy. The EUEI is in the process of creating a financial facility of €250 million to finance renewable energy, energy efficiency, and rural electrification projects in Africa, the Caribbean, and the Pacific. The Johannesburg Renewable Energy Coalition (JREC), a coalition of countries committed to increasing the share of renewable energy, has also announced plans to set up the GREFF, referenced earlier in this chapter.

4.3.5 Other International Agencies

The GEF represents a major source of financing for renewable energy projects in developing countries. During 1991–2003, GEF allocated US$838 million to 130 renewable energy projects in developing countries. GEF financing leveraged an additional $4 billion in co-financing, comprised mostly of public financing as well as loans and grants from the GEF implementing agencies—the World Bank, UNEP, and UNDP.

UNDP's service line, Access to Sustainable Energy Services, focuses on several dimensions of renewable energy such as rural electrification, capacity building, and integrating sustainable energy considerations into national development policy. The UNDP portfolio is reportedly the largest among UN agencies at US$2 billion, including GEF co-financing. UNDP is currently implementing over 800 energy projects in more than 50 countries under the UNDP-GEF small grants program. About 400 UNDP energy projects are now underway with $200 million in investments from UNDP's core resources.

UNEP is active in the research, development, and commercialization of renewable energy technologies, and collaborates with a number of partners in these program areas. UNEP's renewable energy portfolio equals about US$35 million, and consists of partnerships with the finance community on various aspects of clean energy investment; with policy makers on renewable energy policy development and implementation; and with SMMEs on enterprise development. The UNEP climate change project portfolio has $135 million of financing approved, of which $43 million is from GEF. The Renewable Energy for Enterprise Development (REEED) Program of UNEP is active in five African Countries, Brazil, and China, and has provided $9.6 million in financing since 2000.

The United Nations Industrial Development Organization (UNIDO) implements renewable energy and rural energy projects aimed at productive end uses, and is active in biomass gasification, small hydro, and wind energy. UNIDO, in cooperation with UNEP, is also active in implementing renewable energy mini-grid projects in Cuba and Zambia. In addition, UNIDO is working on a US$40 million initiative on hydrogen energy involving establishment of an International Centre for Hydrogen Energy Technologies. UNIDO has technical cooperation projects in renewable energy in Africa and Asia.

The United Nations Foundation supports the various UN agencies in their development projects and has additionally funded renewable energy and energy efficiency initiatives worth US$50 million since 1998. The UN Foundation has extended support to UNDP, UNEP, UNIDO, and United Nations Department of Economic and Social Affairs (UNDESA) to implement renewable energy programs.

4.4 Global Partnerships and Foundations

There are a number of partnerships launched at the WSSD that are active in the financing of renewable energy. REEEP offers financial support to projects involved in policy and financing issues in promotion of renewable energy and energy efficiency. Since 2004, REEEP has supported 58 such projects and invested over $6 million.

GVEP is involved in a number of financing facilitation activities on issues related to energy for poverty reduction, which includes renewable energy. This includes banker training, design of risk mitigation instruments, support for micro finance for energy initiatives, and assistance to GVEP countries in fund raising for country action plan implementation (over $12 million to date). Additionally, GVEP is about to launch a new Global Actions Program (GAP) Fund capitalized with US$1.2 million and supported by the Government of the Netherlands and DFID. The GAP fund will facilitate the development energy-poverty reduction activities to increase energy access at the community level.

Several foundations are also supporting renewable energy advancement in developing countries. The Shell Foundation supports projects in renewable energy and improved cooking and indoor air pollution campaigns. The Shell Foundation has supported a number of initiatives in developing countries including the India Solar Loan Program with UNEP, the Uganda Energy Fund, and the East Africa Energy Fund, among others. Other foundations supporting renewable energy activities in developing countries include the Blue Moon Fund, (BMF), Rockefeller Brothers Fund (RBF), the Energy Foundation, and the Oak Foundation.

4.5 Implications for BIREC 2005

Finance and investment are essential elements in the growth and advancement of renewable energy for industrialized and developing countries alike. As the industry grows it will be increasingly important to expand the scope and breadth of financing sources and instruments, both locally and internationally. For developing countries, financing will be needed not only for larger scale grid connected projects, but also for off-grid and rural projects that may involve SMME and end-user finance. BIREC 2005 provided a forum for investors, developers, governments, and the donor community to discuss renewable energy financing needs and issues; explore financial instruments and deal structures; and further accelerate the capital formation process.

5 Capacity Strengthening for Market Development

5.1 Capacity Building for Renewable Energy

For renewable energy markets to expand and deepen, capacity building is required in all areas of project and program design, development, and implementation. Capacity building is the process of creating, mobilizing, and converting skills and institutions to achieve desired socio-economic results. It requires a long-term commitment, with activities focusing on individuals, institutions, and systems, and targeting public, private, and non-government organizations. In the renewable energy area, capacity building is needed at several levels, and these must be coordinated to maximize effectiveness.

At the *technology* level, capacity is needed to develop academic, professional, and vocational skills. Support is required on all aspects of technology research, development, demonstration, deployment, marketing, financing, operation and maintenance. Further, continued emphasis on accelerating renewable energy R&D is essential to bring down costs, improve performance, and enhance competitiveness with conventional energy sources.

At the *institutional* level, national and sub-national governments require capacity support in the formulation, implementation, and enforcement of effective policies and programs. Financial institutions, whether public, private, or micro-finance, require training on the costs and rewards of renewable energy, how to review and assess projects, and the risks and risk mitigation instruments associated with renewable energy.

At the *business* level, a range of business planning and support services are required to ensure development and delivery of renewable energy services. These need to be aimed at utilities, SMMEs, entrepreneurs, non government organizations (NGOs), communities, and community organizations.

At the *individual* level, capacity strengthening is needed to increase consumer awareness of the costs, benefits, and uses of renewable energy, and how to access, finance, and deploy the technologies.

As this chapter describes, the needs for capacity support can often vary between the industrialized and developing nations, and a host of institutions will need to be involved in the delivery of capacity services. Nonetheless, the fact remains that more effective strengthening of individuals and institutions worldwide is a prerequisite for the global scale up of renewable energy.

5.2 Identification of Needs and Requirements

This section outlines the needs and requirements of countries in different stages of development with regard to capacity building for renewable energy market expansion. Countries described here are grouped as follows: (a) Less Developed Countries, with low levels of per capita income and economic development; (b) Newly Industrialized Market Economies, that are experiencing higher income flows and economic growth over a sustained period; (c) Transition Economies of the Former Soviet Union; and (d) Developed Countries with high sustained per capita incomes and advanced levels of economic development.

Textbox 5.1 Mechanical Power for Productive Uses in Mali

Women in Mali spend much of their time in the daily tasks of grinding cereals, collecting wood, and fetching water, leaving little other free time in their day. UNDP performed a needs analysis and found that the greatest wish and demand from the women was for more time; this includes time to engage with and take care of the family, time to assist in the education of the children, time for income generating activities, and just time off after a long and hard day. Focusing on addressing these women's needs, UNDP created a program to increase the availability of time through better energy access, in this case through mechanical power. UNDP introduced a Multifunctional Platform (MFP), a simple diesel engine that can power various tools, such as a cereal mill, husker, alternator, battery charger, pump, and welding and carpentry equipment. The women found that the MFP is able to perform their daily tasks with mechanical energy considerably more efficiently than human energy and thus gained desired time in the day.

The Multifunctional Platform in Mali has been one of UNDP's flagship programs and has translated into a West Africa regional energy access program. In addition to working with communities to provide the MFP, UNDP has increased the capacity of villages to operate and repair the MFP as well as take advantage of additional applications for income generation. UNDP has also worked with the government to increase the use of the MFP—with good results. The project has gone from a pilot phase of 50 to approximately 500 platforms and the government is looking to scale up the provision of motive power at the community level to the national scale under the slogan "one village, one platform".

5.2.1 Less Developed Countries

LDCs present significant challenges for the promotion of renewable energy and for energy access in general. Most of the LDCs suffer from the absence of an enabling environment for renewable energy promotion, and limited research and industrial capacity. Lack of local skilled entrepreneurs and limited financing further limit the growth opportunities for renewable energy. Moreover in several developing countries, traditional biomass sources—often used unsustainably—account for the bulk of the energy consumed, hindering economic growth and advancement.

While some LDCs, such as Bangladesh and Sri Lanka, have ongoing initiatives to address their capacity building needs, these are largely deficient in most of the countries. The needs and requirements for initiation and development of renewable energy markets in LDCs in general include the following:

- Creation of human and institutional capacity to integrate renewable energy utilization into national development programs in poverty alleviation, health, education, food and agriculture, water, and rural electrification;
- Establishment of specific policy instruments that provide opportunities for renewable energy development such as national targets, regulatory directives, portfolio standards, and tax incentives;
- Development of local industrial capacity in R&D, manufacturing, installation and maintenance, and improving the quality of practice in this important area;
- Awareness building at the national and local levels and in key institutions in the government, administration, education, and private sectors;
- Joint research efforts between local research institutions and industry, aimed at renewable energy applications and collaborative efforts to carry out renewable energy resource assessments;

- Combined efforts between industrialized countries and LDCs to promote knowledge transfer and the development of appropriate renewable energy technologies;
- Established mechanisms for coordination between donors and governments on renewable energy programs to ensure maximum impact and synergy;
- Enterprise development efforts to provide business training, incubation, and seed capital to establish private sector enterprises that can source, integrate, install, operate, maintain, and service renewable energy systems;
- Capacity building to develop renewable energy markets through the opportunities presented by the CDM under the Kyoto Protocol;
- Initiatives to increase the engagement of the finance and banking sectors in funding renewable energy projects, such as capacity building programs and development of standardized appraisal tools and financial instruments that are suitable for renewable energy investments;
- Capacity building on international standards for renewable energy products and equipment, as well as harmonization of standards across countries;
- Linkages of renewable energy to poverty reduction and income generating opportunities, including ties between energy and other cross sector programs (agriculture, education, health, rural development, SMME, water, etc); and
- Integration of renewable energy into rural electrification and development planning, including into country level poverty reduction strategies.

5.2.2 Newly Industrialized Market Economies

Many of the emerging market economies, especially in Latin America and Asia, are experiencing high rates of energy growth and rapid industrialization. These countries have the opportunity to pursue a more sustainable path of energy development, and due to the relative size of their economies, have the potential to create significant global demand for renewable energy. Some of the emerging market economies such as China, Brazil, and India have large renewable energy development programs that have led to an increased local capacity for market development.

Most emerging market economies have established an institutional framework for the energy sector. Often the major challenge is to mainstream renewable energy into the existing framework, and reform the traditional approach to energy sector planning and implementation.

Some of the needs and requirements to accelerate the development of renewable energy markets in emerging economies include:

- Creation of renewable energy legislation and/or a legal framework, including establishment of targets to ensure long-term sustained development of renewable energy markets and to induce private sector investment;
- Integration of environmental concerns and renewable energy components into large-scale rural electrification efforts and other development programs;
- Ways and means to incorporate renewable energy into existing energy systems (feed-in laws, etc.);
- Capacity building for local level institutions, since renewable energy systems are often decentralized;
- Mainstreaming renewable energy into planning and implementation processes, which traditionally favor conventional sources of energy;

- Rationalization of the subsidies for fossil fuel and nuclear energy, which implies providing appropriate fiscal and financial incentives for renewable energy investments—in other words, creation of a level playing field;
- Establishment of the required educational and research framework to foster human capital in support of renewable energy development—accomplished by instituting courses and programs in renewable energy, and supporting research in renewable energy applications;
- Development of low-cost, long-term domestic financial resources to support development of renewable energy markets, in concert with development of financial instruments and risk mitigation mechanisms to encourage investments by the domestic financial sector in renewable energy projects and enterprises;
- International collaborative RD&D of renewable energy technologies such as biofuels, energy storage technologies, and distributed electricity systems;
- Capacity building aimed at the local public and private sector to utilize the opportunities for renewable energy offered by the CDM; and
- Expansion of the national standardization and quality assurance framework to include renewable energy systems and service delivery, as well as development of local standards to harmonize with international standards.

5.2.3 Transition Economies

The transition economies of the former Soviet Union are undergoing significant political and economic reforms as part of the transformation process. Several of these countries have experienced significant progress in their reforms and some have joined the European Union, making their economic indicators comparable to the EU-15 countries. However, other transition economies are lagging behind.

Many transition countries have surplus heat and power generation capacity and an aging power sector infrastructure. Further, energy pricing is distorted by subsidies for fossil fuel generation. The needs and requirements to develop renewable energy markets in transition economies include:

- Enactment or creation of renewable energy legislation and/or a legal framework that includes targets to ensure long-term sustained development of renewable energy markets, and induced private sector investments;
- Rationalization of the subsidies for fossil fuel and nuclear energy, which includes provision of fiscal and financial incentives for renewable energy investments, especially from the private sector;
- Development and implementation of models for public-private partnerships in renewable energy projects with European or other international partners;
- Establishment of mechanisms to encourage large- and small-scale grid-connected renewable energy generation such as feed-in directives, portfolio standards, and associated regulatory and legal frameworks;
- Capacity building to utilize the JI mechanism under the Kyoto Protocol, to develop markets for renewable energy; and
- Creation of a framework to facilitate the increased use of renewable energy for heating applications.

5.2.4 Developed Countries

Access to electricity is more or less universal in industrialized countries and economic indicators such as gross domestic product (GDP), per capita income, and the Human Development Index (HDI) are significantly higher than in developing and transition countries. Renewable energy initiatives exist in several industrialized countries, including Germany, Spain, Italy, the United Kingdom, and the United States. However, institutional barriers continue to limit the potential for renewable energy development.

Some of the needs and requirements to develop renewable energy markets in industrialized economies include:

- Enactment or creation of renewable energy legislation and/or a legal framework, including establishment of targets to ensure long-term sustained development of renewable energy markets;
- Rationalization of subsidies for fossil fuel and nuclear energy, which includes providing medium- to long-term fiscal and financial incentives for renewable energy investments, especially from the private sector;
- Establishment of mechanisms to encourage small- and large-scale grid-connected renewable electricity generation, such as feed-in directives, portfolio standards, and associated regulatory and legal frameworks;
- Capacity building targeted at policy makers at the national and local levels, to provide an energy security perspective as well as lessons learned from successful experiences in renewable energy promotion in leading industrialized countries;
- Capacity building initiatives targeted at ECAs and government departments and divisions responsible for public procurement, to develop internal and external markets for renewable energy; and
- Awareness campaigns targeted at the media and the public in general, to foster public support and promote the rational use of energy, including increased renewables.

5.3 Capacity Building: Progress since Bonn

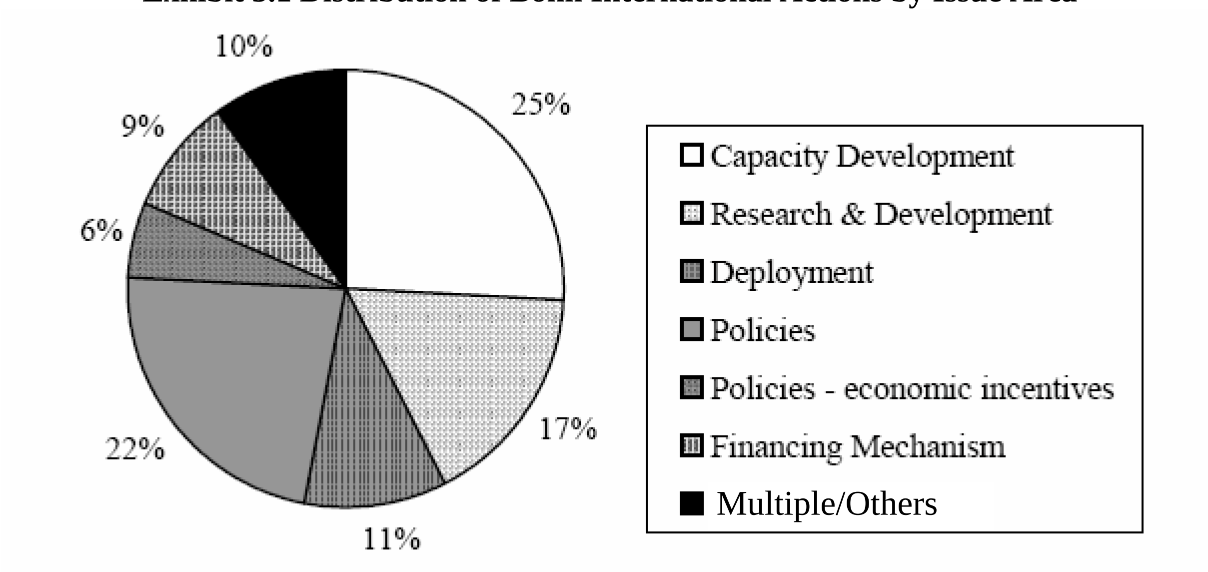
At the *Renewables 2004* Conference, capacity building for market development was recognized as a key challenge. In fact, of the 200 actions and commitments set forth in the IAP, 25 percent targeted the development of human and institutional capacity (see Exhibit 5.1). This was more than any other issue identified and underscores the importance of capacity building across country classifications.

Since Bonn, a number of capacity development activities have ensued. Examples include:

- Industrialized countries, newly industrialized countries, economies in transition, and developed countries, have continued to build capacity on policy, finance, and technical issues. Policy makers, private firms, utilities, industry groups, and NGOs have sponsored and participated in a range of domestic, regional, and international fora aimed at strengthening the capacities of decision makers and implementers of renewable energy projects and programs. Examples are the APEC Renewable Energy Working Group meetings, World Bank Energy Week, Asia Renewable Energy Financing Forum, Euromoney Renewable Energy Finance Meeting, American Council on Renewable Energy (ACORE) Renewable Energy Wall Street meetings, etc;

- Research organizations such as Frauenhofer Institution for Solar Energy Systems, the Trans Mediterranean Renewable Energy Cooperation, the African Energy Policy Research Network, the Heinrich Boll Foundation, NREL, and others continue to advance renewable energy R&D and develop and enhance models and tools for evaluation;
- Partnerships such as REEEP and GVEP have made capacity strengthening part of their core strategic work plans and support efforts in this area in a number of countries worldwide;
- Benefiting from capacity building activities, several countries have recently put in place policy commitments, targets, and timetables for renewable energy advancement and are following through on implementation (see Chapter 3);
- Capacity building efforts have helped to expand the range of corporate and financial players now investing in renewable energy (see Chapter 4); and
- G8 Gleneagles Action Plan (in dialogue with +5 countries of Brazil, China, India, Mexico and South Africa), task with IEA.

Exhibit 5.1 Distribution of Bonn International Actions by Issue Area



5.4 *Implications for BIREC 2005*

For renewable energy markets to grow and deepen, capacity building is needed in all aspects of project and program design, development, implementation, and operation. Capacity development is required for governments, private firms and entrepreneurs, financiers, developers, academia and for industrialized and developing countries alike. Areas where capacity strengthening are most needed include technology RD&D, deployment, marketing, financing, operation, and maintenance; policy formulation, implementation, and regulation; business planning and development; and consumer outreach and awareness. Capacity needs differ across developing and industrialized countries given their varying stages of technology advancement. BIREC 2005 helped to frame capacity building priorities for various countries and constituency groups and explore mechanisms and means for addressing these.

6 International Collaboration

6.1 Introduction

Although the biggest impact on renewable energy markets will result from the actions taken by national governments, it is critical for national governments in both developed and developing countries to take leadership on the advancement of renewable energy in their countries. There are significant benefits to be gained from international collaboration. International collaboration refers to activities undertaken jointly by a variety of actors—including governments, international organizations, multilateral financial institutions, the private sector, NGOs, research institutions, and civil society—in pursuit of shared objectives that form part of an agreed agenda. International collaboration can be truly global, and should involve manufacturers, developers, trade associations, financiers and other private stakeholders with valuable knowledge and experience, to ensure the resources and methods applied are the best available. Importantly, international collaboration should enhance, not displace, independent national initiatives.

International collaboration can support national governments and industries to build market frameworks, strengthen industrial capacity, and enhance technical know-how through information sharing on successful (and not so successful) efforts, facilitation of industrial relationships, and connection of local players to a wealth of international expertise. By linking national efforts to the broader international community, a country can reap the benefits of technology improvements and cost reductions at home, while contributing to the collective scale up of renewable energy worldwide.

Though different renewable energy technologies are in varying stages of development, all can benefit from international collaboration. Many developing countries have hydropower and geothermal resources that can be exploited, and would gain from the experiences of countries that have successfully deployed these technologies. For the "newer" renewable energy technologies (e.g., wind power, solar technologies, and newer forms of bioenergy), policy approaches, incentive mechanisms, and market structures are in relatively early stages of development. International collaboration is useful to exchange experiences, learn from each other, and discuss best practices, in order to avoid time-consuming and costly mistakes, and provide a "short-cut" to success.

Since industrialized countries are currently the leaders in most renewable energy technologies (with the exception of some of the newly emerging countries such as China, India, and Brazil), it is important for these nations to work with their counterparts in developing countries to advance the technologies in these markets. The potential benefits of international cooperation could include:

- Reduced technology development and production costs;
- Improved technology performance and reliability;
- Improved market growth worldwide leading to economies of scale and further cost reductions;
- Enhanced knowledge of effective market strategies and mechanisms to enhance technology competitiveness;
- Expanded equipment standardization, and harmonization across countries;
- Reduced trade and investment barriers;

- Expanded opportunities for cooperative technology development and joint venture manufacturing and marketing opportunities;
- Increased South-South and North-South trade opportunities;
- Reduced dependency on imported energy sources;
- Improved employment and income opportunities; and
- Increased energy access to those in need.

International cooperation in renewable energy is occurring today via a number of mechanisms including workshops, fora, technical assistance and training, pilot projects, and other information exchange media. Yet to date, these efforts have not yielded significant growth at the global level. Thus, opportunities exist to increase international collaboration and enhance the global penetration of renewable energy products and services, as well as the establishment of truly international markets.

The need for increased collaboration was highlighted at WSSD and manifested through the JPoI and a number of voluntary partnerships. The Political Declaration from the *Renewables 2004* Conference stressed the need for stronger international cooperation in six areas: policy development, capacity building, technology transfer, joint R&D, financing, and trade barrier reduction (see Textbox 6.1). Continued attention to the themes drawn from Bonn, through implementation of the IAP and others, will enhance the success of international collaboration to promote renewable energy, and help optimize its contribution to sustainable development.

Textbox 6.1 Themes from Bonn identified as core "metrics" for international collaboration on renewable energy:

1) Policy Development
2) Capacity Building
3) Technology Transfer
4) Joint Research and Development
5) Financing
6) Reduction of Trade Barriers

In many cases, the major gap in collaborative programs is international funding for applications and capacity building within the industry to develop assessment tools and performance standards. Key drivers from the investment community are essential for growth and new market development, with collaborative efforts often producing success where there is support for strategic development and road-mapping. These can encourage industry and RD&D programs to set development priorities together with government, providing regulatory foresight to anticipate novel products and processes.

In addressing international cooperation it will be important to focus on technologies that have broad and deep applications and not on niche markets, and those that can help to address the energy access issue. It will also be necessary to address specific gaps with targeted solutions.

This chapter explores the major collaborative themes identified at the Bonn Conference, as well as progress made to date in these areas. It also provides specific recommendations for activities that can further advance international collaboration in the global deployment of renewable energy.

Exhibit 6.1 Illustrative Areas for International Cooperation

Key Processes	*Barriers In Developing Countries*	*Potential Areas for Collaboration With Industrialized Countries*
Policy Development	• Political Support for Consistent RE Policies • Unstable Energy Market Reforms • Lack of Enabling Platforms • Immature Regulatory Responses • Lack of Institutional Framework • Energy Security/Diversity • Conflicting Trade Policies • Removal of Outdated Subsidies	• International Agreements and Market Mechanisms • Open Trade Policies • Integrated Policy Networks • Policy/Regulatory Exchanges and Technical Support • International Policy Cooperation
Capacity Building	• Government Investment In Training & Skills Development • Established Accreditation Processes • Institutional Capacity Building • Capacity Building in Assessment Tools And Performance Standards	• Technology Innovation • Business Management Expertise • Collaborative Educational Programs • International Research Institutes • Private Sector/Industry Collaboration • Transfer of Tools/Models for Technology/Financial Assessment
Technology Transfer	• Technology Development Policy • Technology Awareness Programs • Regulatory Reform For Intellectual Property • Long Term Partnerships On Technology Cooperation	• National Policies for Technology Transfer. • Technology Transfer Co-Operative Agreements. • Private Sector Technology Transfer/Business Ventures • International Technology Transfer Funding Streams
Joint R&D	• R&D Policy/Priorities at National Levels • Innovation Culture • Resource Assessments • Alternative R&D • R&D Funding Streams • Regulatory Foresight on Novel Products & Processes • Product Standardization/Harmonization	• R&D Funding For International Collaboration • Integrated R&D and Technology Deployment • International Collaboratives • R&D Programs and Partnerships • Inventory on R&D Capabilities • International Product Standards
Finance	• Government Funding Support • Limited Market Liquidity • Regulatory Risk • Lack of Enabling Frameworks • Attracting the 'Kyoto Effect' • Credit Risk For Private Sector • Planning and Development Hurdles • Lack of International Investment • Fluctuating Currencies	• Carbon Investment – CDM • Carbon Funds • Multilateral /Bilateral Credit Lines • Export Credit • Fiscal Incentives • Tied Aid Restrictions
Trade Barriers	• Conflicting Government Trade Priorities, particularly between new & existing industries • Grid Access • Access to Global Markets	• International Law Reform • Subsidy Reviews • International Grid System Access • World Trade Organization (WTO) Tariff Reform – Doha Round, Conclusion Of Multilateral Trade Negotiations • International Standards

6.2 Collaborative Support for Policy Development

A key conclusion drawn at Bonn was the importance of implementing effective policy frameworks to support renewable energy development. There is an urgent need for individual governments to formulate appropriate and effective policies that promote renewable energy under local conditions, by overcoming specific local barriers and capitalizing upon unique local opportunities. Successful government policies cultivate international collaboration by helping to create supportive enabling conditions and incentives for investment in and capacity building for renewable energy; strategic international collaboration can help inform the development of sound policy frameworks. International collaboration can assist through the exchange of knowledge and experience in policy development, on issues such as incentive mechanisms that include feed-in tariffs and renewable portfolio standards, and sustainability guidelines developed by both the hydro and wind industries. Further, governments have experienced varying levels of success in their implementation of policies to promote renewable energy.

International collaborative efforts in renewable energy policy should be undertaken and targeted at energy policy makers and regulators. These efforts must be tailored to the requirements of each country—whether an LDC, emerging market, industrialized, or transition economy. Such efforts should focus on providing the energy security perspective of renewable energy technologies and stress the need to establish linkages between renewable energy and development and social service programs in health, education, poverty alleviation, and water, etc. Policy activities should provide examples and lessons learned from policy frameworks and specific policy and regulation instruments that have been used successfully in industrialized and developing countries to promote renewable energy. They should also emphasize the importance of private sector involvement in renewable energy development, providing examples of successful policy measures to encourage private sector participation. Finally, international collaboration in the policy area should contribute to efforts aimed at combating the negative effects of climate change, and evaluate the effect of international energy and environmental agreements on renewable energy policy (giving special attention to the United Nations Framework Convention on Climate Change, UNFCCC, Kyoto Protocol and the flexibility mechanisms JI and CDM).

REN21 represents a strong foundation for collaborative policy development. Its goal is to allow the rapid expansion of renewable energies in developing and industrial countries by bolstering policy development and decision-making on international, national, and sub-national levels. REN21 helps create an environment in which ideas and information are shared and cooperation and action are encouraged to promote renewable energy worldwide. The REEEP Sustainable Energy Regulators Network is another example of a mechanism for international policy collaboration. Other vehicles include the GVEP knowledge exchange service line which includes a policy component; the Global Network on Energy for Sustainable Development; the World Bank, which continually reviews policy measures and their effects in countries where they operate; the World Bank's Energy Sector Management Assistance Program (ESMAP) that recently developed a renewable energy toolkit that includes policy information; and the IEA Renewable Energy Technology Development Implementing agreement that was announced in Bonn and recently formalized. Numerous bilateral assistance programs also include policy components.

Since Bonn, a number of developing countries have launched major policy initiatives and/or programs that will inform decision-making. These include development of the China Renewable Energy Law and small hydro resource assessment program; improved planning for integration of renewable energy into rural electrification in the Philippines; the India Ministry of Non-Conventional Energy Sources (MNES); wind resource assessment program; etc. Sharing this information with other developed and industrialized countries will help to further the global experience base.

Many developing countries face problems in formulating effective policies to make available energy to rural populations, due to a lack of relevant knowledge and experience. The African Microhydro Knowledge Network (AMKN) demonstrates the ability of international collaboration to overcome barriers to effective policy development. Another significant policy development example is the EU Commission's Green-X project 2005. This project has developed a model to assess learning curves and costs across the available renewable energy technologies and determine level and types of appropriate price signals that can be introduced to ensure growth at the lowest socio-economic cost. This model could be used to assist many countries.

Textbox 6.2 South-South Policy Collaboration: African Microhydro Knowledge Network

The African Microhydro Knowledge Network provides both a regional example of policy collaboration and a potentially replicable model for similar action in countries or regions in which like conditions prevail. AMKN was launched in April 2005 as a capacity building facility, intended to provide a forum for the sharing and discussion of policies and experiences in developing microhydropower in sub-Saharan Africa. By pooling knowledge and experiences, the 20 nations involved are enhancing microhydro policy development. The AMKN is particularly significant as an example of "South-South" international collaboration.

6.3 Capacity Building

As Chapter 5 discussed, fulfillment of the potential of renewable energy is constrained, particularly in developing countries, from a persistent lack of capacity. In the area of international collaboration, increasing knowledge of and access to renewable energy information and analytic tools that can inform government and private sector decision makers is an important need. Specific areas for support include greater access to: resource assessment data and tools for Geographic Information System (GIS) analysis; input on standardized power purchase agreements; decision support software; and current technology cost and performance data. Analytical tools include the Solar Wind Energy Resource Assessment (SWERA), RETScreen, and the Homer and VIPER economic analysis models developed by NREL.

Information sharing and development of networks among multiple stakeholders should also be an important focus of collaborative capacity building initiatives. In emerging renewable energy markets, particularly, lack of information and familiarity with renewables options can constrain markets. A growing number of capacity building initiatives seek to address this by disseminating information and building networks among diverse potential stakeholders. Some efforts, such as China's efforts to standardize and promote the integration of solar water heating systems in building design, have shown that establishing linkages between developers, manufacturers, designers (architects), and governments can create or expand markets for the benefit of all. In addition, enterprise development approaches that cultivate entrepreneurs, through seed capital and business skills training to provide renewable energy services, have opened new markets for previously underserved populations.

A number of organizations such as GVEP, ESMAP, UNDP, UNEP and other national and international organizations have worked to build energy capacity among energy-poor rural populations around the world. This has included important programs designed to strengthen links between stakeholders, including entrepreneurs, consumers, and consumer organizations. In particular, training programs have been held targeting commercial banks, micro-credit organizations, energy service providers, and others.

For capacity building efforts to maximize their success, it is essential that multiple initiatives continue to build and complement each other. Donor coordination, though often challenging, is an important element of building a successful foundation for renewable energy development. Capacity building should also, where feasible, emphasize and build upon opportunities to link the provision of renewable energy to income-generation and other economic development priorities.

Textbox 6.3 Excerpts from G8 Summit Climate Change Action Plan 2005 Powering Future

10. Reliable and affordable energy supplies are essential for strong economic growth, both in the G8 countries and in the rest of the world. Access to energy is also critical for poverty alleviation: in the developing world, two billion people lack access to modern energy services.

11. To respond to the scale of the challenges we face, we need to diversify our energy supply mix, including increased use of renewables.

Specifically, on renewable energy…

16. We will promote the continued development and commercialisation of renewable energy by:

(c) working with developing countries to provide capacity-building assistance, develop policy frameworks, undertake research and development, and assess potential for renewable energy, including bioenergy.

6.4 Technology Transfer, Diffusion, and Industrial Development

The promotion of renewable energy for sustainable development depends upon access to environmentally-sound and appropriate technologies, particularly in developing countries. Efforts to facilitate technology acquisition in developing and transition countries should build upon the relative strengths of each partner. For example, countries from the North frequently (but not always) have advanced technology and financial and human resources. Countries from the South, on the other hand, can often offer lower production and installation costs, and strong natural renewable energy resources. These strengths can be shaped into significant international collaboratives that maximize mutual gains.

The renewable energy field involves a great variety of technologies and applications. The development of markets depends, in part, on the renewable energy resource available in different locales. Furthermore, production costs and economies of scale may favor developing countries in manufacturing many renewable energy products. As technological innovations are fostered, there may be incentives for international collaboration to develop manufacturing capabilities in other countries, depending on proximity to markets and local enabling conditions for investment. This suggests that there may be significant potential for renewable energy industry growth in developing countries, as well as industrialized countries, and that there will be considerable potential for South-South, as well as South-North trade and technology transfer. As some countries become increasingly concerned about dependence on imported oil, for example, they are exploring ways to cooperate with other countries on a regional basis in the development of joint renewable energy industries.

The CDM of the Kyoto Protocol is an emerging vehicle for supporting the diffusion of renewable energy technology between developed and developing nations. The CDM offers a fast-track for small-scale renewables projects. It can provide a framework for promoting the acquisition of renewable energy technologies on a project scale, as well as allowing for the continued use of the CDM to reduce emissions and promote sustainable development.

Multilateral initiatives, such as GVEP, REEEP, the IEA Climate Technology Initiative, the JREC, and others, as well as multilateral development banks and financial institutions, offer vehicles for promoting technology diffusion. Within the Asia-Pacific region, APEC contributes pivotal collaborative processes on energy, with particular relevance to renewable energy through the Energy Working Group and the Expert Group on New and Renewable Energy Technologies. The APEC Forum, which focuses on advancing trade between member economies, could become a significant collaborative process to increase the deployment of renewable energy technologies. A new vehicle that identifies technology transfer as a particular focus is the Asia-Pacific Partnership on Clean Development and Climate (APPCDC) between the US, Japan, Australia, China, India and Korea (see Textbox 6.4). The APPCDC advocates technology transfer to enable reductions in emission intensity and includes renewable energy.

China, India and Brazil, as well as some other developing countries, have each made exemplary efforts to employ renewable energy as they develop. International initiatives such as the ones above could help to escalate these efforts, and play a significant role in deploying advanced renewable energy technologies in the Asia-Pacific.

Future efforts in renewable energy technology diffusion should consider initiatives driven by multilateral and bilateral country and development agencies focusing on developing countries, especially the less developed countries. Such initiatives should be comprehensive and include capacity building, market development, technology information dissemination, intellectual property protection, and financing components to ensure successful and sustainable technology utilization.

Textbox 6.4 Vision Statement of Australia, China, India, Japan, the Republic of Korea, and the United States of America for a New Asia-Pacific Partnership on Clean Development and Climate

The partnership was designed to collaborate on the promotion and creation of an enabling environment for the development, diffusion, deployment, and transfer of existing and emerging cost-effective, cleaner technologies and practices, through concrete and substantial cooperation so as to achieve practical results. Areas for collaboration may include, but not be limited to: energy efficiency, clean coal, integrated gasification combined cycle, liquefied natural gas, carbon capture and storage, combined heat and power, methane capture and use, civilian nuclear power, geothermal, rural/village energy systems, advanced transportation, building and home construction and operation, bioenergy, agriculture and forestry, hydropower, wind power, solar power, and other renewables.

Similarly, multi-stakeholder collaborative efforts that facilitate technology diffusion to emerging market economies and developing countries where commercial market opportunities exist, should be considered. Such initiatives should focus on increasing the scope of the technology transfer process to include SMMEs, large multi-national energy companies active in the renewable energy sector such as British Petroleum, Shell, General Electric, etc., and other stakeholders such as research institutions and NGOs.

Such initiatives should also focus on policy and financial aspects of technology diffusion, such as intellectual property right issues, and financial support for technology transfer mechanisms like licensing, turnkey, or equipment supply.

6.5 Research, Development, and Demonstration

Although renewable energy technologies have made impressive progress since their entrance into energy markets, and some of the technologies are now economically competitive, more RD&D remains to be done to improve technology performance and cost reduction. G8 leaders at Gleneagles urged increased commitment to international cooperation in and coordination of RD&D into energy technologies, thereby building upon the Science and Technology Action Plan devised at the 2003 G8 Summit in Evian. The final communiqué from the Gleneagles Summit suggests the establishment of an inventory of existing RD&D collaborations, and their differing levels of effectiveness. This would guide governmental efforts to build effective RD&D partnerships, and would be particularly valuable to developing nations in their initiation of collaborative programs to advance renewable energy and other technologies necessary for sustainable development.

To support the development of alternative sources of energy supply while improving energy efficiency, IEA created a flexible mechanism that allows interested governments and organizations to pool resources and research the development and deployment of particular technologies—called Implementing Agreements. For 30 years, the Implementing Agreements have been a fundamental element among IEA Member and non-Member countries in facilitating advancement of renewable energy technologies. Today, there are eight dedicated technology development programs covering all renewable energy technology options. In fulfilling the G8 Gleneagles Program, the IEA is committed to collaborating with all countries, international organizations, civil society, non-governmental organizations, business communities, international financial institutions, as well as its own extensive energy technology network on promoting networks for renewable energy research and development.

There is significant potential to carry out joint RD&D projects in renewable energy technology through collaborative efforts in and amongst industrialized countries, countries in transition, emerging economies, and LDCs. Some of the themes on which the joint RD&D could focus include: (1) research on emerging technologies such as biofuels, hydrogen, fuel cells, energy storage technologies, and distributed generation systems; (2) research on integrating renewable energies with lower utilization characteristics into large-scale power systems, and making use of renewable energy systems for efficiency and demand-side management initiatives; (3) RD&D on regulation methodologies and approaches for development of renewable energy; and (4) socio-economic research on the possibilities for integrating renewable energy into national development programs aimed at achieving the MDGs, as well as research on the development benefits of large-scale renewable energy deployment. Also, renewable energy resource assessments should be directed towards an improved understanding of how best to take advantage of specific and local conditions, as well as specific capabilities of the parties, in order to prioritize the development and deployment of renewable energy on a global scale.

6.6 *Finance and Trade*

Meeting the renewable energy needs of developing country markets will be a costly endeavor. As noted in Chapter 4, satisfying the Bonn IAP commitments will involve funding of approximately US$10 billion per year, and this represents only a portion of the activities in renewable energy today.

The bulk of the funding for renewable energy projects in developing countries will come from self financing (national governments and local financial institutions), as well as the private sector. MDBs and ECAs bring limited direct resources for energy investments (e.g., MDBs and ECAs spend roughly US$4 billion per year for ALL power sector investment, not just renewables). Nonetheless, these organizations have an enormous role to play in using their funding and influence to leverage public and private sector funds for renewable energy investments in developing countries.

Organizations such as the World Bank, regional development banks, and ECAs have all expressed their commitment and support for renewables; however, expanding and deepening their activities will help to accelerate market scale up. Efforts aimed at broadening the depth and breadth of financial instruments will be useful to reduce investor risk, such as guarantees, partial guaranties, loan syndication, equity, insurance, etc. MDBs could also explore how to incorporate renewable energy into sectoral and adjustment lending programs. By finding effective ways to collaborate more closely with private banks, insurers, investors, foreign direct investment (both in project finance and equity investments), official development assistance, and very importantly developing country governments, MDBs and ECAs can play an important catalytic role in increasing the investment base for renewable energy.

Areas for strengthening international collaboration could include technical assistance and support targeting finance and banking sectors in host countries for effective participation in the development of renewable energy markets. Such efforts could cover the business prospects of renewable energy projects, appraisal and due diligence tools, and approaches; project financing and venture capital; risk sharing support; and micro financing, consumer lending, and awareness. Collaboration on the application and use of flexibility mechanisms under the Kyoto Protocol, and their linkages to renewable energy projects, is also important with special attention to JI and CDM.

Additionally, the Renewable Energy and International Law Project (REILP) notes that government support for renewables through the employment of tax and regulatory powers and the provision of subsidies is often essential for the establishment and development of renewable generation in markets dominated by fossil fuel and nuclear power generators. There remains uncertainty as to whether such policies could conflict with rules of the World Trade Organization (WTO), or whether there are unutilized opportunities within WTO law to foster renewables (both for North-South and South-North trade). Continued international collaboration needs to be directed to minimize conflict with and maximize support from trade issues such as: excise and taxation measures; non-fiscal regulatory measures; subsidies; access to grid and transmission; standards and regulations (particularly for vehicles); and renewable energy quotas. These and other issues that stem from international law and are amenable to and appropriate for international collaboration are given in Textbox 6.5.

Ultimately, the ability to attract financing is largely dependent on the local enabling conditions and market potential. Generally speaking, countries which have relatively liberalized, transparent, and stable markets for foreign investment are more likely to attract foreign direct investment than those which do not. It is thus important for technical assistance and public financing initiatives to include policy components that can help develop the appropriate market conditions. Where feasible, public-private partnerships may be utilized to stimulate or expand markets for renewable energy, including areas that offer less promise for the private sector to invest alone.

A variety of innovative financing options have been developed for application in developing countries to promote energy sector development. These include microcredit, seed capital for small- and medium-size enterprises, and larger-scale sustainable energy funds. Additional emerging sources include dedicated government clean energy funds, such as those established by some US states, and global development bonds, a securitized instrument that could allow investors to invest in renewable energy projects and companies in developing countries. Furthermore, the growing interest among some large institutional investors, such as pension funds, in investing in sustainable development, represents a largely untapped funding source for renewable energy. More effective collaboration of the international and developing country communities around the issues of renewable energy finance and trade, with a specific emphasis on how to better engage the private sector, enhance local liquidities, and expand the menu of financing options will be essential to significantly increase renewable market share.

Textbox 6.5 From Renewable Energy and International Law Project (see www.reeep.org):

Issues that relate to international collaboration include:

- Due to the positive environmental effects of RET, should WTO member countries should consider placing RET in the “green” box, whereby member countries identify subsidies that the other parties agree to refrain from challenging?
- How electricity generated from renewable energy is different from that generated from fossils fuels, both in terms of environmental effects and promoting energy security. This difference needs to be taken into account by those applying and interpreting international trade law. Trade rules on non-discrimination do not require that different situations be treated the same, and a proper understanding of how renewable energy is in fact different will lead to interpretations of trade law that could undermine legitimate governmental efforts to promote these technologies.
- How rights of navigation will inevitably impact states that wish to promote development of an offshore generation capacity from wind.
- How international agreements address the handling of waste and the impact of this on renewable energy development (for example, by constraining the use of elements used in the manufacture of photovoltaics or regulating waste sawmill co-products that are used for bioenergy; these factors will impact technology choices).
- How international agricultural agreements interact with the development of the biomass market.
- How international investment agreements could best be used to promote renewable energy projects and the formation of a global market for tradable renewable energy credits.
- Given the administrative and funding difficulties of the CDM Executive Board and legal (and investment) barriers facing the CDM itself, both at the international and national levels, is the CDM of the UNFCCC being optimized for the development of renewable energy, and if not, what changes need to be effected?
- How measures imposed to protect wildlife under treaties such as the Conventions on Biological Diversity and on Migratory Species, as well as the Ramsar Convention, work with wind energy development.
- To help meet both environmental and development goals of the DOHA Round, it is critical that renewable energy be defined as both the finished products and the major components that make up those products. If tariffs are reduced only for finished RE products alone, most of the effect would be concentrated in the handful of developed countries with existing renewable energy industries. Opening tariff reductions to components would greatly increase the dispersion of economic stimulus related to major renewable development efforts.
- How WTO rules on technical standards require that states base their regulations on “international standards.” Thus, international standard setting will have a *very* significant impact on the WTO-compatibility of renewable energy measures. This includes any international standards that define what is a renewable energy source, and norms of reliability, safety, etc. for renewable energy technologies and operations.
- How the very purpose of international investment agreements (IIAs) is to support the making of new investments, such as those in renewable energy. Potentially problematic areas in IIAs include non discrimination, expropriation, and performance requirements. Opportunities to increase the use of renewable energy in new treaties in other areas (such as that to be negotiated for a greenhouse gas regime after the expiration of the Kyoto Protocol in 2012) is a major area of work.
- How it is important to explore the role “soft” international law can play. Emerging legal norms and policies, guidelines and standards and other legally relevant materials arising from intergovernmental agreements and discussion, relate to and impact the development of renewable energy globally. Some legal experts feel the term itself is oxymoronic, as it is not law if not binding, nonetheless, soft law does inform policy and policy in turn informs legislation. Soft law can be the proverbial “camel’s nose under the tent.”

6.7 *Implications for BIREC 2005*

A key role of BIREC 2005 was to explore and elaborate measures for increased international collaboration on renewable energy that strengthen and complement actions taken by national governments. This Chapter served as a baseline for discussion on actions that developing/transition countries and their development partners could take to establish new collaborative initiatives or to reinvigorate existing initiatives. Proposed areas for international collaboration presented at BIREC 2005 are outlined in Textbox 6.6.

Textbox 6.6 Enhancing International Collaboration on Renewable Energy

Areas raised during BIREC 2005 for enhanced international collaboration on renewable energy included the following:

- Inviting governments to contribute to efforts, bilateral and multilateral, that support renewable energy resource assessments and analytical tools to improve understanding of renewable energy market potential in developing countries and the contribution it can make to economic development.
- Encouraging governments to support and expand regional collaborative solutions to advancing renewable energy development, and maximizing economies of scale and comparative advantage to mutual benefit.
- Encouraging international financial institutions, and the governments that govern them, to strengthen emphasis on renewable energy within their energy and infrastructure lending programs, recognizing the multiple sustainable development benefits from renewables.
- Inviting governments to emphasize the importance of sustainable energy in national development plans, including their Poverty Reduction Strategy Papers, that help guide World Bank and donor assistance programs.
- Calling upon governments to increase support for joint research and development efforts for renewables.
- Encouraging governments to support international collaboration efforts such as REN-21, GVEP, GNESD, JREC, and the commitment to renewable energy development within bodies such as the G-8, OECD and UN.
- Inviting governments to resolve to use the WTO ministerial, CSD and other appropriate forums to determine and discuss the most effective means to use international law in its broadest sense to foster the development of renewable energy, and avoid conflicts with trade regulations.
- Inviting governments to make development of renewable energy, along with energy efficiency, a special focus of the upcoming cycle of CSD-14 and -15.
- Inviting stakeholders—governments, international organizations, civil society, NGOs, business, international financial institutions and others—to work with IEA to promote networks for renewable energy research and development.

7 Options for Enhanced Information Gathering, Sharing, Review, and Assessment

7.1 Background

At the World Summit on Sustainable Development, Heads of State and Governments adopted *the Johannesburg Plan of Implementation*. In this document (paragraph 20e), they agreed "with a sense of urgency, to substantially increase the global share of renewable energy sources with the objective of increasing its contribution to total energy supply, recognizing the role of national and voluntary regional targets, as well as initiatives, where they exist, and ensuring that energy policies are supportive to developing countries' efforts to eradicate poverty, and *regularly evaluate available data to review progress to this end"*.

The report of the WSSD also noted that the enhanced role of CSD should include reviewing and monitoring progress in the implementation of Agenda 21 and fostering coherence of implementation, initiatives, and partnerships.

Participants of the *Renewables 2004* Conference contributed voluntary commitments to an International Action Program and further agreed in paragraph 8 of their political declaration that "measurable steps should be reported to the CSD and that progress should be reviewed as foreseen in the Johannesburg Plan of Implementation. An appropriate arrangement for follow-up should be identified in a future meeting in preparation for CSD 14/15."

BIREC 2005 provided an opportunity for sharing information and lessons learned, identifying outstanding data gaps and issues, and exploring reporting and review arrangements as follow up to WSSD and Bonn.

7.2 Importance of Information Gathering, Sharing, and Periodic Review and Assessment

Creating meaningful arrangements for regular information gathering, sharing, reporting, and review on the implementation of renewable energy policies and programs are crucial elements in the future development of international efforts to increase the use of renewable energies. This is particularly important as renewable energy is still an emerging field. As the industry develops, it is coming under intense scrutiny and the need for timely, accurate data is vital for countries, investors, developers, and others.

Today, in the case of conventional energy, data and information on all aspects of production, consumption, and utilization are available from a wide variety of national and international sources. These include national statistical offices, United Nations Statistical Office (UNSO), IEA, the US Energy Information Administration, and others.

For renewable energy however, comparable data sources and information is limited with the exception of some OECD and developing countries. Information on the actual *implementation of renewable energy policies, programs, and related commitments on a real time basis*, including barriers and opportunities encountered, has remained very limited to date and has not allowed a systematic and comparative assessment. This lack of information constrains the potential for further progress in extending the use of renewable energies.

A regular periodic review of implementation constitutes good practice in the development and elaboration of any significant renewable energy policy or program—as in any policy. It encourages implementation and enables policies and programs to be adapted so as to enhance their effectiveness, for example by addressing gaps and barriers that prove to be of importance during implementation or by exploiting particular opportunities that emerge during implementation. As long as no effective mechanisms for reporting and review exist, efforts to increase the use of renewable energy miss out on an opportunity and will not realize their full potential.

International information gathering, sharing, reporting, and review on various aspects of renewable energy offer a number of benefits:

- Provides industry with up-to-date information on the status of renewable energy research, development, demonstration, and commercialization, including costs, benefits, and applications;
- Supplies investors with information on the risks, rewards, and risk mitigation instruments associated with renewable energy investments;
- Encourages effective implementation of commitments and actions;
- Provides policy makers and regulators with the range of policy options available for advancing renewable energy technologies, as well as lessons learned in implementation.
- Identifies practical steps towards making existing policies and programs more effective.
- Provides access to an expanded pool of knowledge and expertise than is available at the local or regional level;
- Provides access to financial assistance for program and project support;
- Offers a means for assessing progress on renewables at a national, regional, and global level by countries and other relevant actors;
- Provides access to technical and analytic tools for program and project design; and
- Provides access to methodologies for harmonizing data systems.

The challenge becomes how to put in place mechanisms for renewable energy information gathering, sharing, reporting and review that are timely, meaningful, and have the buy-in and support of the international community.

7.3 Principles for Information Gathering, Sharing, Reporting, and Review

Mechanisms for international information gathering, sharing, reporting, and review should adhere to a number of principles. These include:

- Information inputs, analysis, and reporting should be voluntary in nature;
- Information provided should be eligible for public domain, and thus available for dissemination on a transparent basis;
- Information should be sought from a range of stakeholders, reflecting the breadth and diversity or organizations involved in the design, development, and implementation of renewable energy policies and programs. These include developing and industrialized

country governments (including representatives from energy, financing, and cross sector ministries of agriculture, water, health, education, rural development etc where energy is required), private firms, financiers, NGOs, academia, consumers, and utilities;
- Information reviews should be facilitative, cooperative, consensus oriented, non-judicial and supportive of the efforts undertaken by governments and other actors to be reviewed;
- Data collection, analysis, and review should be conducted in an efficient and effective manner, with costs kept to a minimum; and
- With a view to the given institutional economy and efficiency, reporting and review should also be as lean as possible.

7.4 Information and Assessment Needs

There are a number of areas in the renewable energy field that would benefit from further analysis and review. These include, but are not limited to:

- *JPoI and IAP Commitments*: Progress reviews on JPoI and IAP commitments would be useful to assess results, barriers, lessons learned, and next steps. This could include results of national governments that made commitments under the JPoI, Type-2 Partnerships launched at WSSD, Bonn IAP commitments, and other voluntary commitments that have been made in the field of renewable energy.
- *Global Market Status*: Tracking of on-going renewable energy activities and progress across countries would help to better document industry status and global market share. This could be done on a routine basis and conducted in a standardized manner for aggregation and analysis.
- *Topical Issues:* There are a range of topical issues that could be evaluated further to advance renewable energy market scale up and market share, for example:
  - Assessment of policy measures for addressing specific barriers to technology deployment of individual renewable energy technology options (solar, wind, biomass, geothermal, hydro, etc).
  - Updates and assessments of new and emerging investment and financing sources for renewable energy projects and programs.
  - Cost and performance information by technology option.
  - Current information on renewable energy R&D progress.
  - Case studies and lessons learned in renewable energy deployment.
  - Tools, models, and methodologies for analyzing renewable energy.
  - Assessment of renewable energy experiences by application, e.g., grid, off-grid.
  - Assessment of successful renewable energy programs for poverty reduction and their contribution to the MDGs, etc.
- G*eographic Priorities:* Stakeholders, including governments, financiers, NGOs and others may be interested in coming together at a regional, state, and/or local level to review issues, options, and barriers to renewable energies in their locales.
- *Targeted Groups*: There may be support for convening specific types of individuals on areas mutual interest, including policy makers, financiers, entrepreneurs, technology developers, utilities, the research community, etc.

Textbox 7.1 International Reporting on Renewable Energy

The collection of relevant data is an important precondition for national decision making. Many national and international statistical offices collect data on commercial and non-commercial development and use of energy resources. During the past decade, efforts have been stepped up to include the diverse range of renewable sources of energy in the calculation on local and national energy balances. Many national organizations contribute to international efforts of expanding existing databases and energy balances to include differentiated data on the use of renewable energy.

Renewable energy can be derived from a great variety of energy sources using different energy technologies. Aggregation of national data at regional and global levels presupposes data comparability which can be enhanced through international cooperation.

The Statistics Division of the UNDESA publishes periodical *energy statistics yearbooks* compiling all available national data on commercial energy production, trade and consumption. With regard to renewable energy, available historic data only include hydro and geothermal energy. However, forthcoming UN statistical data on electricity production will also include other sources of renewable energy.

IEA compiles and publishes comprehensive data and analysis primarily based on national data provided by its OECD member countries, but also including energy statistics provided by non-member countries. Since 2002, IEA publishes an annual report entitled *Renewables Information* with information on renewable energy use in OECD countries. Furthermore IEA is in the process of setting up a *Renewable Energy Policies and Measures Database* covering IEA member countries and some developing countries, in particular those from the Johannesburg Renewable Energy Coalition.

The EIA compiles and publishes comprehensive statistical data and analytical reports on recent, on-going and projected trends in energy production and utilization. EIA publications include detailed data on the utilization of renewable sources of energy for most industrialized countries. Information on developing countries is frequently not available.

Renewable energy is derived from a great variety of different sources. The methods used in data collection can vary considerably between countries and organizations. All of the organizations mentioned above offer assistance aimed at harmonizing methodologies in order to ensure a reliable and comparable data collection and analysis at national regional and global levels. Continued international cooperation on improving data collection on renewable energy use at all levels and enhancing the comparability of data will be essential to provide energy policy decision makers as well as investors in energy with a sound basis for decision making.

Since 1999, a group of representatives and experts from several international organizations have collaborated under an international initiative to define a set of Energy Indicators for Sustainable Development. This will include the role of renewable energy and other energy technologies on indicators for sustainable development.

7.5 Mechanisms for Information Collection, Reporting, and Review

There are a variety of mechanisms for collecting, reporting, and reviewing information on renewable energy progress. Examples include:

- *Commission on Sustainable Development*. CSD has in place mechanisms for national reporting on JPoI commitments. These could be enhanced/strengthened as needed to better meet stakeholder needs for analysis and review. For example, CSD could include progress reporting on renewable energy every 2-4 years in combination with regular national reporting, and/or entrust the CSD secretariat or another body with the task of preparing a Global Progress Report on renewable energy every two years and report out at the CSD session. Type 2 partnerships could be invited to submit reports with the same frequency as governments.
- *Partnerships*. In addition to improvements above, CSD could also supplement its activities by commissioning an external group for more detailed reporting and review of renewable energy activities by countries and others. Partnerships emerging from WSSD/Bonn could provide a mechanism for enhanced review and reporting, for example, REEEP and REN21.
- *National Level*. National governments and other key stakeholders should conduct detailed assessments of their activities and progress at a national, state, and/or local level in order to learn from and advance progress on renewable energy. The results of these assessments should be shared with CSD and others.
- *Regional Initiatives*. There are a variety of organizations at the regional level that could take the lead on aggregating, reviewing, and reporting country level renewable energy information on a routine and standardized basis. This will facilitate sharing of experiences and knowledge on common problems and strengthen regional cooperation. Regional entities could include the Organization LatinoAmericana deEnergia (OLADE) or OAS in Latin America, APEC or ASEAN in Asia, the New Partnership for African Development (NEPAD) or African Energy Policy Research Network (AFREPREN) in Africa. Regional development banks, including ADB, AfDB, IDB, and EBRD could also play a more important role in renewable energy information collection and review.
- *Global Initiatives*. Globally, there are a number of organizations and initiatives that can be used to enhance information collection, analysis, and review. These include IEA, the UN (including UNDP, UNEP, UNIDO, UNDESA, UNESCO, FAO, WHO, etc), the World Bank Group, GEF, etc.

These activities can be conducted individually or in collaboration with others.

7.6 Process for Information Reporting and Review

7.6.1 Reporting

The establishment of a meaningful process for the review of progress towards increasing the use of renewable energies requires that <u>sufficient information</u> is generated and becomes available. The availability of sufficient information is a basic requirement of any policy or program review, and is necessary to ensure effective implementation in general. Only with appropriate information can gaps be identified and strategies for further progress explored in a meaningful way. Therefore, information is also a prerequisite and creates opportunities for demonstrating the need for, and actually attracting, targeted financial and technical assistance.

Periodic self-reporting is the most appropriate and promising basis for generating the necessary information on implementation of renewable energy policies and the international commitments to expand the use of renewable energies. To date, no appropriate process has been established that would allow for international comparisons, a general review, and a systematic assessment of progress. Periodic self-reporting is an important and proven practice for generating the necessary informational basis in many relevant international processes. Providing for a feedback loop in the reporting process that allows for clarifying data and information submitted enhances the accuracy of reported information. Since not only countries but also non-state actors (including international organizations, private entities, and NGOs) have entered into relevant international activities, required reporting by both governments and other stakeholders would seem to be indicated.

7.6.1.1 Periodicity

It may be most appropriate for reporting on the use and promotion of renewable energies to occur periodically every 2-4 years. Such a frequency would allow sufficient time for review, learning, policy adaptations, and feedback, while ensuring that available information could be updated and reviewed regularly so that progress becomes visible timely.

7.6.1.2 Content of reports

In regard to the content of the reports, two partially competing considerations must be balanced:

- On the one hand, the difficulties resulting from a generally increasing burden associated with international reporting would speak in favor of a lean reporting that makes use of existing information to a maximum extent and limits the required effort as much as possible.
- On the other hand, the reports need to contain sufficiently elaborate information to allow for comparison and aggregation of data and to serve as a basis for review that creates added value in the form of useful advice and assistance.

Finding the right balance between these considerations will require developing a clear and simple format for a brief but sufficiently informative report on the basis of a more detailed consideration of the minimum information required. These minimum information requirements would include baseline information on the situation in 2000 (or earliest possible subsequent year); action taken since then and in particular since the previous review (if any); the current situation and the effects of action taken; gaps, barriers and opportunities encountered; and planned future action and its expected effects (including likelihood of achieving aim/target of action, if any).

7.6.1.3 Resources

Establishing a reporting system on renewable energies is likely to require a certain amount of additional resources. These additional resource requirements will depend on the extent and depth of the information requested as well as the extent to which reporting can rely and build on existing sources of information. Ideally, reporting could largely consist of the collection and compilation of existing reports. For example, monitoring activities constitute a portion of many actions contained in the IAP and many relevant Type-2 Partnerships. Under real-world conditions, however, some additional effort will be necessary—in order to ensure timely and accurate reporting by a broad range of actors, a certain amount of capacity building may be required, particularly in least developed countries. If necessary, an expert group could be established to assist in the collection of data.

7.6.2 Review Process

To exploit its potential added value to the fullest extent possible, the review process must be based on excellence, expertise, and swiftness. Expertise and excellence are required not only to produce high-quality review outcomes but also to ensure that these outcomes can be accepted and used in productive ways by the actors concerned. The review process also must be conducted in an expeditious way to ensure that its results can be used easily and timely so as to further improve the promotion of renewable energies.

7.6.2.1 Broad based information sources

Reviews should ideally be based on a wide range of information sources. The quality of a review is highly dependent on the quality of the information and expertise on which it relies. A wide range of stakeholders are interested in the promotion of renewable energies and possess relevant knowledge and expertise. In addition to reports submitted, the review should therefore take into account additional sources of information, including information specifically provided by interested stakeholders (at the beginning of the review process as well as in response to any preliminary findings). Depending on their availability, these additional sources of information may reduce the reporting effort required to enable a meaningful review.

7.6.2.2 Scope and depth of reviews

The value of a review's outcomes will depend on its scope and depth. Two general approaches can be distinguished: a review of information would be limited to assessing the aggregate effects of reported activities for the promotion of renewable energies (for example at the regional or global level). Such a review would involve very limited costs but could not be expected to create significant additional value. In contrast, a review of implementation could yield significant additional benefits but may require some additional effort. Individual reviews of the implementation of individual countries and other initiatives/actors allow for outcomes such as advice and assistance focused on individual circumstances. Intermediate solutions include the following:

- Individual in-depth reviews could be conducted for all or certain actors *on their demand*; and
- Individual reviews could be carried out only for certain categories of actors (e.g. actors experiencing particular difficulties, only for countries, etc.).

To limit the effort required for a review of implementation and ensure against a potential overload of the review process (a) the individual reviews of countries/actors/initiatives facing similar challenges could be combined or clustered, and (b) periodic reporting and review of different actors could be phased so that the review effort is spread more evenly over the reporting period (e.g. half of all reports would be due every two years of a four-year reporting and review cycle). These options are not mutually exclusive but can be combined. For example, individual reviews could be conducted for all countries, distributed evenly over the reporting cycle, and clustered according to similarities of challenges, while non-state actors could make use of individual reviews on their demand only.

Successful formulation and implementation of national policies and regulations can greatly benefit from an inclusive decision-making process and from the participation of all concerned stakeholders. In some countries, energy policy and regulatory frameworks are periodically reviewed at the national level with a view to identify and realize potentials for improvement. However, there is often a disconnect between energy policy and promotion of renewables, especially in developing countries. Therefore, national decision-making processes can benefit from international sharing of experiences through knowledge transfer and institutional linkages. Countries that have not yet formulated comprehensive national renewable energy promotion policies may require assistance to bridge the gap between policy and its implementation.

7.6.2.3 Resources

Overall, additional resource requirements are likely to remain limited. They will depend on the scope of the review and the institutional arrangements chosen. In the most far-reaching variant, additional resources may in particular be required for the organization of several meetings. Assuming that the review process will be supported by the CSD, it may be possible to draw on existing structures to some extent (e.g. secretariat services). Limited additional requirements may need to be covered through voluntary contributions.

7.7 Synergy and Feedback to CSD

There are a variety of means for reporting progress on renewable energy back through the CSD process. These can include:

- Formal national country reports provided through the existing CSD process.
- Progress reporting by voluntary partnerships and networks.
- Reports of national, sub regional, and regional meetings and forums regarding renewable energy.
- Reports on multi-stakeholder forums/activities regarding renewable energy.

For most of these options, reporting could be enhanced through external reviews by expert teams that can provide more in-depth evaluations of individual and aggregate process. These expert teams can be convened on demand by relevant international organizations (e.g., OECD, IEA, UN, World Bank, etc). Alternatively, a self-standing expert group could be assembled to conduct independent (peer) reviews of country/partnership activities on a more routine basis and to report to and supplement the CSD reporting and review work.

The results of the above activities could be discussed at CSD and be placed on the CSD website, as well as linked to other relevant websites operated by governments, partnerships, and other key stakeholders. Textbox 7.2 provides selected examples of international policy review approaches, with a particular focus on the peer review methodology.

Textbox 7.2 Selected Examples for International Policy Review

Currently there is no or only limited experience among members of the Commission on Sustainable development on the use of peer review mechanisms; some national and international examples are given here.

In his speech at the World Summit on Sustainable Development, the President of the French Republic, M. Jacque Chirac, made a commitment that **France** would submit its **National Strategy for Sustainable Development** for a **peer review** by other countries, following a proposal by the European Union to develop such a system in order promote the sharing of experiences. A pilot peer review project was initiated in 2004 in cooperation with the United Nations Department of Economic and Social Affairs and the European Commission (DG Environment). The peer review involved eight invited visiting experts, two each from Belgium, the United Kingdom, Ghana and Mauritius. The visiting experts represented both, governmental and non-governmental organizations. The peer review process was facilitated by the International Institute for Environment and Development and has been documented in several reports of the Ministry of Economy and Sustainable development and the Ministry of Foreign Affairs of France. The information exchange and policy dialogue has been rated very useful by the participants who recommended voluntary cooperation under similar mechanisms also among other countries and/or on selected issues of sustainable development.

Various policy peer review mechanisms have been established at regional levels and among members of several international organizations. The **OECD** and **IEA** have established peer review mechanisms among respective members. Peer reviews are undertaken and published in line with the respective OECD / IEA statutes and guidelines. The periodic IEA energy policy review covers all dimension of energy policy, including the use of renewable energy sources.

Peer review mechanisms have also been established under the OECD **Environmental Action Program (EAP).** Under this program, OECD established a Task Force for the Implementation of the Environmental Action Program for Central and Eastern Europe, Caucasus and Central Asia, with a subsidiary Regulatory Environmental Program Implementation Network (REPIN) and a REPIN Peer Review Scheme. The country of Kyrgyzstan was the first country to invite a peer review under this scheme. Upon request of the Ministry of Ecology and Emergency Situations of the Kyrgyz Republic, a peer review team comprising seven experts carried out a review mission in March 2004, and subsequently submitted its 23 page report summarizing the conclusions and recommendation of the review. The expenses of the review were covered by the EuropeAid Program of the European Union.

During recent years peer review mechanisms have also been established among developing countries. The **African Peer Review Mechanism** (APRM) is generally considered the most innovative aspect of the **New Partnership for Africa's Development (NEPAD).** The APRM is a voluntary mechanism open to all member states of the African Union. NEPAD is premised on the need for improved democratic political, economic and corporate governance and an end to conflict as preconditions for sustainable economic growth. As a result the issues of tracking and reporting on political, economic and corporate governance have featured prominently in all NEPAD and APRM documentation as an integral part of the partnership. The NEPAD secretariat appointed the United Nations Economic Commission for Africa, and the African development Bank to prepare indicators and benchmarks for the operationalization of APRM. Thus far, 22 African countries have joined and participate in this regional peer review mechanism. The policies reviewed under APRM do not directly relate to energy or renewable energy, but the functioning of the mechanism may be studied by interested countries and organizations intent on establishing similar voluntary mechanisms of information sharing pertaining to other issues of sustainable development.

7.8 Implications for BIREC 2005

BIREC 2005 provided a forum for verifying the importance of continued and expanded efforts on renewable energy information collection and sharing. During the meeting, discussions examined the data gaps and barriers, with particular emphasis on the areas of policy, finance, and capacity development discussed in earlier chapters of this report.

BIREC 2005 also explored mechanisms for improving information reporting and review. In this regard, participants invited the Commission on Sustainable Development to consider an effective arrangement for reviewing and assessing progress towards substantially increasing the global share of renewable energy as foreseen in the Johannesburg Plan of Implementation. It was agreed that this would provide a long term prospective and encourage prompt action. Such periodic review could offer opportunities for enhanced national, regional, and international cooperation on renewable energy for sustainable development that could lead to more favorable environments for technology transfer and accelerated commercialization of innovative renewable energy technologies. The review would also be useful in addressing the link between energy and the Commission's biannual thematic cluster. Finally, it was noted that voluntary reporting could be enhanced through inputs from relevant international organizations, partnerships, and networks.

8 Conclusions and Next Steps

Renewable energy technologies have a significant role to play in improving the lives of people around the world. These technologies provide modern energy services that contribute to greater employment and income opportunities, technological advancement, cleaner environment, energy security, improved health care, secure water supplies, educational advancement, equal rights and gender equality, and overall, enhanced economic and social well being.

Today, renewable energy technologies represent a fast and growing industry. With some exceptions however (e.g., China, India, Brazil), the major markets for these technologies are in developed countries that have put in place the policy and regulatory frameworks necessary to encourage their use. Developing countries, where the energy demand is the greatest, have not yet significantly reaped the benefits of the technologies.

At WSSD, Heads of State and Governments from across the world committed to substantially increasing the global share of renewable energy as part of total energy supply–*with a sense of urgency*. This message was reaffirmed and reinforced at the Bonn *Renewables 2004* Conference through the Bonn Declaration and International Action Plan.

Accomplishing this goal of increased market share requires the active participation and engagement of many more countries around the globe, including those throughout the developing world. The challenge is how to support these countries in fulfilling their commitment to expanded renewable energy growth and market penetration.

This report has outlined a number of priorities for the international community in accelerating the scale-up of renewable energy, particularly in developing countries. It also identified the potential role for BIREC 2005 in moving these priorities forward. Proposed actions include:

- *Technology RD&D*. Continue and accelerate investments in technology research, development, and demonstration to in order to drive down costs for the technologies; enhance product and system performance, reliability, and efficiency; and expand the base of cost competitive end use applications. This includes renewable energy RD&D for electricity, thermal, mechanical, and refined fuel needs. It will also be important to take forward renewable energy technologies like solar, wind, and modern biomass, to the next generation in order to advance the learning curve, achieve cost breakthroughs, address outstanding technical issues, and increase scale of production. BIREC 2005 raised visibility on the need for more RD&D funding; the importance of ongoing dissemination of information on technology performance, costs, and market potential; and joint opportunities for RD&D both between and among industrialized and developing countries. Also needed is further research and development on "low tech" applications in the field (water pumping, water purification, etc.), and productive use applications, in order to expand the benefits of renewable energy, including to the rural poor.

- *Improve Policy and Regulatory Frameworks*. Securing political commitment and putting in place effective policy and regulatory frameworks are crucial elements to improve the investment climate for renewable energy. Governments have a role to play at all levels—federal, state, and local—and there are a range of policy options that have been applied and from which lessons are being learned. As many of these policies are still relatively new in their application, and field results limited, BIREC 2005 provided an opportunity to share experiences on policy approaches, tools, and techniques; discuss pros and cons of various options; and further the body of knowledge on best practices.

- *Financing Facilitation*. Finance and investment are essential ingredients in the growth and development of renewable energy for industrialized and developing countries alike. As the industry matures it will be increasingly important to expand the scope and breadth of financing sources and instruments, both locally and internationally. More creative leveraging of public and private sector resources will be needed to meet the financing requirements of the renewable energy industry, including ODA, GEF, and carbon financing. For developing countries, financing sources will be sought not only for larger scale grid connected projects, but also for off grid and rural projects that may involve SMME and end-user finance. BIREC 2005 offered a medium for investors, developers, governments, and the donor community to discuss renewable energy financing needs and issues and further accelerate the capital formation process.

- *Capacity Strengthening*. For renewable energy markets to grow, capacity strengthening is needed in all aspects of project and program design, development, implementation, and operation. Capacity development is a prerequisite for governments, private firms and entrepreneurs, financiers, developers, academia and for industrialized and developing countries alike. Areas where capacity strengthening is most needed include technology RD&D, deployment, marketing, financing, operation, and maintenance; policy formulation, implementation, and regulation; business planning and development; and consumer outreach and awareness. Capacity requirements differ across developing and industrialized countries given their varying stages of technology advancement. BIREC 2005 helped to frame capacity building priorities by various countries and constituency groups and explore mechanisms and means for addressing these.

- *International Collaboration*. Though each country has the lead responsibility for developing its own domestic renewable energy market, and fulfilling commitments made at WSSD towards increasing the global market share for these technologies, a role exists for enhanced international collaboration. BIREC 2005 explored opportunities and modalities for improving international cooperation, with a particular focus on capacity building and technical assistance, joint R&D, technology transfer, reduction of trade barriers, and investment and partnership. It identified broad-based areas for cooperation including North-South, South-South, and South-North.

- *Mechanisms for Reviewing Progress on Increased Use of Renewable Energy*. Chapter 7 outlined options for reviewing and reporting progress on renewable energy, including JPoI commitments at WSSD and the Bonn IAP. At BIREC 2005, participants reviewed existing arrangements for information collection and sharing and explored mechanisms for periodic review and reporting on renewable energy progress. As an outcome of BIREC 2005, participants invited CSD 14 to consider an effective arrangement to review and assess progress toward substantially increasing the global share of renewable energy. The review would be useful in addressing the link between energy and the Commission's biannual thematic cluster, and voluntary reporting could be enhanced through inputs from relevant international organizations, partnerships, networks.

In conclusion, the opportunities for renewable energy are enormous and virtually untapped, and countries across the world have committed to work together on increasing the global market share of the technologies. BIREC 2005 provided a timely forum to share experiences on renewable energy development, exchange views on policies and approaches, explore financing mechanisms, promote international cooperation, and determine how to monitor and measure success. The beneficiaries of BIREC 2005, however, will be more than those present in the Great Hall of the People on November 7-8, 2005, but will extend to those recipients of clean, modern renewable energy services that now have a better quality of life and livelihood.

Appendix

BEIJING DECLARATION ON
RENEWABLE ENERGY FOR SUSTAINABLE DEVELOPMENT

1. We, Ministers and Government Representatives from 78 countries, having met at the Beijing International Renewable Energy Conference 2005 (BIREC), reaffirm our commitment to implement the outcomes of the Earth Summit, the World Summit on Sustainable Development (WSSD), and the United Nations 2005 Millenium Review Summit, and to substantially increase with a sense of urgency the global share of renewable energy in the total energy supply, as called for in the Johannesburg Plan of Implementation.

2. We welcome the ongoing and future activities and commitments that have arisen from the WSSD, the Bonn International Conference for Renewable Energies, the G-8 Gleneagles Summit, and other international and regional initiatives that help promote renewable energy.

3. We emphasize the multiple benefits of increased energy efficiency and the use of renewable sources of energy for improving access to energy services, thereby contributing to the eradication of poverty as called for in the UN Millenium Development Goals (MDGs), increasing job opportunities, improving air quality and public health, reducing greenhouse gas emissions and combating climate change, enhancing energy security, and offering a new paradigm for international cooperation.

4. We note with concern that more than 2 billion people in developing countries do not have access to modern energy services and 2.4 billion people rely on traditional biomass for their basic energy needs. This energy divide entrenches poverty by limiting access to information, education, economic opportunity, and healthier livelihoods, particularly for women and children, and erodes environmental sustainability at the local, national, and global levels.

5. We also note with concern that recent trends in the world energy market, especially the doubling of oil prices in less than two years, has increased the economic risk of relying primarily on imported energy and a volatile world energy market. By developing local sources of energy such as hydro, wind, solar, geothermal and modern biomass including liquid biofuels, countries can create diversified energy portfolios that are less vulnerable to wide price fluctuations. There is considerable scope, for example, for deploying biofuels in support of rural development and the transport sector.

6. Despite the growing expansion in the development and use of renewable sources of energy in developed countries, the combined share of renewable sources in the global primary energy supply remains small and limited. Most developing countries have not benefited from such expansion. The international community should strengthen its

commitment to the scaling up of renewable energy development and use, especially in developing countries.

7. We agree to take further actions at the national, regional, and international levels to accelerate the market uptake of renewable energy technologies and increase investment in research and development (R&D), especially by developed countries, in order to enhance efficiency and reduce up-front costs. We also agree on the need for strengthened support for the commercialization and transfer of technologies through North-South and South-South cooperation.

8. We recognize that significantly increasing the use of renewable energy faces a number of challenges. Government policies have a significant impact on attracting private sector investment and the pace of expansion of renewable energy as demonstrated in several developed and developing countries. Experience has shown that successful actions for scaling up the use of renewable energy, include: (1) creating supportive policy, legal, and institutional frameworks; (2) securing public sector commitment, including for R&D and procurement policies; (3) leveling the playing field; (4) promoting private sector involvement and a stronger alignment between policy timeframes and timelines for investment; (5) supporting the establishment of national renewable energy industries including small and medium enterprises; and (6) providing access to affordable finance, including micro-finance, and consumer credit mechanisms.

9. We also recognize the need for significant financial resources, both public and private, for investment in renewable energy and energy efficiency, including the use of innovative financing mechanisms, such as loan guarantees and the Clean Development Mechanism (CDM), and market-based instruments that can leverage scarce public funds. We are committed to creating a positive investment climate to attract private capital for renewable energy. We emphasize the catalytic role that financial incentives and higher shares of ODA can play and we urge International Financial Institutions (IFIs), including the World Bank, the Regional Development Banks, and the GEF, as well as individual governments to significantly expand their investments in renewable energy technologies. We also urge IFIs and other actors to design improved instruments and products to ensure effective blending of public and private financing which should help buying down the risks associated with renewable energy technologies.

10. We further emphasize the need for enhanced international cooperation for capacity building in developing countries for: (1) strengthening national policy frameworks and the integration of renewable energy use into national sustainable development strategies for poverty reduction, health, education, and agriculture; (2) enhancing national capacity for R&D and transfer and diffusion of renewable energy technologies; (3) establishing markets for renewable energy; (4) increasing access to finance; (5) enterprise development for sourcing, installing, operating, and maintaining renewable energy systems; and (6) combining the increased use of

renewable energy, energy efficiency, and greater application of cleaner fossil fuel technologies.

11. We recognize the need for making technical assistance for renewable energy widely accessible to developing countries, especially least developing countries. The UN system can and should play a key role in this regard. Its capacity and resources should be strengthened and interagency cooperation should be enhanced in order to avoid fragmentation of effort. We also recognize the importance of disseminating information and knowledge, lessons learned, best practices, and scaling up experiences in the development and application of renewable energy and energy efficiency. Connecting multi-stakeholders through networks as well as other international and regional initiatives should facilitate such exchanges and make information more accessible to developing countries.

12. We note with appreciation the major focus on energy in the upcoming 2006/2007 cycle of the United Nations Commission on Sustainable Development (CSD). We also note that the current global situation, including a growing awareness of energy poverty in developing countries, the risk of climate change and the important role that renewable energy should play in sustainable development and energy security, the increasing number of international initiatives and commitments, and volatility of world energy markets, provides an unprecedented opportunity for addressing the strategic challenge of transforming our energy systems and closing the energy divide between poor and rich, and between developing and developed countries. We invite the Commission to consider an effective arrangement to review and assess progress towards substantially increasing the global share of renewable energy as foreseen in paragraph 20(e) of Johannesburg's Plan of Implementation. This would provide a long-term prospective and encourage prompt action. Such periodic review could offer opportunities for enhanced national, regional, and international cooperation on renewable energy for sustainable development through, for example, exchange of lessons learned and best practice and a more favorable environment for technology transfer and the rapid commercialization of innovative renewable energy technologies. The review could also be useful in addressing the linkages between energy and the commission's biannual thematic cluster, and voluntary reporting could be enhanced through inputs from relevant international organizations and networks.

13. We welcome the participation, and contributions made, at the conference by parliamentarians, local and regional authorities, international institutions, the private sector, international industry associations, NGOs, civil society, women's groups, youth, and academia, and emphasize the importance of their continued role in increasing the development and use of renewable energy.

14. We express our deep appreciation and thanks to the people and Government of the People's Republic of China for successfully organizing this conference and for their generosity and hospitality. We kindly request the Chinese authorities to consider reporting the outcomes and declaration of the Conference to the CSD at its 14th session.

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